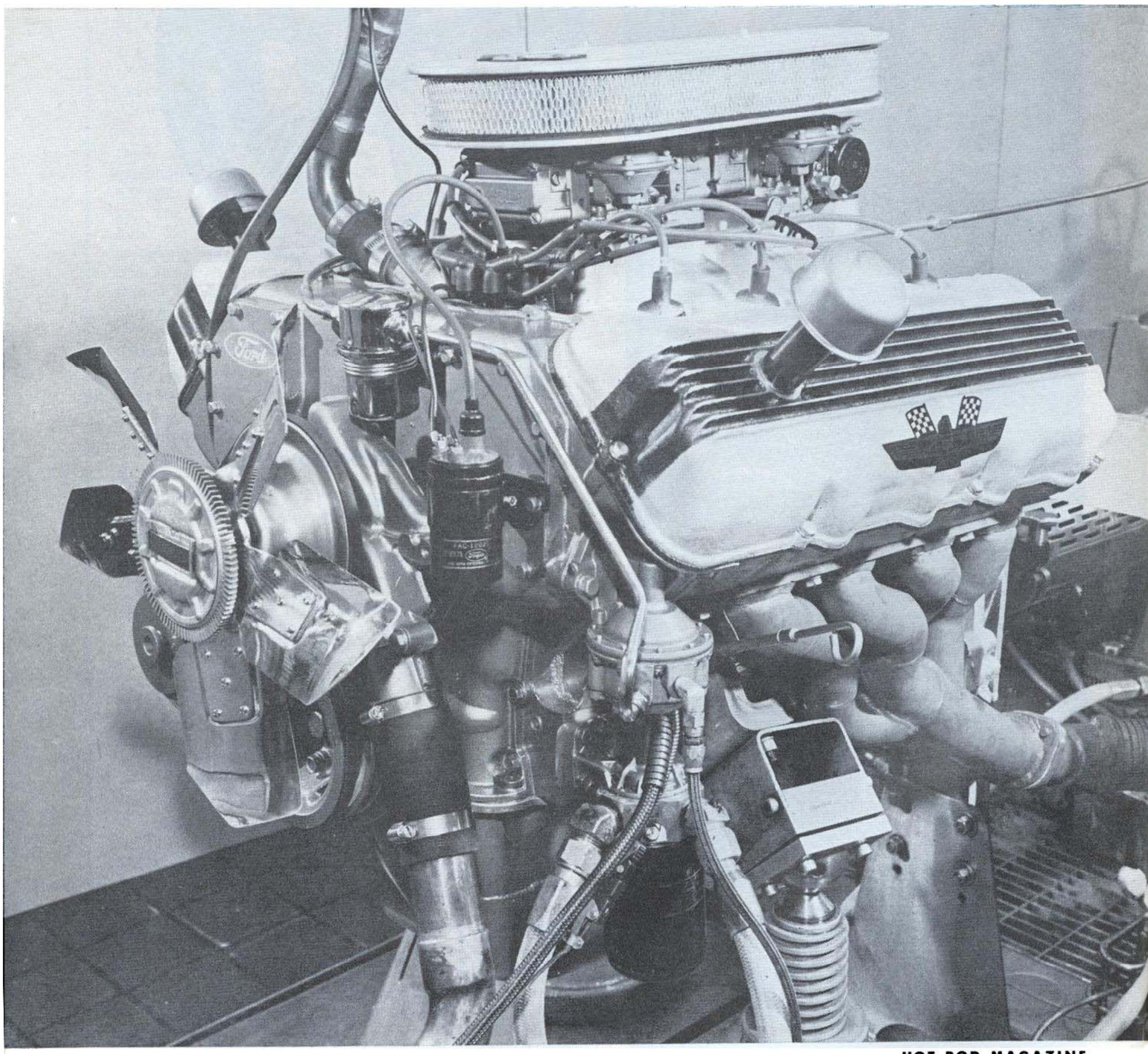
FORD'S 90-DAY



WONDER

Their 600-horse OHC hemi was "programmed" from drawing board to dyno in just three months with the magic of space-age computers **by Eric Dahlquist**

If there's ever been a new engine that attracted widespread notoriety, it's the new 427 hemi overhead-cam V8 designed and developed by Ford as part of their continuing total performance theme. Ever since the first prototype was seen in a '64 Galaxie at Indianapolis last May, the body of conjecture about the new mill has mushroomed all out of reasonable proportions until some souls expect to see it as a production line option in the near future.

Except for a few passing words, HOT ROD has kept mum about the whole project because, frankly, we didn't have the full story. Ford officials preferred that their creation not be too well publicized until it was in finished trim. Anyway, not long ago we received news from the Dearborn Engineering works that the wraps were to be removed for the first time, so we jetted East to record the exclusive full story for HRM readers. The engine was laid to its bare bones and then carefully reassembled, piece by piece, as we watched and raised numerous questions where unfamiliar engineering occurred.

To begin with, the hemi-cammer, like the small 289 type that set Indy on its ear two years ago, is, in essence, a sophisticated extension of an existing design; in this instance the so-called "hi-riser" 427 that blazed a luminous trail across American track events last season. The block is identical to the high-performance pushrod model for '65 save for an oil drain provision in the rear of the casting on each side.

Starting at the heart of things, the forged steel crank is identical to its pushrod brethren, with the exception that extra bob-weights have been supple-

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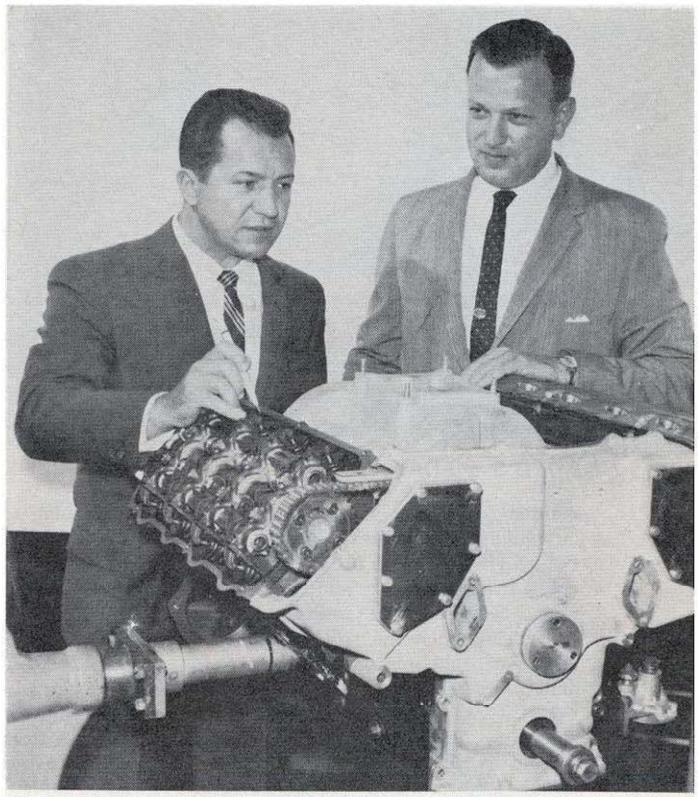
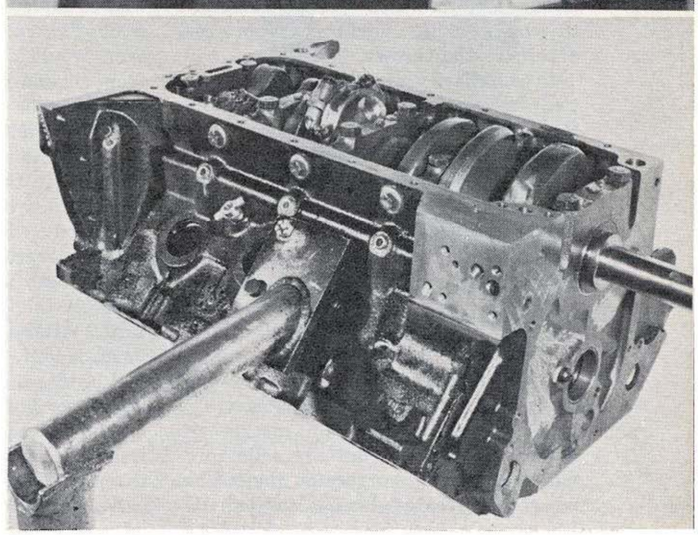
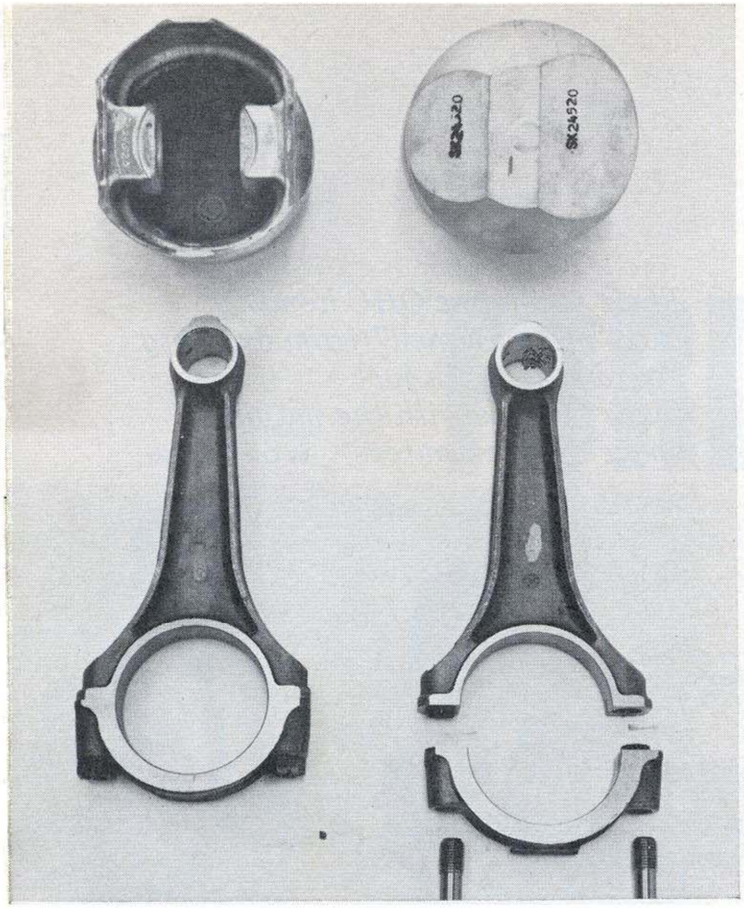


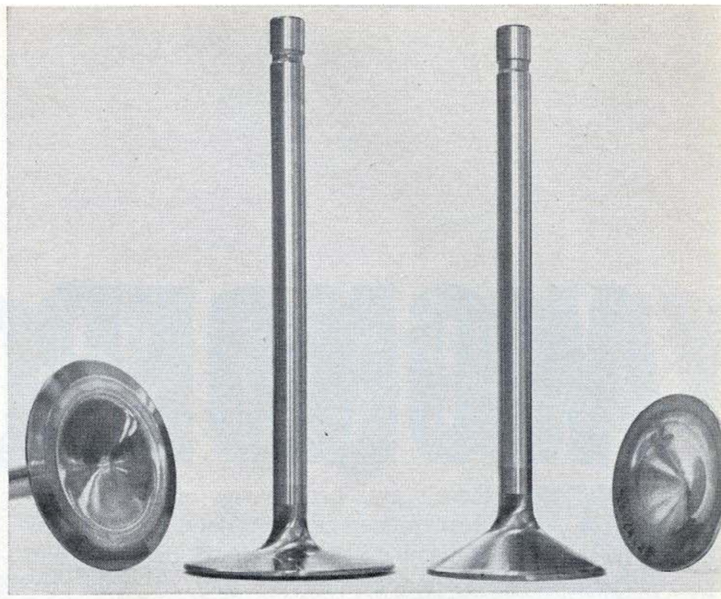


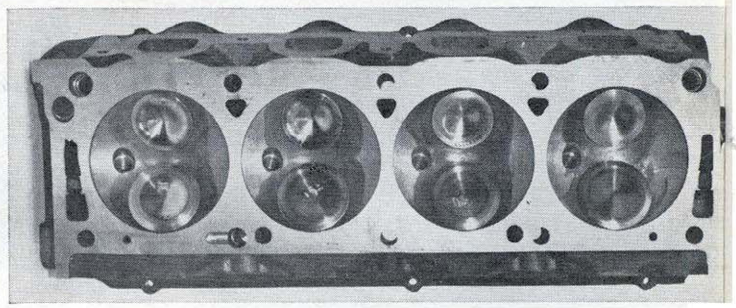
TOP RIGHT – Ford Engineering's Norm Faustyn (left) and Joe Eastman discuss valve characteristics of their OHC hemi creation brought to completion in three months.

RIGHT – Hemi block is identical to '65 pushrod high-performance model with the exception of rear oil drain. Notice that crank fits well into block and mains are cross-bolted.

LEFT – Ready for action, 427 cammer awaits dyno run. Single four-throat model produced horsepower in excess of six hundred. Spark plug accessibility is good in top location.







FORD'S 90-DAY WONDER *continued*

mented for a new piston configuration on which we'll elaborate later. In addition, each journal is fully radiused and cross-drilled to ensure sufficient bearing lubrication for the extreme rpm range in which the engine will operate. Perhaps we could qualify the term cross-drill for some of you who might have been thrown a curve by explaining that it is nothing more than a pair of oil holes, drilled at right angles to the crank throw, which passes lubricant to the bearing surfaces from reservoirs in the throws.

In a majority of cases, normal practice finds the lubrication system designed so that the cam bearings are fed first and then pressure is bled off to the mains and rods. Not so with this hemi. Since the cams are on the heads and, equally important, the bottom end needs all the oil it can get, the initial oil pump pressure is delivered via a single large gallery along the left skirt of the block, directly to the mains from where it passes into the aforementioned throw reservoirs and then onto bearing insert surfaces. The lower halves of the main inserts are not grooved for oil but are solid, providing additional surface on the bottom where the greatest load is carried. Besides this, a close crank inspection will disclose oil holes chamfered in elongated fashion so that oil will gush forth with ease.

We should retrace our steps a few paces here to elaborate on these oil reservoirs in the crank throws. With strokes getting way out there in length these days, it has become imperative that reciprocating weight be reduced as much as possible, so one obvious step was to hollow the crank throws where a lot of extra beef is carried. This, however, would disrupt the passage of oil from the mains to the rods so the open ends of the hole are plugged with snap-ring retained cup plugs, thereby creating reservoirs. Finally, a quantity of liquid in the crank, constantly being circulated, will tend to absorb frictionally produced heat, thus keeping down oil temperature and, correspondingly, engine heat as well. Clever, what?

While the connecting rods are identical to those in the high-performance pushrod 427, pistons are not. Because the heads embody hemispherically designed combustion chambers, an entirely new slug was required for the application that in final form emerged as a three-ring forged aluminum job. Plans called for a hemispherically shaped piston top of course, but some provision had to be made for intake and exhaust valve action, so two flat clearance areas were machined in the crown. These flat spots also function rather uniquely as a means of closing either valve should it float or come loose in some unplanned fashion. In most engines, piston/valve contact is coincident with piston destruction but not here. The valve will continue to move up and down, nudged by the parallel flat spot in the piston.

The main interest point is without question the cylinder head assembly and the single camshaft per side. Inspecting the heads first, one discovers they have fully machined combustion chambers to precisely control compression which could run as high as thirteen and a half to one if desired (present prototypes have 12:1 compression). The valves are set in at an included angle of 48 degrees, so that there is no possibility of interference with each other. The seat angles for the exhausts and intakes are 45 and 30 degrees respectively. All of the seat angles, contours, and widths were determined by extensive testing with an air flow box so there is little chance that they are other than optimum.

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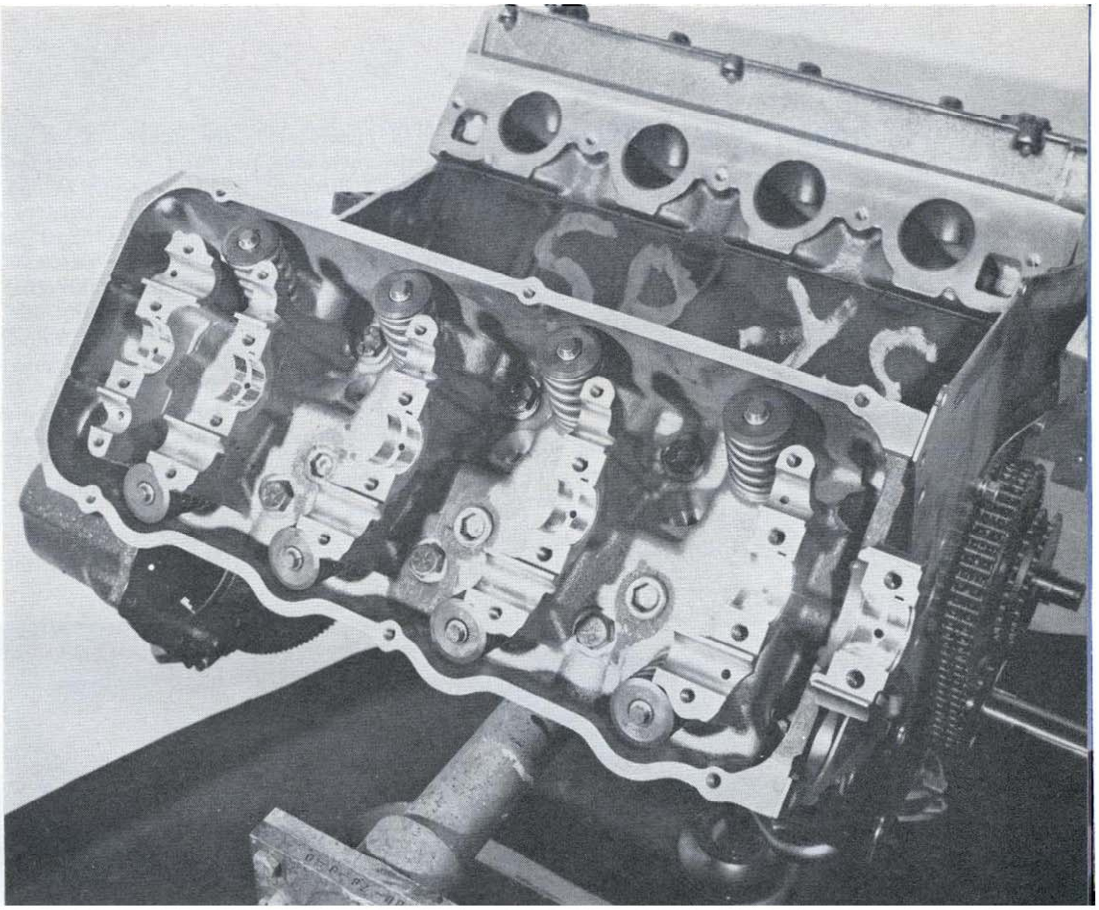
FAR LEFT – Piston/con rod assembly were specially developed for OHC application. Notice alignment sleeves in rod cap and body through which cap screws pass for tightening.

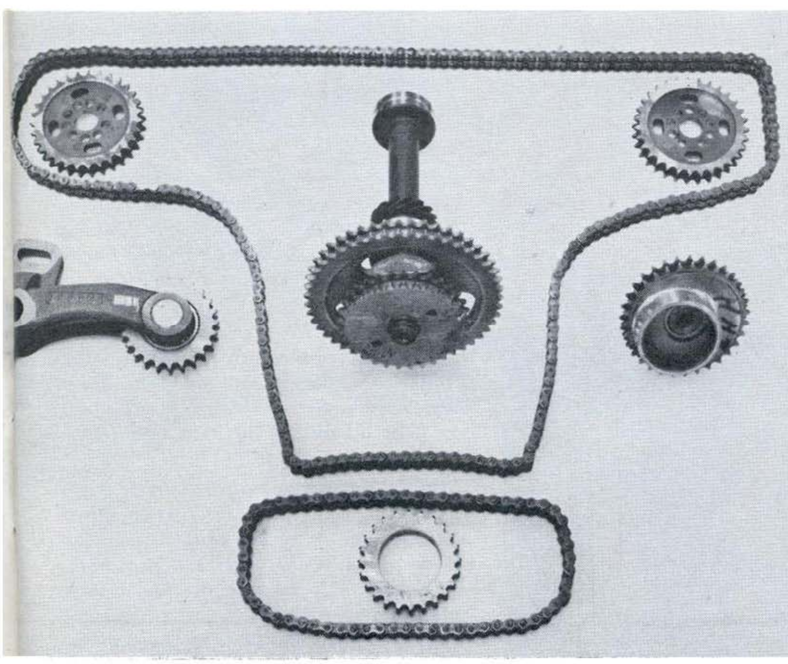
LEFT – Intake (left) and exhaust valves are tuliped, swirl polished for efficiency. Sodium fills hollow exhaust stem for cooling purposes. Weights are 98 and 99 grams respectively. Lightness indicates high rpm.

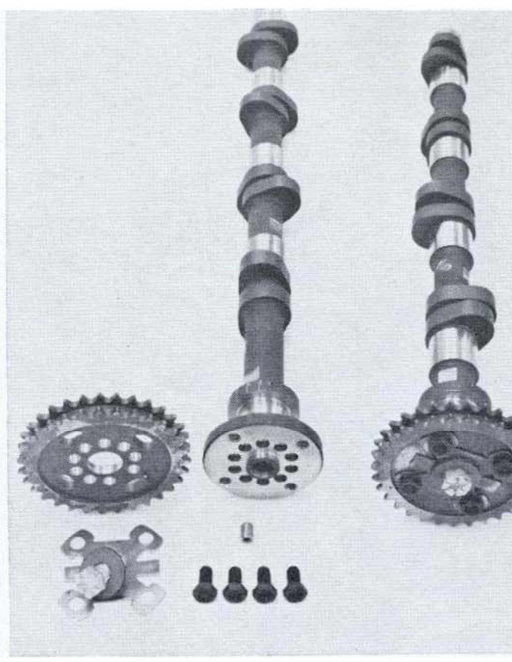
BELOW LEFT – Hemispherical head design lends itself to superior breathing. Intake and exhaust passage shapes were determined by lengthy flow-box testing and evaluation program. Valves narrowly clear.

RIGHT – Overhead camshafts ride in these align-bored yokes. Split-shelled cam bearing inserts are grooved for full-pressure oiling. Valve springs exert eighty pounds pressure closed, three hundred pounds open.

photos by Ford Photographic







ABOVE LEFT – Around and around and up and down we go, following the motion of the OHC chain drive. Shorter chain is primary power source tapped from crankshaft. Stub shaft fits into spot normally held by camshaft, drives oil pump, distributor. Cam speed is ½ crank.

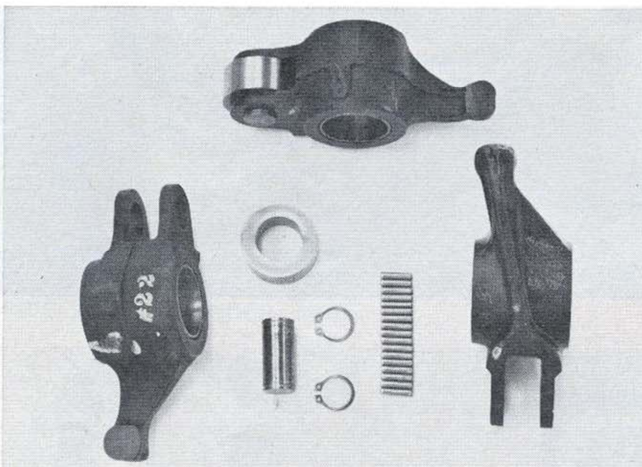
ABOVE RIGHT–Overhead cams actuate valve stems directly. Profile was determined by computer which evaluated reams of related data. Alignment dowel positioning allows various timing settings. Center cap screw, plus 4 others, holds gear, prevents torque on dowel.

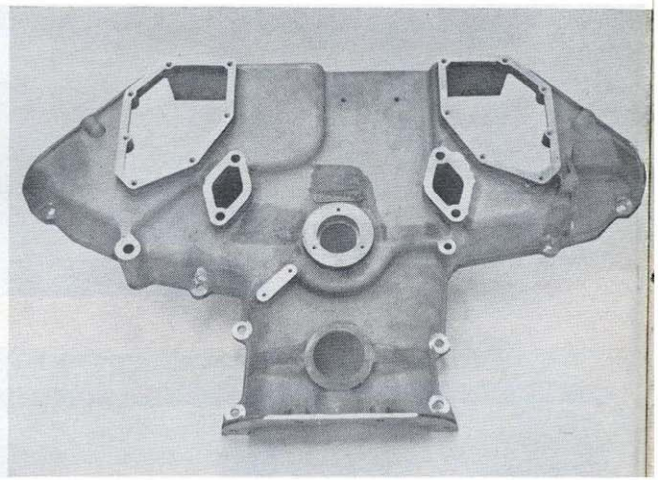
FORD'S 90-DAY WONDER
continued

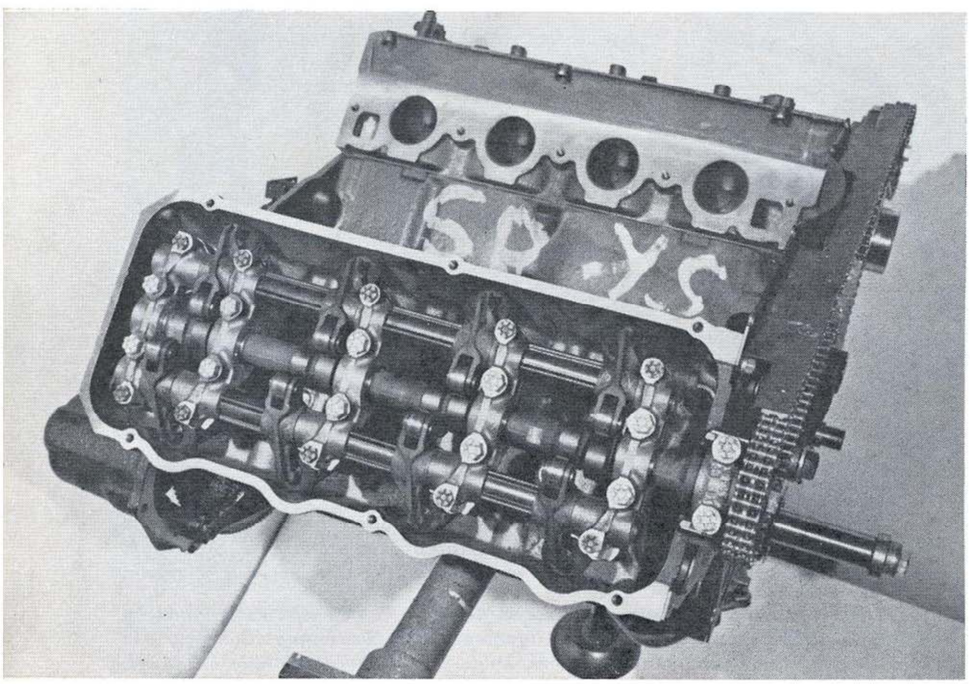
Running a finger inside the intake port from the valve side, not far from the seat, you'll discover a slight depression in the otherwise smoothly curving wall. It appears that early flow experiments showed the air-stream tended to encounter turbulence in this region because of a residual boundary layer of air. Engineers not only overcame the problem by designing in an irregularity but turned it to their advantage because the same boundary layer now aids in directing the air flow into the combustion chamber, increasing efficiency. In the final analysis, port-to-port balance was the desired end for peak performance and they attained it.

On the exhaust end of things one facet immediately catches your attention; the ports are D-shaped at the outflow end. A profusion of patterns was tried to discover one which would exhaust gases most efficiently and this particular design's flat side aids in directing flow out the port better than any other so it received the nod.

Riding high in the saddle above all the previously mentioned equipment is, rightly or wrongly, the focal point of the engine's excitement: single overhead camshafts. The actual camshaft shape was determined by a computer which digested data of desired valve characteristics and then programmed an appropriate profile. One is certainly struck with the exactness of such an idea







ABOVE – Engine front cover was cast from aluminum to cover chain gear. Center machined hole takes bearing which cancels forward torque. Large openings allow access to camshaft gear.

ABOVE LEFT – Rocker arms transfer motion from cam to valves directly. Roller cam follower rides on needle bearings shown. Setup is strong and light to take advantage of OHC principle.

LEFT – In full operational trim, parts impart solid, efficient impression. Steel spacers clip on rocker shafts and keep them apart. Cams are not exchangeable from side to side in this design.

RIGHT – Looking as if it belongs in tough competition, this Ford may rewrite drag record books across the nation, continuing the heritage of its famed Indy predecessor. Although entire future is undetermined at this point, engine's initial test under fire may come at the Winternational drags.

and there's little reason to doubt that this is close to the ultimate answer: tailoring the cam for the application.

The principal advantage of exploiting the OHC system at all is, of course, that much of the lost motion, weight and parts in the normal pushrod valve train is eliminated by doing away with the pushrods and lifters, thus enabling the rocker arms to act directly between the camshaft and the valve stem. Since the rockers are non-adjustable, there immediately comes to mind the problem of valve lash settings. Ford solved this puzzle by the simple expedient of fabricating a series of exchangeable, different thickness caps that fit over the valve stem ends, providing various settings while still allowing the stem to rotate.

The rockers are brass-bushed in the shaft pivot points and feature needle bearing, roller cam followers to ride on sulphate-treated cam lobes. Location of rocker arms in proper alignment was accomplished by spring steel spacers that snap over the rocker shafts and negate the possibility of side scrubbing on an adjoining cam lobe.

The cam and rocker shaft positioning and rocker oiling are extremely critical in this scheme so they are identified for each position and the yokes which hold them are align-bored, causing the parts concerned to be non-interchangeable. Each of the camshafts is fully pressure lubricated to the split shell, grooved inserts. Additionally, rocker arms too receive the pressure treatment through use of hollow rocker shafts.

Degreeing in the cam, a hot rod practice of long standing, is accomplished in clever fashion. The cam driving sprocket is held in place by one centrally located cap screw and four peripheral cap screws that fit through elongated holes in the sprocket. Also, there is a machined alignment dowel. By leaving the cap screws loose, the cam may be rotated to advance or retard timing. Cams can be set to within 1½° crankshaft. When the desired spot is reached, the dowel is slipped into one

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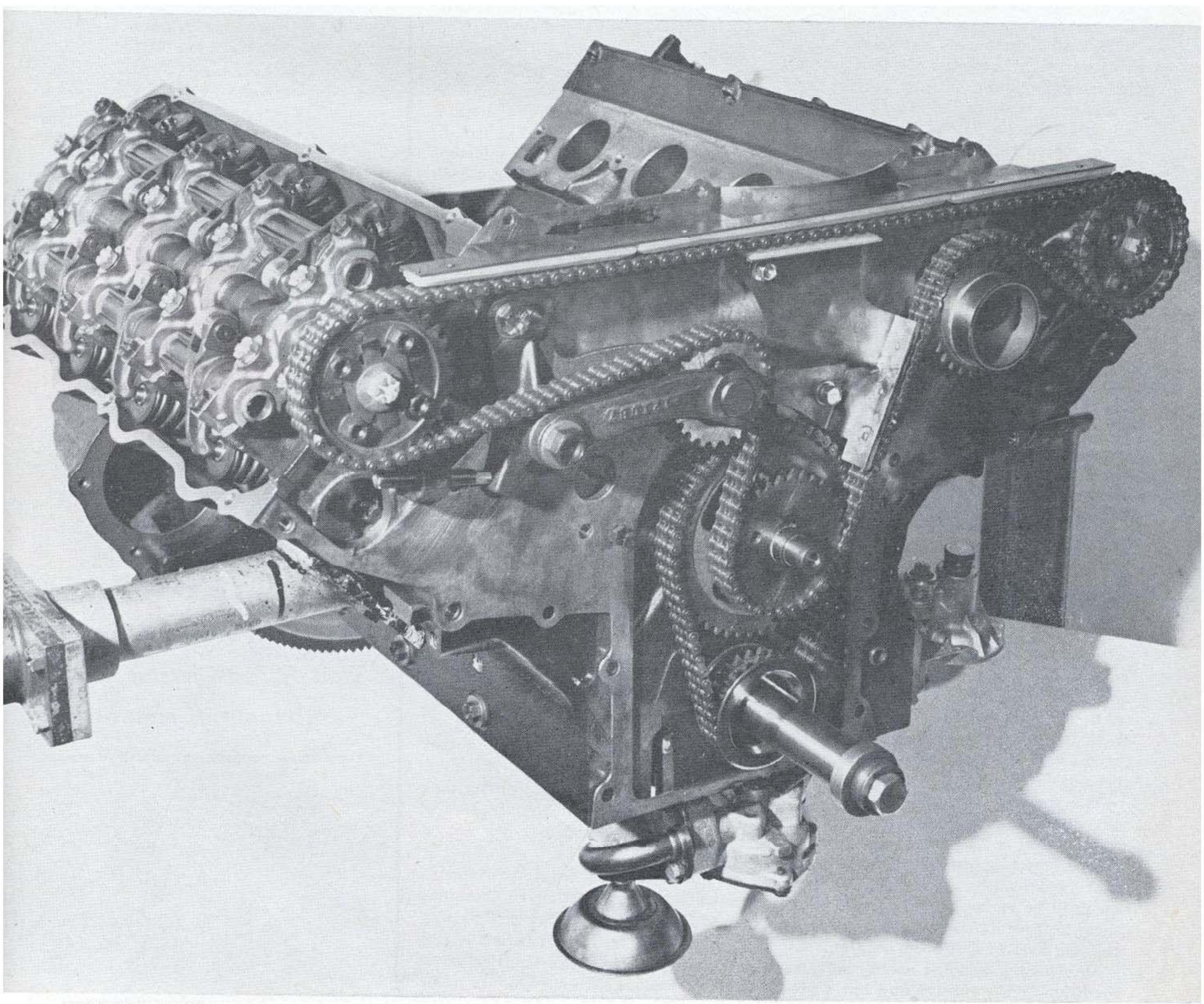

of the holes (out of a total of nine provided) on the sprocket which aligns with a corresponding hole (one of ten) in the cam. Since torque applied to the alignment dowel could tend to distort it and cause timing to be erratic, the five bolts tighten and resist driving torque so that this can't happen. It is a neat system that allows tuning to a fine edge.

The driving force for the camshafts and associated accessories is six feet of double link roller chain that snakes its way around a drive sprocket, two idlers and the two cam sprockets. The primary source of power for the long chain is a smaller one that runs off the crank sprocket and drives a sprocket twice as large fastened to a stub shaft where the camshaft is located in an ordinary 427. This abbreviated "cam blank" not only serves as a means of reduction to halve engine speed but also carries the worm gear to drive the distributor and oil pump. Fuel pump action is supplied by an eccentric shoulder on the left side chain idler. The other idler pivots on a cast arm for tension adjustment.

With an arrangement like this, fore and aft movements of the stub shaft in reaction to torque are naturally undesirable so provisions were incorporated to frustrate it. Rearward tendencies are handled by a shoulder machined on the accessory gear drive while a flat plate which bolts to the chain cover houses a bearing to support the shaft and cancel forward movement.

You would naturally assume the valves in this bear would be something special, and they are. The $2\frac{1}{4}$-inch intakes weigh in at a diminutive 98 grams due to the fact that they are hollow-stemmed. The exhausts, also hollow-stemmed, are $1\frac{61}{64}$-inch diameter and tip the scales at 99 grams. This seeming discrepancy of a smaller valve weighing more than a larger one is due to the exhausts containing an amount of sodium for cooling by thermal convection. The sodium liquifies under heat and advances up the cooler end of the stem where it solidifies and then falls back to repeat the cycle, transferring heat away from the valve head in the process.

The spring story doesn't quite have an ending at the present moment for several dual coil and flat wire internal damper types are still under consideration. Seat loadings, however, are fixed and will be eighty pounds closed while three to three hundred and fifty will get the job done in full open position.

Manifolding rests at about the same condition as the springs now but a proposed drag strip version will certainly have a dual-four setup, the exact design of which will again be determined by flow box testing. Actual carburetors will probably be the Holley four-barrel 780 cubic feet/minute units which can stuff about as much gas down the hole as you'd want.

Now that we have inspected all the salient aspects of the Ford OHC, the time is at hand to ask the impact of the combined components. At this writing a dyno'd 427 operating with a single four-barrel has delivered horsepower readings in excess of six hundred at 7500 rpm, or roughly one and a half hp per cubic inch on gas.

Ignition has never gotten to be a problem at these revs but engineers feel that the border line of efficiency has been attained with the conventional battery-powered distributor presently used on the dyno so an Autolite transistorized ignition will be fitted for future tests to ensure adequate voltage above 7500 rpm.

The final beauty of Ford OHC design is this: should the power peak at 7500 rpm, for example, the engine may be wound a grand more without hanging everything out in the wind. The ramification of this in applied terms is that the drag racer can safely over-rev each shift point so that the engine will always remain on the high end of the power curve during any particular run.

And just imagine what a deep breathing, free revving mill like the Ford could do with a blower fitted and/or fuel. If the thing will deliver six hundred horsepower on gas, it is entirely within the realm of possibility that it should belt out well over the thousand mark with a modest load of nitro. Wow! This isn't what the engine was intended for but then neither were the original Chryslers.

One last question is by this time pulsing everyone's lips: How can one of these jewels be latched on to? Well, that's kind of a moot question now because none are available and are not likely to be immediately because the engine is still very much in the experimental stage. Furthermore, with racing rules fluctuating as greatly as they have in the past few months, the factory is at a loss to keep pace and this further retards positive action. With luck several may see the light of competition as A/FX'ers at the Winternationals in February, but after that everything is still up in the air. In any case your local Ford dealer will not be stocking them.

It would be one of automotivedom's greatest ironies if the engine that caused the greatest excitement in many a moon should be retired before it had an opportunity to prove itself in front of the nation. We'll see. ■■