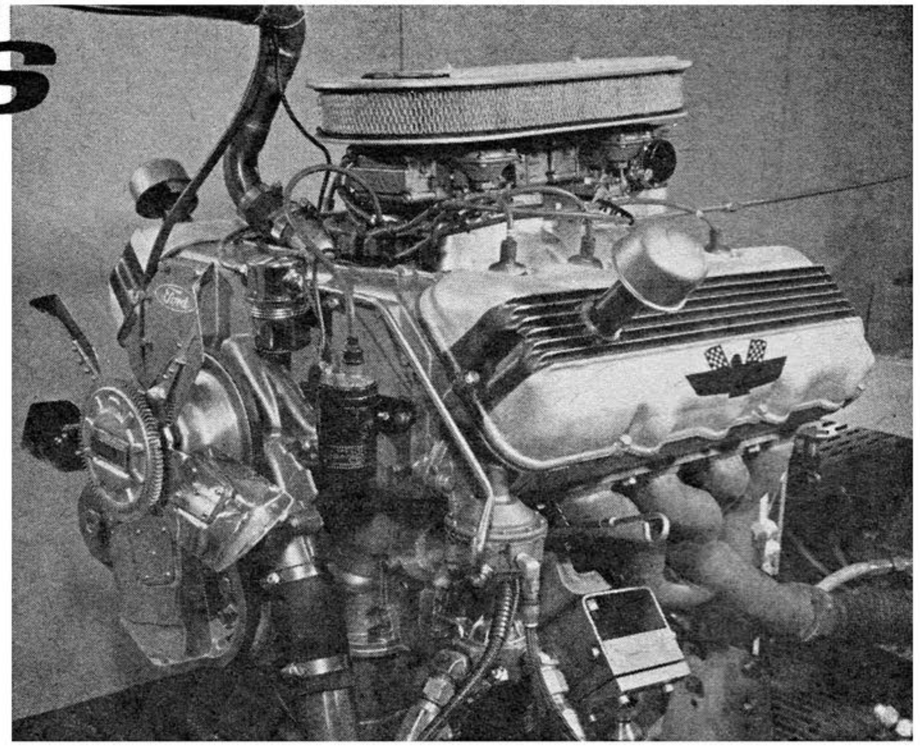
Ford's sohc 427



Look for This Exotic Engine At the Dragstrips!

BY ROGER HUNTINGTON

NOT MANY OF us would have predicted 10 years ago that we would soon be able to order a special overhead-camshaft racing engine in a Detroit production car. But what we're seeing today is not a normal pace of performance development in the Motor City. This is "forced-draft" evolution, pushed by a mushrooming youth market that apparently is highly influenced by performance. The development pace may not always be at this rate in the future, but right now the picture is nearly beyond belief. Ford's new overhead-cam 427 is a broad step that puts the Dearborn firm one jump ahead of the field.

Picture the exciting outlook: A rev potential of at least 9000 rpm; a power potential in the 650-700 bhp range on gasoline with factory equipment and probably at least 1500 bhp in modified form with hot fuels; mid-range torque output well over 500 lb.-ft. for the street; reasonable engine weight of around 700 lb.; and an outright over-the-counter purchase price for the home builder of probably less than $3000. This new engine is bound to change the whole picture in big-inch American high-performance production engines.

Admittedly a lot of plans for the engine are still up in the air as this is written. The original intention, when serious development started a year ago, was to use it primarily to counter Chrysler's new hemispherical-head 426 on the racetracks and dragstrips. It was quite a blow when NASCAR banned these "special racing engines" for the 1965 season as many enthusiasts were afraid Ford would drop the expensive development program. Instead, Ford has channeled its efforts more toward the dragstrip and apparently a secondary result is that it has concentrated even more on adapting the engine for reasonable production volumes, and eventual use on the street. This latter aspect was hardly expected. At best the enthusiasts were looking for perhaps 40—50 hand-built engines for use by a few selected professionals in Factory Experimental dragstrip machines. Now it looks as if the engine will be eligible for the Super/Stock class this season (100 units minimum production), as well as A/FX and probably by summer or fall will be available in a street version for the Fairlane or Galaxie!

More specifically, the new sohc-427 is to be used in a Mustang for the A/FX class, to get the superior weight transfer of a short wheelbase and deep engine set-back. NHRA rules prevent the 427 Mustang in the S/S class (wheelbase too short), but here it could be used in a steel-bodied Fairlane. Though this is uncertain, street versions likely will be confined to the Fairlane or Galaxie package and, of course, these models would also be promising for the upper stock classes at the strip. These are the plans now; things could change, but it seems certain now that Ford's new sohc-427 will be a lot more widely available in 1965 and '66 than most of us thought a few months ago. And, of course, there are bound to be many other applications of the engine in all-out dragsters (at least one under construction right now), boats, Bonneville cars and various track racing cars. We're going to see a lot of this one.

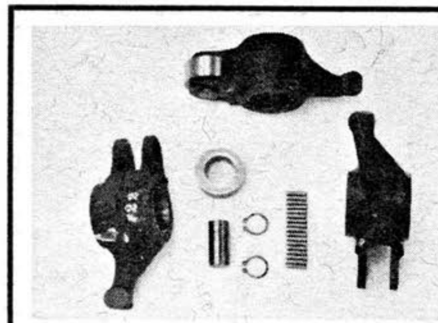
Most impressive is how this new engine has been adapted to existing production components. Normally, new overhead-cam cylinder heads and the camshaft-drive system would require practically a brand new engine, with relatively few components adaptable from the previous wedge-head pushrod design. But Ford product engineers like Norm Faustyn, Joe Eastman, Al Rominsky and their boss, Gus Scussel, have put a lot of thought and effort into this problem.

The 1964 427 cylinder block, crankshaft, rods, bearings and oil pump are used as is. The only difference is that an oil line must be tapped into the back of the block for oil drainage from the heads and a small boss is being cast on all 427 blocks to allow for this. Otherwise, the parts are identical. The new heads mount to the original block stud locations and use former water passage holes. The front housing for the chain drive to the overhead cams is formed by placing a large stamped plate over the front of the block, to act as the back cover for the chain drive, and then bolting a cast-aluminum front cover over this plate. This gives a complete oil-tight chain housing without changing the original block casting. The distributor stays in its original position behind the chain housing. The water pump bolts to the front of the front cover and just requires slightly shorter water passage legs to keep it from sticking too far forward (a minor pattern change; passage bosses are cast inside the front cover casting). The water pump is belt-driven from a crankshaft pulley. The belt sits about 1.5 in. farther ahead than on the pushrod engine, but this is easily taken care of with a special pulley that bolts to the original vibration damper. The alternator is bracketed off to the lower right of the block and the fuel pump bolts to the left side of the front cover and is driven from an eccentric on the left chain idler sprocket.

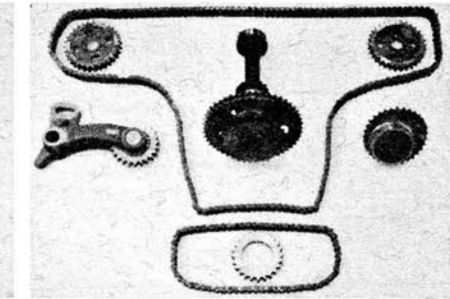
That's about all there is to it. One could conceivably convert a '64 pushrod 427 engine to overhead cams by merely bolting on a few parts and adapting the rear oil return line.

The chain drive to the overhead cams is interesting. The whole job is done by simple two-row roller-type chain, similar to bicycle chain, rather than the more usual inverted tooth "silent-type" chain. It's cheap and apparently completely adequate. A roller chain has rolling bushings over the pins, which serve to reduce the rubbing speed the same as floating bearings in an engine. But chain experts say there is not always a lot to choose between the friction and durability of the two types in certain applications. The Ford application is apparently an easy one. The primary chain drives from a crankshaft sprocket up to the original camshaft axis at the usual 2:1 reduction. This sprocket turns a short dummy camshaft, that spans just two bearings, with a gear to drive the distributor and oil pump. (Solid shells are put in the three rearward cam bearings to seal the oil flow.) Then on the front of this sprocket is another sprocket that drives the 6-ft. long secondary chain that follows a kind of T-shaped routing—up over two idlers and around the cam drive sprockets, then straight across the top. The right idler is adjustable by a self-locking set screw, to adjust chain tension. Whipping is prevented where the chain passes across the top by a 20 in. long steel guide, with nylon rubbing surface. There is another shorter guide below the left idler to give further whip damping. There has never been a minute's trouble with this chain drive. And noise level is unexpectedly low. This was one reason for using the roller chain. It's actually quieter than a "silent" chain. You will hardly know there are overhead camshafts in the car. (Maybe that's bad!)

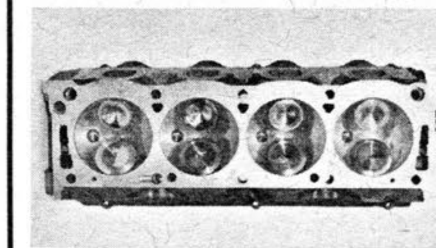
Speaking of chain drive, it might be mentioned that Ford has experimented with overhead-cam drive by Gilmer cogbelts in the last five years. The prototype 390-cu. in. sohc engine that was in existence in late 1963 had this belt drive. The belts proved to be quiet but they didn't have the strength and toughness for extended use in this application. The belt wouldn't break in two, or stretch excessively, but the rubber teeth would break off. Ford engineers didn't want to fuss with it for this new engine. Also, the rubber timing belt doesn't work well when enclosed, particularly where there's oil.



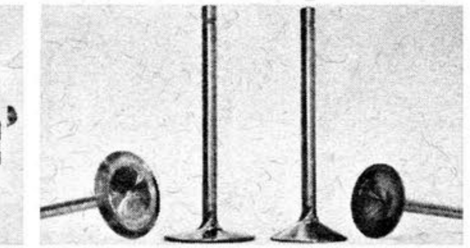
ROCKER ARMS are cast of nodular iron, have roller-bearing cam followers; needles are retained by spring clips.



CHAIN DRIVE must be one of longest ever used. Dummy camshaft spans two bearings in original bore, drives distributor.



COMBUSTION chambers are clean hemispheres for minimum surface area to volume ratio and shortest flame travel.



HOLLOW-stem, lightweight valves weigh only about half as much as regular units. Exhaust valve is sodium filled for cooling.

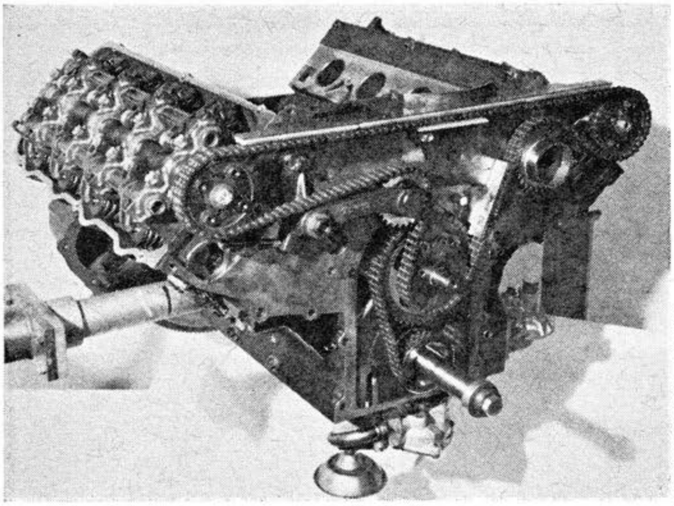
The new cylinder heads have the single-overhead camshafts running right down their center with the valves inclined at an included angle of 80°, operated through rocker arms that pivot on shafts on each side of the head. This gives a beautiful hemispherical combustion chamber, with minimum area/volume ratio, short flame travel and a minimum of shrouding around the edges of the valves. The spark plug is offset lengthwise from the center of the chamber and is reached by inserting a gasketed tube down through the heads (like the Chrysler hemi engines).

The same head casting can be used for either bank by milling off the front cam bearing boss on the left head (which leaves the left cam with five bearings and the right cam with six). This isn't as bad as it sounds. The left cam (and cylinder bank) is further forward, hence the overhang from bearing to sprocket is reasonable. On the other hand, the right side has considerable overhang, hence two bearings are necessary—see photo with right hand cover removed. The rocker arms are nodular iron castings and have steel roller cam followers on needle bearings. (Ford engineers are not sure they really need needle bearings here but they didn't want to take any chances on this crash program.)

Cam gear lubrication is through the camshaft and through the rocker shafts with feed passages to each cam bearing and rocker arm. The camshafts can be indexed by Vernier graduations on the front of the cam and adjacent bearing cap. Valve clearance adjustment is presently being done with selective-fit valve stem caps but they will eventually have adjustable set screws in the rockers.

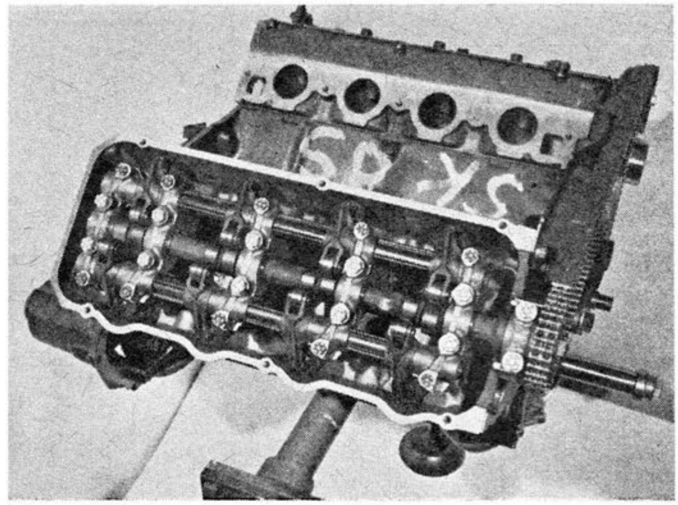
The valve and port specifications on the new sohc engine are really exciting. Intake valves have 2.25 in. head diameter, exhausts 1.9 in. Valves are the same type hollow-stem, flexible-head units that are used with the "7000 rpm" kit for the 427 pushrod engine. These weigh only a fraction of what conventional valves of this size would weigh and Ford engineers feel, with a valve spring tension of 375 lb. at the open position, that this engine should be able to turn to 8500 or 9000 rpm without destructive valve float. The flexible valve heads have a conformability that gives them longer life under severe conditions. The exhaust valves are sodium-filled. The rockers are heavy but the overall package is lighter, simpler and more compact than dual overhead camshafts on each bank.

You can just about stick your arm through the intake ports. Note that these are round, instead of the usual rectangular ports on Ford engines. Engineer Norm Faustyn says the circular cross-section is ideal for any flow passage, because it gives the minimum surface area per square inch of flow area, for minimum skin friction, and ▶



FORD MOTOR CO. PHOTOS

CHAIN DRIVE layout for the sohc Ford 427. Idler on right (on arm) can be adjusted to vary tension. Nylon rub strip across top damps whip.



HEAD AND valve layout: Camshaft runs down center of head and rockers pivot on parallel shafts. Cam bearings have babbitt bushings.

Ford's sohc 427

the entire cross-section can be utilized for flow area. With rectangular ports, the flow mixture will swirl and "wire-draw" into an elliptical pattern, so the entire cross-section can't be utilized for flow anyway. The only reason Ford uses rectangular ports anyway is because of the space taken up by pushrods passing up through the heads. This was the only way the engineers could get a decent flow area around the pushrods. But, the new sohc engine has no problem with pushrods so they went wild with round ports. Current intake ports have a diameter of 2.10 in., for an area of 3.44 sq. in. The '64 427 pushrod engine had 2.44 sq. in. of port area. And, they can go out a lot further with these round ports if they need to!

Breathing and performance characteristics are phenomenal. The air flow per cubic inch of displacement is much higher than with the 427 pushrod engine in even its most sophisticated NASCAR versions. Power development has only just started as this is written and already it exceeds 600 bhp at 7000 rpm with 12:1 compression and a single 4-barrel NASCAR carburetor. Maximum torque runs more than 500 lb.-ft. in the 4000-5000 rpm range—all this handicapped at the top end by sharp intake turns to the four inboard cylinders. Now that NASCAR has banned the ohc engine for the '65 season, Ford engineers are turning to dual-4-barrel carburetion for the dragstrip and substantially higher outputs are anticipated. Incidentally, the engineers will stick to the usual "over-and-under" 180° type manifolding here. Ford has found the more exotic ram and log-type manifolds to be beneficial only in the mid-speed range, and to sometimes actually reduce power at the top end.

We asked Faustyn if they had been able to utilize the higher rev potential of the valve gear to go to hotter valve timings that would push the power peak to a higher rpm. He admitted that they hadn't yet had time to experiment much with the valve lift curve. Current prototype engines are using 0.55-in. valve lift and 328° duration, compared with 0.50-in. lift and 324° for the 427 pushrod engines. This timing, plus the additional breathing efficiency, has put the power peak up about 400 rpm, or from an average of 6800 rpm for the high-riser 427 to about 7200 on the sohc. He said they plan to try 0.600-in. lift and longer duration soon and feel the engine will eventually peak at 7500 rpm or more.

But Faustyn was quick to point out that one of the chief benefits of the overhead-cam configuration was that it permits wind up well beyond the peak of the power curve on dragstrip shifts. The whole idea is to bracket the power peak with the operating rev range. Wild cam timing for a power peak at, say, 7200 rpm might mean a shift at 7400 to keep from floating valves and it might be better to use cooler cam timing to get a bigger torque bulge in the 6000-7000 rpm range, since the engine will be dropping clear back to 5700 rpm on the shift (with the average close-ratio 4-speed). Wild valve timings that put a sharp peak on the power curve are bad business unless the engine can wind well above the peak in the gears. On the other hand, if we can wind to 8500 rpm with overhead cams, we drop back to only 6500 on the shift and then the 7200-rpm peak is bracketed in the rev range.

How high can the new sohc Ford turn? Faustyn was cagey. He admitted they had not had it above 7500 rpm on Ford dynamometers because of fear of breaking something on the dyno in the dyno room (dynos are much more expensive than engines). But he feels there would be no distress in the valve gear at 8500 or 9000 rpm. However, he sees the lower end as a weak spot, now that the valve gear problem has been solved. He can see troubles with rod caps, lubrication, bearings and cranks as flash revs go over 8500 on the dragstrip. He hopes he's wrong, but they'll be keeping a close eye on these areas.

How about the important matter of engine weight? Admittedly, the new sohc 427 is about 100 lb. heavier than last year's pushrod 427. The bare head castings weigh 72 lb. for the sohc, compared with 39 lb., and then there's the extra weight of the chain cam drive, double rocker shafts and brackets and front chain housing. The complete sohc engine, with all accessories but without flywheel or the heavy cast-iron exhaust headers, weighs 697 lb. with single 4-barrel carburetor. The pushrod 427 weighs just under 600 lb. in this trim. This weight will be a disadvantage on the dragstrip, where front-rear weight distribution is just as important as overall weight. However, Ford engineers have designed the heads so they can be later cast in aluminum, which will trim off about 70 lb. Then the engine will be very competitive on weight. (Note that Chrysler has knocked 80 lb. off the hemi 426 engine this year with aluminum heads and magnesium intake manifold.)

So that's the story on Ford's new sohc 427. We think it's going to prove to be the most important "raw material" to hit the hot rod sport since Chrysler's '51-58 Firepower hemi and Chevrolet's 265-cu. in. V-8. This is a milestone engine. ■