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Y-BLOCK REVISITED

Ford's earliest overhead is massaged to make mega-power

Words and photography by Vic Moore

Ford Motor Company may have done more to foster American hot rodding during the infancy of that movement than any other manufacturer. Though the practice of "hopping up" cars for increased performance started long before Ford's original V-8 existed, once the '32 models debuted with the now-famous "flathead," the automotive landscape was forever changed.

However, in spite of the flathead's popularity and the affinity most enthusiasts had for Henry's products going into the 1950s, they were not as quick to take to Ford's flathead replacement, the overhead-valve "Y-block" that was introduced for 1954. While gearheads were looking skeptically at the new engine's "monkey-motion" pushrod valvetrain, Chevrolet rolled out its new V-8, and soon managed to steal much of the thunder from Dearborn's efforts.

The Y-block would continue into the 1960s, though its finest hour may have been 1957's Thunderbird Special offerings, with a 312-cu.in. version of the engine offered with a single four-barrel, another with two four-barrels and yet another with a centrifugal supercharger. Ford's FE-series big-block engines were on the horizon, and the small-block would follow a few years later, both of which conspired to draw attention away from the Y-block, both on showroom floors and in Ford's engineering halls. The engine maintains legions of devotees to this day, but in the world of high-performance engines, the Y-block has been largely overlooked.

Which is what made it so astounding when noted racing engine builder Jon Kaase ultimately managed to produce over 700 hp with a Y-block engine last year. The project was initially spurred by an annual engine building competition, The Engine Masters Challenge (EMC), which in 2015 offered a class for "obsolete" engines. Kaase, a Ford specialist who has built championship-winning IHRA Pro Stock engines for a lengthy list of clients and recreated the Boss 429, saw the Y-block as an intriguing challenge for the competition.

The results he achieved are as impressive as the lengths he went to fortify Ford's Y-block in order to enhance its output so substantially, so when one of his collaborators offered us an inside peak at the build process, we took the bait.

The following details the components used, modifications made and processes employed to create this one-off beast, which did manage to take the win in the Vintage class of the dyno-test competition.

Follow along as Jon Kaase readies a Y-block to garner some long due respect.

WORLD'S MOST POWERFUL Y-BLOCK

"To the best of my knowledge," said Jon Kaase, "prior to last year's Engine Masters Challenge, the most powerful naturally aspirated Ford Y-block engine produced around 600 hp." This enduring feat, however, was substantially exceeded on January 17, 2016, when Kaase's efforts raised the peak power record to 709 hp @ 6,300 RPM and 748-lb.ft. of torque at 5,400 RPM.

That actually occured after the EMC competition was over, when Kaase removed the Vintage class-compliant camshaft from his 400-cu.in. Y-block and substituted a drag racing alternative to see what more the engine could produce without the restrictions imposed by the competition rules. The specifications of the replacement camshaft are 269 degrees duration (intake) and 279 (exhaust). The lobe center separation angle is 106 degrees with 0.700-inch valve lift.

In the future, Kaase plans to replace the current tunnel-ram

Jon Kaase's EMC-winning Y-block
DECK HEIGHT: 9.78 inches
BORE: 3.876 inches
STROKE: 4.250 inches
DISPLACEMENT: 400 cubic inches
COMPRESSION RATIO: 13.7:1
In EMC specification it produces 620 hp @ 5,800 RPM and 625lb-ft of torque @ 4,800 RPM

In the spring of 2015, Kaase purchased a Ford Y-block, rocker covers and several other components from an online auction. The engine block, which served in Ford passenger cars from 1954 to 1962, cost him $175.

The term "Y-block" means the lower regions of the block structure don't end at the crankshaft centerline, but instead extend further downward, their deep skirts introducing strong bulkheads or webs that support the main bearings. In the second half of the twentieth century, Y-block configurations were popular with several car companies; today the Chevrolet LS-series V-8 engine is a prominent example.

The cam retaining plate of the original Y-block was made from cast-iron, but Kaase planned to use two different camshafts. One cam would be produced from tool steel for use with roller tappets during the EMC competition. The other was made from a traditional chilled iron core to be used in a more personal challenge: setting a record for Y-block peak power. Though the cast-iron cam would have worked with the original retaining plate, the tool steel cam would not. So an alternative brass plate was made to accommodate both.

Because the finished crankshaft hadn't yet arrived, a hand-made one-cylinder crank section was constructed for mock-up purposes. By machining it to accept a timing wheel, piston-to-valve clearance could be established. Equally important, as the engine would take advantage of a longer stroke, the short crank section would demonstrate by how much the connecting rods would impinge upon the camshaft. To alleviate cam-to-rod clearance concerns, a camshaft with a smaller lobe and a smaller base circle was selected. Luckily, these properties wouldn't be too detrimental because of the relatively low rev range dictated by the rules.

induction system with a shorter intake accompanied by one four-barrel carburetor—a more suitable arrangement for street use. Again, he'll be aiming for a peak power output of around 700 hp.

KAASE'S EMC-WINNING Y-BLOCK

Apart from some cylinder head work performed earlier, Kaase spent three weeks last September preparing what turned out to be the winning Vintage class entry of the 2015 EMC competition. Of the five competing classes, the Vintage class was by far the most liberated, its rulebook almost unfettered.

The EMC competition is held each October at the University of Northwestern Ohio in Lima to determine the highest average power output of an engine.

Measured over a specified rev range—in this case 3,000 to 6,000 RPM—the output is calculated by adding the highest horsepower and torque values.

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Still, Kaase was limited to 0.345-inch lobe lift. To do otherwise would have meant grinding more material from the connecting rods and thereby weakening them further. Consequently, he decided to make up the valve lift deficit by increasing the rocker ratio to 2.0:1.

The concern here was that by increasing the rocker ratio, pressure on the tappet also increased. For example, if the valve spring has 350 pounds open pressure, then the pressure on the cam lobe will be 700 pounds. So the more rocker ratio applied, the more hazardous the effect on the camshaft and tappets.

Although EMC rules permitted a roller cam, there was insufficient metal in the block to accommodate them. Even with a roller cam, the lobes would still collide with the connecting rods.

"I knew I'd have to remove materials from the connecting rods and bolts, which would weaken them. Therefore, I needed very high quality rods and bolts. I used Carrillo, which has been the Gold Standard for connecting rods for so long—30 to 40 years, probably. Also, they supply high-quality bolts to go with them; they're premium materials."

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To obtain the longest possible stroke length—in an effort to gain maximum torque in the lower RPM range—Bryant Racing Crankshafts made a custom billet crank with the same properties and finish as applied to its Pro Stock items. Because no blueprint of the Y-block crank was available, Kaase bought a used crankshaft for a 292 Y-block online and sent it to Bryant for modeling.

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The reason for creating a main cap girdle and longer main bearing caps was to increase the strength of the lower regions of the crankcase to protect the expensive crankshaft and connecting rods. "I probably could have succeeded without introducing a mains girdle and new main caps, but I had purchased a very expensive crank and rods ($4,000 to $5,000), and I wanted to ensure their safety as much as I could, particularly against the severe downward forces that could strain the caps. By extending the caps flush with the lower crankcase mounting flange, I could fully integrate them with the crankcase."

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Cleverly, the main cap girdle was produced from one-inch-thick 1045 steel, and the main bearing caps were created by claiming and machining the sections of steel cut out to form each of its five windows—a process known as nesting. A series of long, 1/2-inch head studs from another engine, probably a Ford Cleveland V-8, and 20 perimeter bolts were used to unify the crankcase, mains caps and girdle. The medium tensile carbon steel known as 1045 is typically used in the construction of mains caps.

Attached to the lower surface of the steel girdle by a series of 1/4-inch bolts was a Chrysler Hemi Funny Car oil pan. The Chrysler oil pan uses a rear pick-up, so all that was necessary to connect the stock replacement external Y-block oil pump (from Melling) was to link the pickup in the sump to the pump with a pickup tube.

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Two sets of cylinder heads were acquired. One set of original heads was purchased in an online auction. These were sacrificed in a quest to ascertain the layout of the water jackets. "I'd never known an engine with upper and lower intake ports," says Kaase.

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The other set of heads was purchased from Y-block specialist John Mummert (www.ford-Y-block.com). These were raw unmachined castings. Because Y-block heads feature more turns and, therefore, are more difficult to port, Kaase decided to convert the Mummert head castings to conventional intake ports. "A shining flashlight at the port entry barely penetrates the other end of the Y-block heads," he notes.

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Kaase not only modified the combustion chamber as suggested by the faint weld line still visible on the finished result shown here, but also changed the depth of the chamber and moved the valve locations. Valves were made from blanks obtained from Ferrera. "The stems are already finished, and I introduced valve lock grooves and machined the valve heads to the finished sizes: 2.08 and 1.54 inches."

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Combustion chamber alterations at earlier stage: "The original intake valves were operating too close to the cylinder walls in two places. First, they were close to the cylinder walls as they traveled up and down. Second, because of the valve's angle, the further it opened, the closer it moved toward the outer wall of the cylinder." Consequently, the valves and spark plug and many combustion chamber "landmarks" were relocated toward the intake manifold. The purpose of the half holes (for valve seats) is the signal to stop welding. Next, a blueprint was made, which would ensure the remaining valves would be situated similarly.

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Kaase knew approximately where the valves would be located, so he installed a head in a Bridgeport machine and cut the seat registers and drilled tentative valve guide holes. The angle of the spark plug wouldn't change significantly, but its final location would be positioned much deeper in the head.

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Notice how the depth of the cylinder head has been increased by approximately 1/4 inch at the rocker cover mating surface. Also, observe the sea of aluminum weld metal, which will provide sufficient material to raise the entry of the intake ports and introduce adequate substance to accommodate machining of the port roofs.

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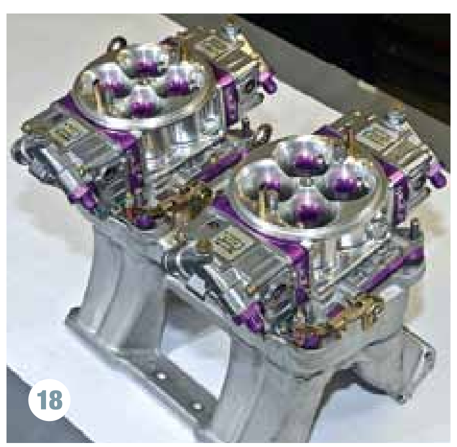
A dividing wall of a new Siamese port is cut, inserted and welded in place.

A competent rocker stand was created from 1018, a mild to low carbon steel. Among its requirements are correct positioning, particularly the height of the rockers. It's critical that the rocker's nose wheel operates near the center of the valve stem during its arc of travel.

To gain optimum induction flow, a high-rise manifold was acquired. The Edelbrock 7110 Street Tunnel Ram for a small-block Chevrolet (SBC) was selected. But because the deck height (that is the dimension from the crankshaft center line to the upper deck surfaces) of the Chevrolet differed by approximately 0.780-inch and, in addition, the induction port roofs in the cylinder heads were raised, substantial aluminum spacers were required. Phenolic spacers were also made and placed between the intake manifold and the aluminum spacers to shield the intake from heat. "It's an insulator—if the manifold is exposed to heat, the engine will lose around 10 hp." (Y-block deck height 9.78 inches; SBC is around 9 inches.)



The carburetor company CFM is owned by Dale Cubic, whose main carburetor bodies are constructed of billet aluminum. Cubic supplied Kaase's carburetors, whose chief concern was that they draw sufficient fuel at low engine speeds. "I didn't want it to go lean at 3,000 RPM."

At low RPM, air speed through the carburetor is minimal and as a result, fuel is also limited. This condition is further exacerbated when there are two carburetors.

But Cubic rose to the challenge by concentrating on the metering blocks. He also developed king-size annual boosters that were sensitive to the most diminutive vacuum signal. Though Kaase had them prepared specifically for the contest, how odd it was when he tried them on his big-block test engine where they recorded 900 hp—performance similar to his customary and much larger Dominators.

For the Engine Masters Challenge, a steel camshaft (left) was employed. After the contest, a cast-iron camshaft was substituted to test the engine for peak power. Both camshafts used tool steel tappets with DLC ("diamond-like carbon") coating being applied to those operating with the steel cam.

Compared to the original Y-block tappets, Kaase's variants are longer and thicker, and possess an oiling circuit within. Furthermore, the original Y-block tappets had no direct supply of oil. So Kaase introduced an oiling hole about half-way up the middle of the tappet shank. When the cam is on base circle and the tappet is all the way to the bottom of its travel, the groove within the tappet bore aligns with the tappet oiling hole.

For competition purposes, the oil couldn't drain efficiently from the front and rear of the valley to adequately lubricate the camshaft. The only method of camshaft lubrication was by oil splash from the connecting rods. But at lower RPM, oil splash from the rods was insufficient. So a series of small-bore holes was inserted. Above them, in the valley, a dam was created at each end—around the distributor location at the rear and another at the front. This resulted in "a reservoir of oil about one-inch deep. It held a quart or two of oil and lubricated the camshaft," explains Kaase.

"My preference would have been to enclose the bottom of the camshaft area and run the cam submerged in oil, which I've done before in big-block engines. But because we introduced the long-throw crank, the camshaft operated so close to the rods that there was insufficient space."

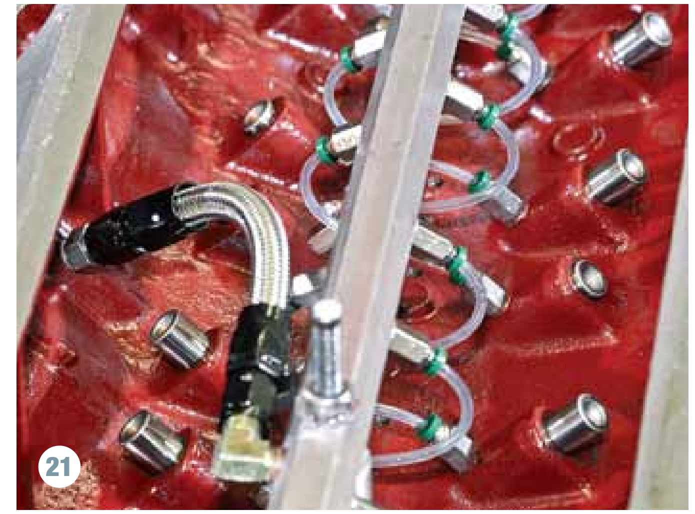
SOURCES:

Jon Kaase Racing Engines
www.jonkaaseracingengines.com
770-307-0241

Innovators West Inc.
www.innovatorswest.com
785-825-6166

Rollmaster Performance Products
www.rollmasterusa.com

MSD Ignition
www.msdperformance.com
888-258-3835

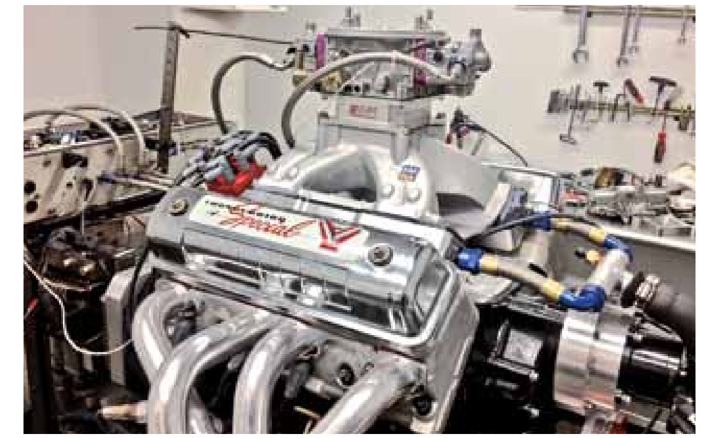


Originally, the Y-block lubricated the rockers by transferring oil up to the cylinder head and through the one-piece rocker shaft. But the system used on this EMC engine was altered: Oil was diverted to the tappets, which were equipped with an internal oiling system that moved the lubricating oil northward to the rockers via the tubular core of each pushrod.

Initially, to supply oil to the tappets, the main oil gallery that routes upward was plugged at the deck surface by drilling, tapping and inserting a setscrew. Then, in the valley, a hole was drilled to intersect the oil gallery. Down the middle of the valley, a piece of hexagonal aluminum bar stock was mounted. Its flat sides made for easy mounting; they were also ideal for attaching the fittings complete with their oil transfer tubes. Inside the hex bar, a 3/8-inch oil gallery was created by drilling from both ends; a braided hose with an A/N fitting at either end transferred the oil from the main gallery to the hexagon rail. Where the braided hose attaches to the block, a small restrictor measuring 0.040-inch was inserted.

Tappet lubrication was further enhanced when Kaase hand-ground a small circular groove where the oil enters the tappet bore. "Normally I'd have ground an oiling groove on the tappet shank, but they were so small I was concerned they might break—so I put the oiling groove in the tappet bore."

The water pump was formerly used on Kaase's 2013-EMC-winning Ford Modular V-8 engine. He simply machined a round alloy component and adapted it for use on the Y-block. The primitive-looking pipe fitting is to accommodate the water supply used by the university where the contest takes place.



In a more street-friendly configuration running a shorter intake and single four-barrel, Kaase still managed to reach 700 hp.