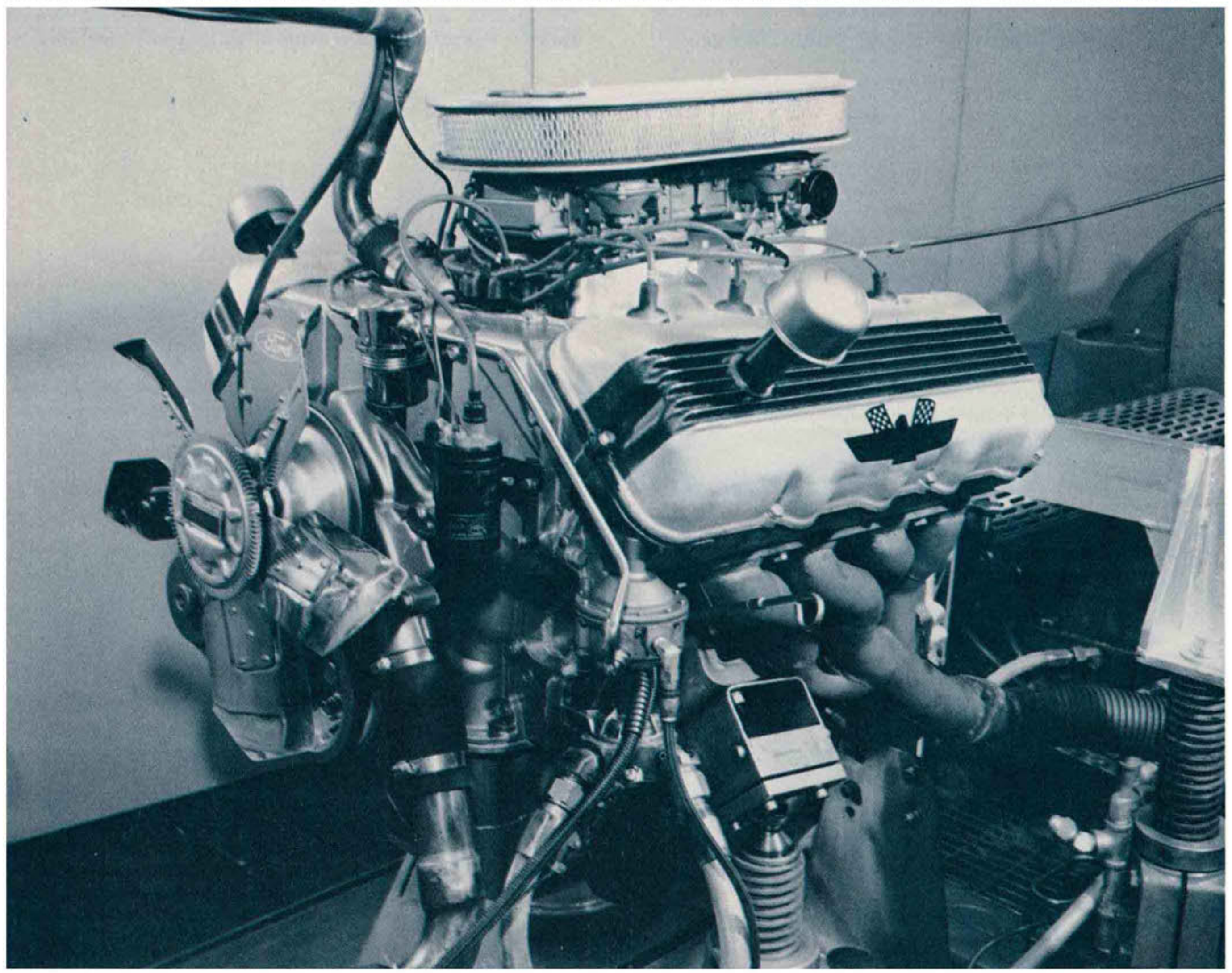
Ford's '66 OHC hemi drag mill develops
615 HP...STOCK! part one

By Perry Haskell

The SOHC engine's valve train is driven by a pair of dual strand chains. The short chain drives an accessory shaft at 5,400 fpm @ 7,200 rpm while the second, longer chain is drive at half speed by the shaft to operate the cam on each head.



EARLY IN 1962, the Ford 390 cubic inch passenger car engine was modified for use as the first of a series of high performance engines. This same basic engine was enlarged by boring to 406 cubic inches later in the year, and to 427 cubic inches in 1963. Refinements in the induction system led to the release of the "High Riser" package. The latest major modification, referred to as the "7,000 rpm Kit," consisted of a valve train change.

All of these refinements have been made to a basic passenger car engine with a conventional pushrod type valve train and wedge shaped combustion chamber.

The continuing demands for performance improvements led to another engine project. Dual overhead camshafts were added to the 255 cubic inch 1964 Indianapolis engine, which was a modification of the Company's 221-260-289 cubic inch engine.

Since FoMoCo engineers had developed and proven these two competion engine concepts — the 427 pushrod engine with greater performance and durability and the overhead camshaft arrangement for Indianapolis — the natural evolution was to combine these features into one engine.

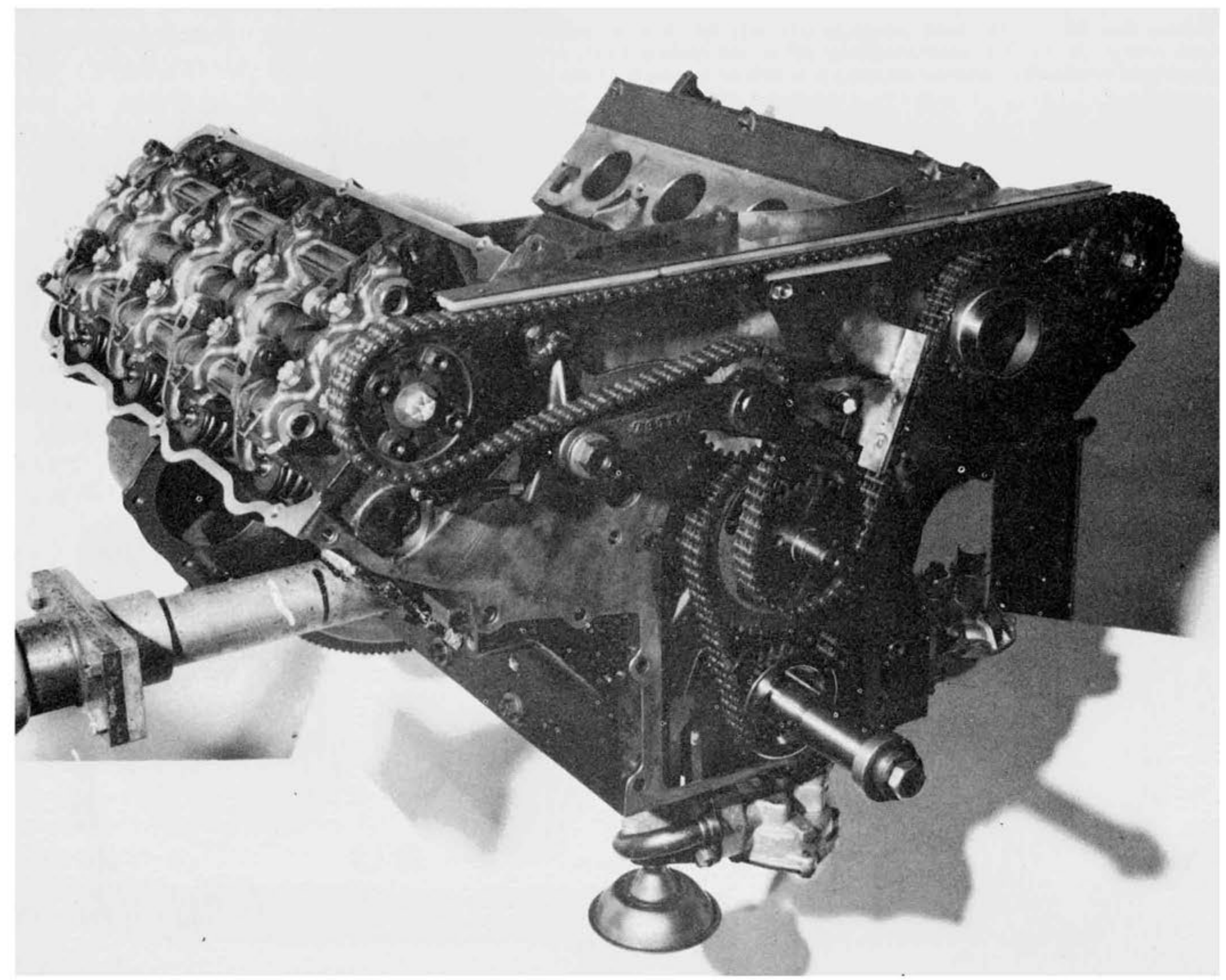
Early in 1964 the decision was made to launch the single overhead cam engine program.

Although NASCAR has ruled FoMoCo's '66 NASCAR racing package, the SOHC 427 hemi in a Galaxie, off its tracks because the engine doesn't meet the organization's under-1,000 dollar cost and mass production requirements, the eight-barrel version of this beast is presently eligible for NHRA and AHRA competition this '66 season. Let's take a close nut-and-bolt look at the engine and its development.

DESIGN OBJECTIVES

By designing a conversion type overhead camshaft package around the basic production 427 engine, Ford hoped to utilize proven hardware wherever possible to reduce cost, development time, and tooling time. With this broad objective in mind the following design parameters were established:

1. Utilize the production 427 cylinder block and tooling in its entirety.
2. Design single overhead camshafts with two rocker shafts per bank. Analytical studies indicated that projected rpm and performance could be obtained with two valves per cylinder, thus avoiding the



Ford's '66 Drag Mill

design complexity of dual overhead camshafts.

3. Employ roller follower type rocker arms to eliminate
4. Develop a lightweight inexpensive chain and sprocket type of valve train drive mechanism.
5. Incorporate the hemispherical type combustion chamber to afford optimum valve size and arrangement. It would also provide the most efficient combustion process and port design.
6. Cast the cylinder head in iron as a matter of expediency.
7. Design a simple and flexible induction system for gasoline that could later be adapted to multiple carburetion, supercharging, fuel injection, exotic fuels, etc.

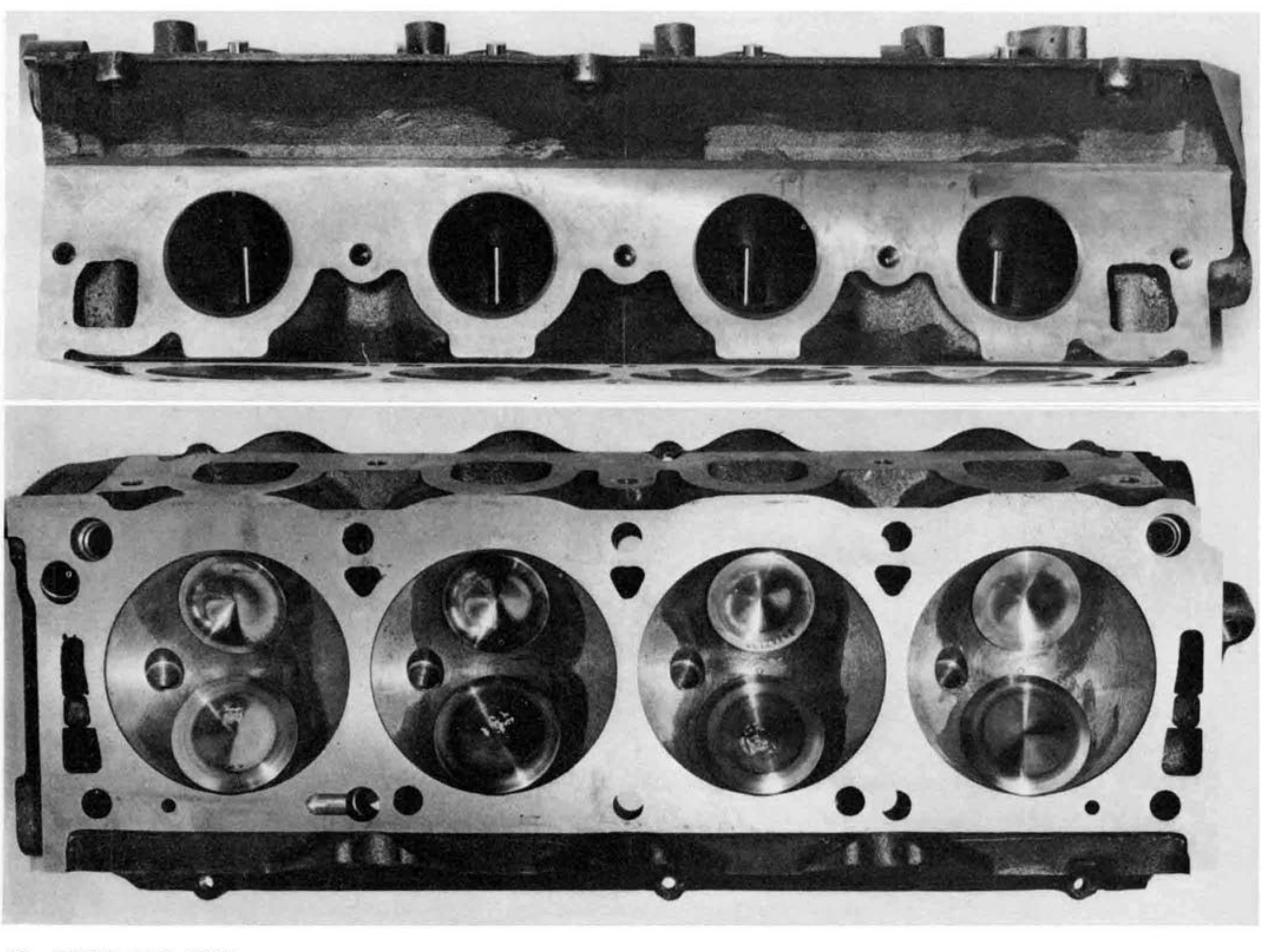
Ford engine engineers were certain that the accomplishment of these objectives would provide an economical conversion package with the desired increase in rpm and improved air flow not available in the pushrod engine.

RETAINED FEATURES

Only slight deviations were made from the original objective of utilizing the pushrod engine cylinder block design in its entirety. The accessory driveshaft is installed in the old camshaft position but only the #1 and #2 camshaft bearings are used. Steel bushings replace the three rear camshaft bearings to seal off the lubrication system and provide an oil passage to the overhead valve train. A cast boss and drilled passage through the water jacket at the rear of the block on each bank provided a return for the oil from the rear of the cylinder heads to the crankcase.

THE remainder of the cylinder block is common to both engines. A nominal-cylinder bore of 4.2346 inches is located on 4.630 inch centers. To obtain a minimum of .122″ sand opening between upper sections of bores, the bore walls

Coolant flow through the head moves mainly over the chamber roofs and around seats and guides for maximum scrubbing action and cooling effect. As finally redesigned, the combustion chamber locates the valves on a common chamber centerline.



were reduced to .090" locally on the longitudinal centerline. This was done by "clover-leafing" the bore walls on the water jacket side and shifting the water jacket core parting line to the lower end of the bore so that the minimum wall section was placed below the ring travel area. The original four-bolt pattern for attaching the cylinder head was retained and a new head gasket design was employed to seal the high gas pressures.

As engine rpm increased, the horizontal vectors of the inertia load forces could not be entirely contained by the two vertical main bearing cap bolts. Strain gauge and photostress analyses demonstrated that our deep skirt block would be an excellent means for tying in two horizontal main bearing cap bolts through the skirt into the cap to resist the horizontal load vectors by loading the cap in tension. This was done on the highly-loaded intermediate caps only. With the inertia load stresses being transferred from the bulkheads to the main bearing caps, we increased the tensile strength of the cap by switching from gray iron to nodular iron.

The engine originally contained a cast nodular iron crankshaft. A forged steel shaft which provides a greater safety factor at high engine output and rpm is now used interchangeably in the pushrod and overhead cam engines.

Main bearings are of the steel-backed overplated copper-lead lining construction. The #3 main bearing takes the crankshaft thrust loads.

A rope-type rear oil seal rides on a knurled journal behind an oil slinger machined integrally in the crankshaft, adjacent to the rear main bearing journal.

All of the bobweighting is counterbalanced within the crankshaft counter weights. External counterbalancing has been avoided because of the excessive loading it would impose on the front and rear main bearings.

SINCE crankshaft torsional properties displayed no significant variation when the overhead cams were adapted to the pushrod engine, the production crankshaft vibration damper was retained. It is constructed of an alloy iron inertia ring mounted with an elastomer sleeve to an iron hub casting. Torsional amplitudes and frequencies induced by higher peak rpm, however, require a significant mass increase in the inertia member as compared to low peak rpm engines.

Both flywheel and vibration damper contain holes for the insertion of weights when mass balancing the entire engine assembly.

The piston and connecting rod assembly design is the most critical for durability. This assembly, with the exception of the piston dome configuration, has remained completely interchangeable with the pushrod engine.

The connecting rod is forged from steel. In order to withstand the inertia loading, which increases as the square of the rpm, the crankpin end of the connecting rod was completely redesigned. In a conventional connecting rod, the cap or lower half of the rod is attached to the upper half by means of a nut and bolt.

A CONSTANTLY varying I-beam section connects the piston pin end with the crankpin end. Here again the exact sections were determined by photostress analysis under very high static tensile and compressive loads. A full floating piston pin oscillates in a conventional bronze bushing pressed into the connecting rod. Weight milling pads are located on the vertical centerline at both ends of the rod.

The piston pin is a steel extrusion. The machined inside diameter is cantilevered for constant strength sections with a minimum of weight.

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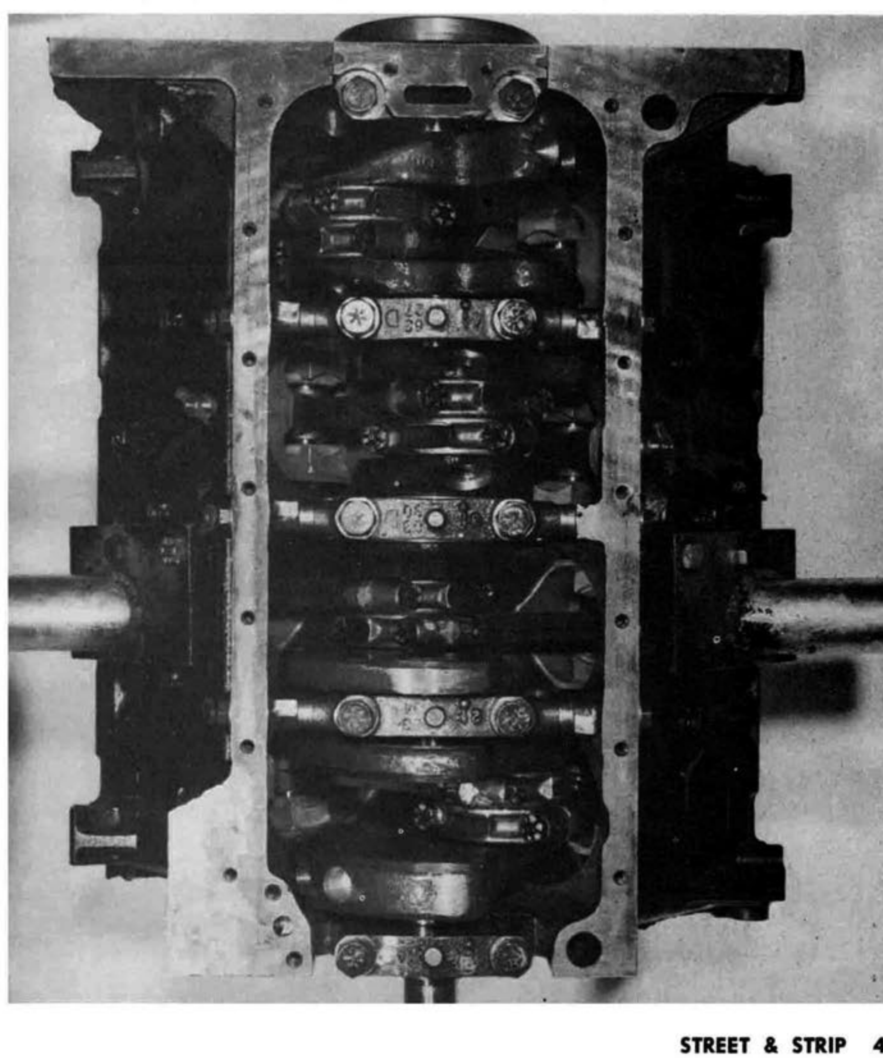


Ford's '66 Drag Mill

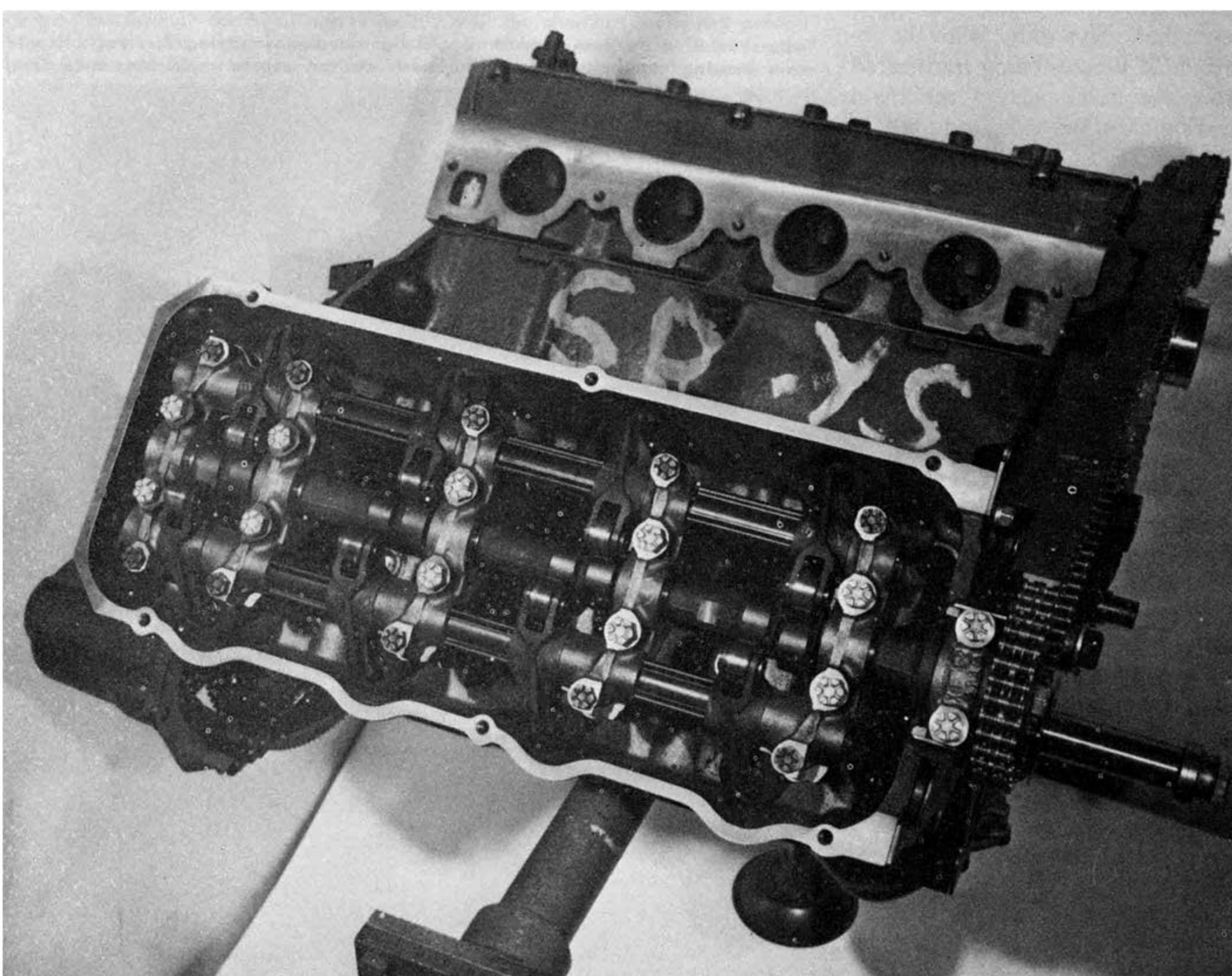
Both compression rings are 1/16-inch thick and are barrel-faced and chrome plated. The top ring is cast of ductile iron, and the second compression ring is cast of standard piston ring iron. The ⅛-inch oil control ring set consists of two chrome plated steel rails and a stainless steel expander. Oil is returned from the oil ring groove through six drilled holes. Ring tension is approximately four psi lower than the standard passenger car set of rings.

The overhead came engine retains most of the pushrod engine lubrication system passages and components.

The pin is constrained in the piston pin bores by retaining rings, and the end play between the rings is kept to a minimum to reduce hammering of the retaining rings by the pin.

The piston is extruded from a cast aluminum alloy for maximum strength-to-weight ratio. The slippered skirt is machined by a contour cam grinder which produces a controlled thread-type finish for lubrication. Cam drop is .030" on the diameter. The piston pin bore is located on center since cold start piston slap is of no concern. Pin bores are lubricated by oil splash fed to the pin through several broached slots.

Cam journals are located near the lobes and at the driven end to support drive-chain load for minimal deflection. This positioning and use of a common head casting resulted in placement of five journals on the left cam, six on the right.



To minimize whipping and aeration of oil by the crankshaft, the forward sump of the 7½-quart capacity oil pan has been deepened as much as competition vehicle ground clearance limits will permit. The rear shallow section contour is governed by chassis clearances. A curved stripper baffle has been added to shear oil from the crankshaft counterweight and return it to the pump. Other baffles are added as required for various types of competition.

The oil pick up tube assembly is suspended from the oil pump into the oil pan. It is designed to withstand severe vibration loads, especially in the horizontal plane. The oil pump is bolted to an integrally cast pad inside the oil pan mounting rail at the front of the engine.

OIL IS DELIVERED through a short drilled passage to the oil filter adaptor mounted externally on the left front skirt of the cylinder block. The filter, a screw-on throwaway type, has been slightly modified to decrease pressure-drop and to prevent by-passing at high delivery rates by using a 100 percent molded dacron element. The highly restricted water and sludge removing feature of the standard filter has been eliminated. The oil filter adaptor also includes two tapped bosses for mounting oil temperature and pressure sending units. If extra oil cooling is required, an oil cooler adaptor may be inserted between the cylinder block and oil filter adaptor.

High-pressure oil is fed directly from the filter through the oil flter adaptor into the main oil gallery which runs from the filter mounting pad to the rear of the block. It is routed to the bearings by a system of cross-drilled passages from the main gallery to an intersection between the main and cam bearing bores. Full pressure oil is then taken off #2 and #4 cam bearings through passages to the block deck, and into the cylinder head for lubrication of the overhead valve train.

In the overhead cam engine, a drilled passage connects the oil hole opening in the block deck to a full length gallery running beneath the cam bearing towers on the cylinder head. This gallery supplies full pressure through drilled passages to the individual cam bearings as well as to the hollow rocker shaft. The hollow rocker shafts are dowelled to assure registration with these passages.

Rocker arm oiling is conventional in that the hollow rocker shaft has oil feeder holes and slashes on the lower side at each rocker arm location. Drilled holes in the upper side of the rocker arm meter oil to the valve stem and rocker pad. The roller follower and its needle bearings are lubricated by rocker arm oil throw-off.

Valve train drainback oil is returned to the oil pan by means of oil return holes at the rear of the heads and block. The front end sprockets and chain drive are lubricated by bearing throw-off.

COOLING BELT DRIVE

Ventilation of this high speed engine is not a problem. Oil fill tubes and breather caps installed in the rocker covers of each bank introduce fresh air for scavenging the overhead system. Fresh air is routed through the front cover area into the crankcase and ascends into the valley through oil drain back holes. A sheet metal baffle between the bottom of the intake manifold and the valley directs the flow of air to a road draft tube mounted externally on the top and at the rear of the intake manifold.

conclusion next month