CHEVYS IN THE INDY LINEUP

Offenhauser engines have for many years dominated the Indianapolis 500 racing classic with little or no competition from any other makes. But, as evidenced this year, there's an increasing threat being posed by American passenger car powerplants. Here's a report on what was in one of the first 'Indy rebels'

text and photos by Don Francisco

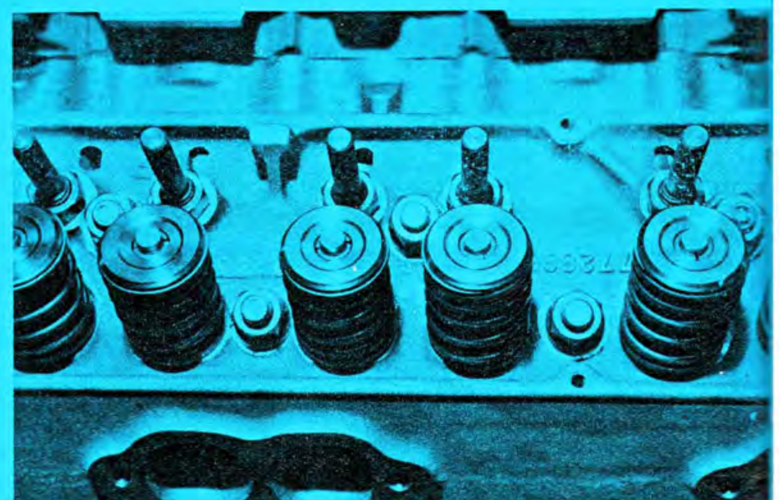
Just as the two long straightaways, two short straights, and four turns of the Internationally famous Indianapolis Motor Speedway inevitably bring a driver back to where he started, the engines in the cars that compete on the Speedway are returning – more slowly to be sure but just as inevitably – to where they started.

Most of the first cars that raced on the Speedway had modified stock passenger car engines. As time went on and competition for the prize money a man could win became keener, various individuals and companies began manufacturing special high-performance engines designed strictly for racing. At first these engines were in the minority among the Speedway entries but the cars that had them performed so well that those with passenger car engines just couldn't compete with them. Eventually, stock engines dropped from the entry lists.

The engine that has been the undisputed king at the Speedway for many years is the powerful four-cylinder, dual-overhead camshaft Offenhauser, or "Offy," which gained its name from Fred Offenhauser, the man responsible for much of its development. Offy engines are now built by Meyer-Drake Engineering Corporation, in Los Angeles. But, although the Offy is still king, highly-modified passenger car engines have, in the last two races, succeeded in chopping just about three of the four legs from its throne. The passenger car engines required lighter chassis to do the job than those seen in the past few years at Indy but nevertheless they did it.

Mickey Thompson broke the ice for the return of passenger car engines in 1962 when one of three cars with Buick Special aluminum engines built in his shop qualified for the race. Although the car didn't win the race, or even finish, it put up a good showing by completing more than 100 of the race's 200 laps. Failure to complete the race was the result of the loss of lubricating oil from its rear drive assembly. The engine was still running, a little tired perhaps, but running, when the car pulled out of the race.

In 1963, four cars with passenger car engines were successful in making the starting lineup. If this doesn't sound like a high percentage of the 33-car starting field, keep in mind that between 60 and 70 cars try to qualify for each race and most of these have Offy power. Two of the four had Ford Fairlane engines and the other two had small Chevy V8's of the type Chevy introduced in 1955. The Fords were built by the Ford Division of Ford Motor Company and the Chevys were built in Mickey Thompson's shop.



ABOVE – Parts in the upper end of Indy Chevys not special were the valves. Spring retainer washers were of titanium.

OPPOSITE PAGE – Photo at top left shows forged aluminum pistons with domed heads that extended into combustion chambers. Photo at top right reveals cast iron cylinder sleeves which provided durable wearing surfaces in aluminum block for pistons and rings. At center is an early version of one of the Chevy-powered Indy cars. Schiefer roller tappets with bronze guides are seen at lower right and, at lower left, the engine, which weighed much less than a cast iron version.

Both Fords finished, one of them within seconds of winning the race, and one of the Chevys finished in ninth place.

The Chevy that finished was driven by Al Miller. Al qualified it at an average speed of 149.613 mph. This was the ninth fastest qualifying speed in the 33-car field. Al's fastest lap of the four required for qualifying was 150.401 mph.

The car's qualifying performance was so good that owners of some of the other cars filed protests against it. They said it wouldn't have gone as fast as it had unless its engine had more cubic inches than the rules allowed. Consequently, officials of the United States Auto Club, sanctioning body

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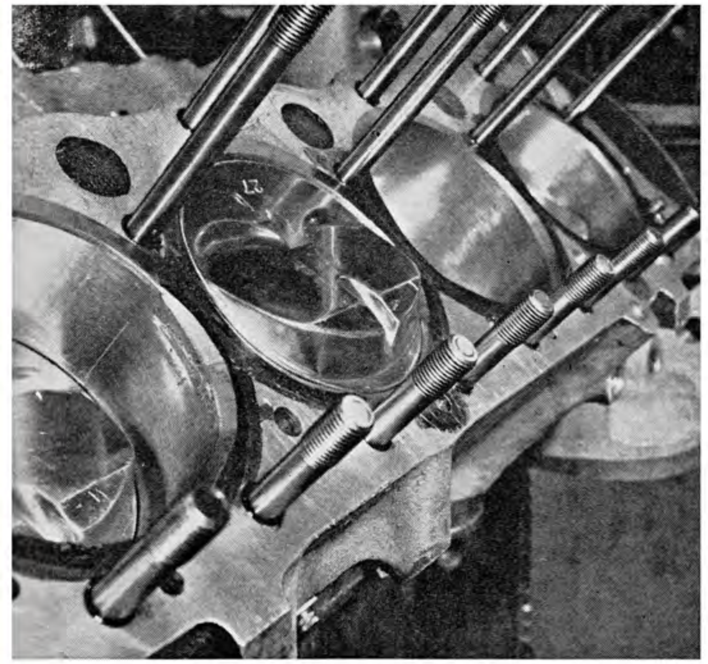
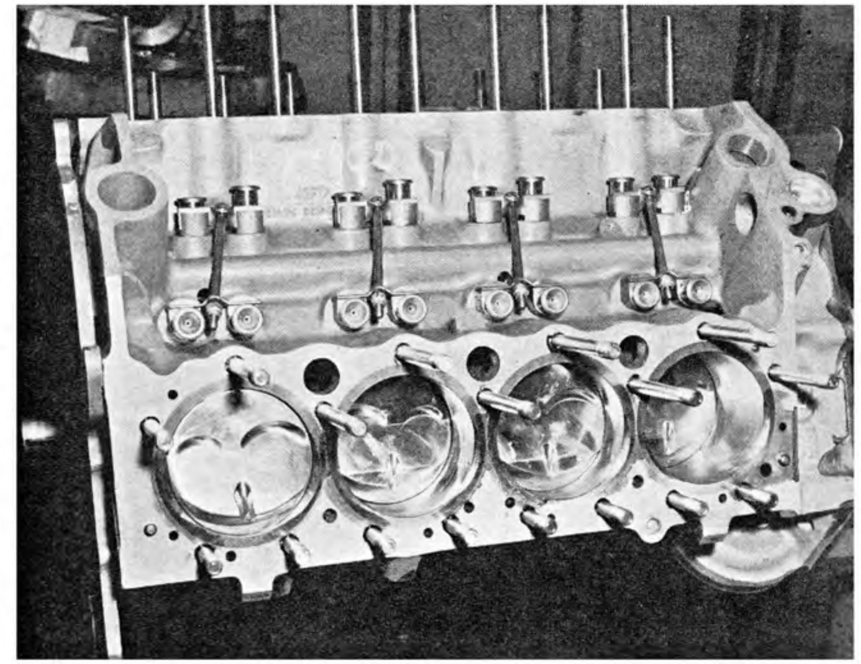
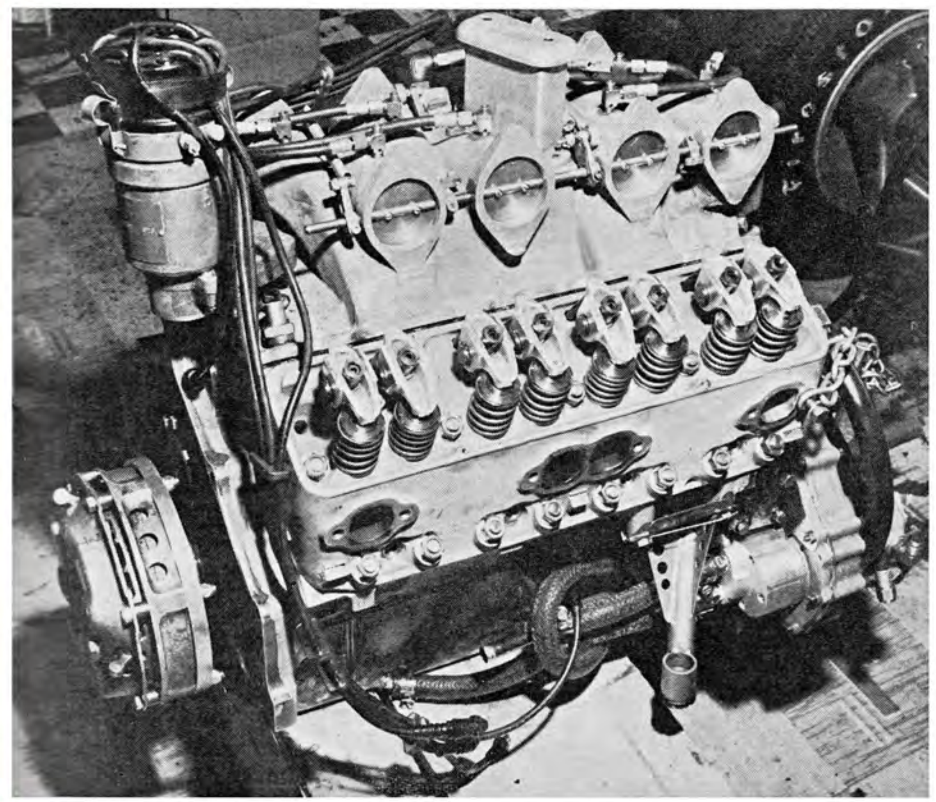
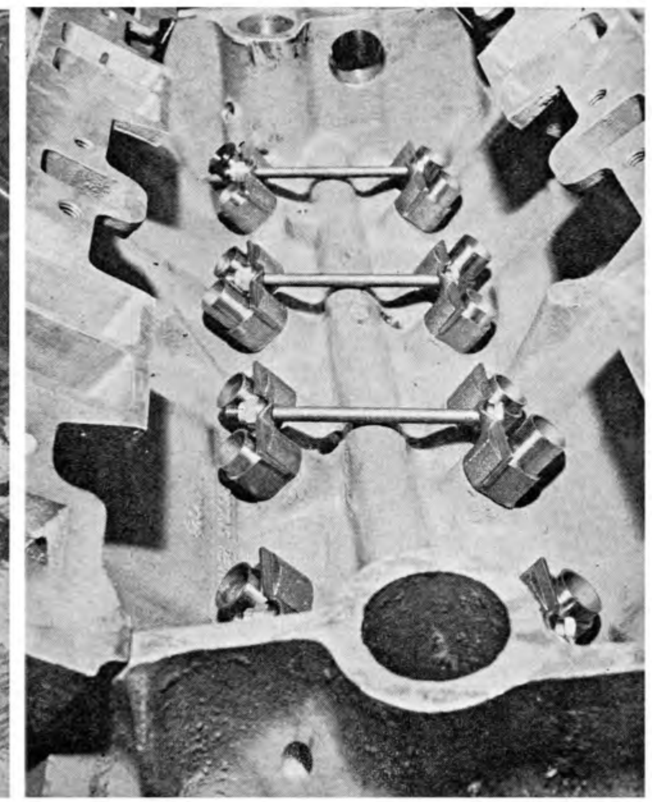
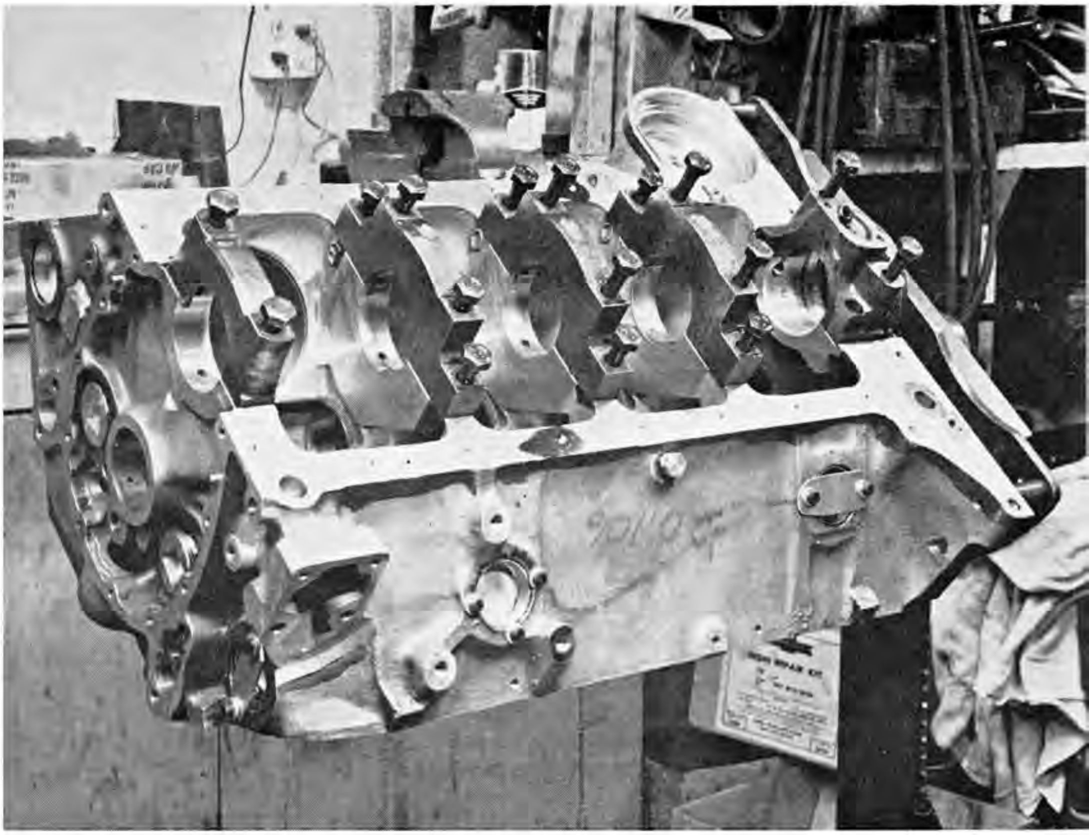










CHEVYS IN THE INDY LINEUP *continued*

for the race, impounded the engine so that anyone interested could measure it themselves. Mick's crew installed one of the spare engines in the car for the race.

Rules set down by USAC for the race limit the displacement of unsupercharged engines of any type to 256.9 cubic inches. Chevy has built their little V8's with displacements of 265, 283, and 327 cubic inches. Mickey's engines were made to conform with the USAC ruling by using the 265's standard 3.750-inch bore diameter and shortening the standard 3.000-inch piston stroke, which Chevy used in both 265 and 283-inch engines, to 2.880 inches. This gave the engines a total displacement of 254.4 inches.

In keeping with the theory that to beat the 1400-pound Offy-powered cars the Chevy-powered challengers would have to be lighter to compensate for the lower power output of their engines, as many of the engine's parts as was practicable were made of aluminum or magnesium. One of these was the cylinder block.

The aluminum block, merely because of its material, differed in several respects from production cast iron blocks. Its four front main bearing caps were cast steel and the rear cap was cast iron. Cap numbers two, three, and four had four rather than the usual two cap screws that secured them to the block. Main bearing webs were beefier to compensate for aluminum's lower strength per cubic inch so they would be strong enough for the loads exerted on them.

Each cylinder had a cast iron sleeve, .060-inch thick, to resist piston ring and piston friction. The upper end of each sleeve had a flange approximately $\frac{1}{4}$-inch wide that rested in a recess in the block's head gasket surface to prevent the sleeve's moving. To minimize possible problems with the threads in the comparatively soft aluminum, steel studs for the cylinder heads were screwed into Heli-Coil inserts.

Complete with main bearing caps but without the head studs, the block weighed 85 pounds, approximately one-half the weight of a cast-iron block.

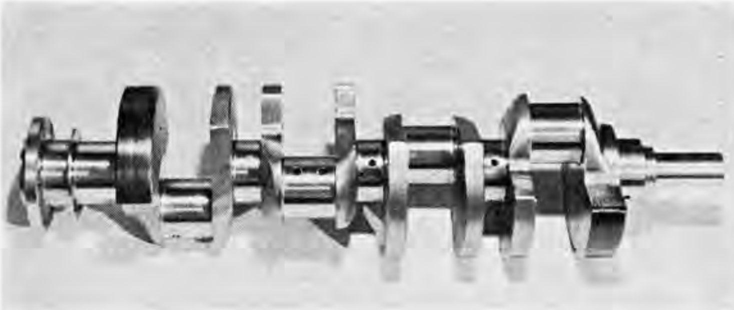
ABOVE – Lower end of cylinder block differs from stock type by having 4-bolt main caps. Moraine 500 bearings were used. TOP LEFT – Intake ports and passages were ground just enough to make them uniform; heads weigh 18 pounds. LOWER LEFT – This titanium rod was shelved for steel.

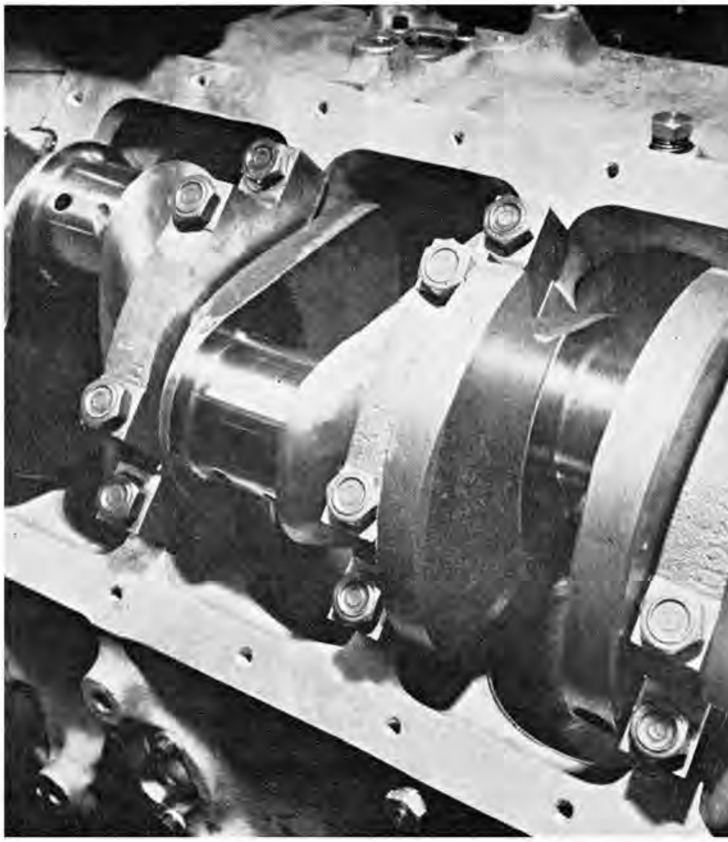
Cylinder heads were also aluminum. Each weighed 18 pounds. This included the steel screwed-in studs for the rocker arms, cast-iron valve seat inserts, and bronze valve guides but not the valves. Intake and exhaust ports and passages and valve ports were the same sizes as those in heads for late-model 327-inch engines. All ports and passages were enlarged just enough to make them equal in area and shape and surfaces were polished. Actually, even in stock form, the ports and passages were on the large side for the engine's comparatively small displacement.

With the exception of a thin layer of hard chromium on their stems to increase wear resistance, the valves were identical to those in 327 high-performance engines. They had the standard head diameters, shape, and 45-degree faces. Heads on the intakes were $1\frac{15}{16}$-inch in diameter and those on the exhausts were $1\frac{1}{2}$-inch.

To guarantee efficient head gasket sealing by creating a ring of high pressure in the gasket around each cylinder, a groove for a ring made of .042-inch diameter copper wire was cut into the gasket surface of the heads around each cylinder. Because the grooves followed the contour of the combustion chambers, which isn't round, they had to be made with a Planograph machine. This was a costly job but it was deemed worthwhile to prevent head gasket problems. Gaskets that were used were of the laminated steel and asbestos type.

After the copper wire had been tapped into the grooves in the heads with a small hammer, material was removed from the exposed portions with a file to reduce height above the head surface to just a few thousandths of an inch. This minimized the possibility of distorting or cracking the heads





TOP – Crankshaft was cast ductile iron with 2.880 stroke for a 254.4 c.i. displacement. Total weight of crank, 48 lbs. BOTTOM – Mallory Mini-mag was special one with step-up gears so it could be used with Schaller quarter-speed cam. RIGHT – Counterweights added each side of center main.

when they were tightened against the gasket. Heads were never tightened to a torque exceeding 75 pounds-feet.

All parts in the engine crankshaft, connecting rod, and piston assembly were special parts sold by Mickey's company. In addition to its shorter stroke, the crankshaft differed from standard forged steel shafts by being a ductile iron casting and having counterweights on either side of its center main bearing journal. A special heat treatment increases the material's durability and the wear resistance of the shaft's bearing surfaces. Also, the material's graphitic structure is said to give the bearing surfaces such good wear resistance that special surface preparations such as hard-chrome plating aren't necessary. Although the cast shafts appear to weigh considerably more than stockers, their actual weight is less. Those for Mickey's engines weighed 48 pounds each. Each of them, before considered usable, was given a thorough X-ray examination to guarantee no internal flaws.

Main bearing journals and crankpins on the crankshaft were finished to provide .003-inch clearance with standard bearing inserts. The pins were the same diameter as those on standard Chevy shafts. Their length was increased over standard to give the connecting rods a total end play of .035-inch. Increasing rod end play allows greater quantities of oil to escape from between the rod bearings and the crankpins. Increasing oil flow in this manner helps cool the bearings because the purpose of oil is to cool as well as lubricate. The greater the flow, the more heat carried away from the surfaces the oil contacts. However, increasing flow at this point to too great a quantity can cause more oil than the piston rings can control to be thrown onto the cylinder walls. The result is excessive oil consumption and too much oil in the combustion chambers for efficient engine operation. Also, in some engines, bearing life can be shortened.

Main and rod bearing inserts were Moraine 500. These are the latest of the aluminum-matrix, heavy-duty inserts used in Chevy's high-performance engines. They have excellent durability and are recommended for any engine, regardless of its intended use.

Connecting rods were the first of a new type Mickey plans to merchandise under the name "Super-Duty Step-Lock." They are machined from alloy steel forgings and have offset caps. The term Step-Lock refers to a series of matching steps on the mating surfaces of the rods and their caps that interlock to prevent the caps moving laterally on the rods. The rods have bronze bushings for the piston pins. Those in Mick's engines had the same center-to-center length as standard rods. Rods of this type are quite heavy but the possibility of breaking is out of the question.

Fortunately, Mickey makes his own forged aluminum pistons. If he didn't he probably wouldn't have been able to afford the 27 different types that were tried before he settled on the one that was used; during the extensive piston testing program, which involved using each type for dynamometer tests, different amounts of piston pin offset and different head shapes were tried.

Usually, when piston pins are offset in piston skirts, the purpose is to enable the pistons to operate more quietly. However, Mickey thoroughly investigated the possibility that offsetting the pins would increase power output. Although he didn't find any extra power he did find extra cylinder wear and connecting rod problems. Pins on the pistons finally used were centered in the skirts.

Different piston head shapes were tried in an effort to make the compression ratio as high as possible, consistent with good power output. A high compression ratio was easy

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to obtain but the type of piston head required shrouded the spark plug opening in the combustion chamber and lowered the power output. Pistons that were used gave a compression ratio of 10.8 to 1 and maximum power. All pistons that were tried had a modified slipper skirt and used three rings. Each piston, with its pin and pin locks, weighed 714 grams.

Piston pins were full-floating in the rods and pistons, with a clearance of .0008-inch. They had a diameter of .927-inch, the same as standard Chevy pins. Their lateral movement in the rods and pistons was restricted by Spiralock lock rings in grooves machined in the piston pin bores.

Piston rings were the same ones Mickey sells under his own trade name. Those for the top and middle grooves have a molybdenum insert in their face. The oil ring is of the chrome-face, steel-rail type.

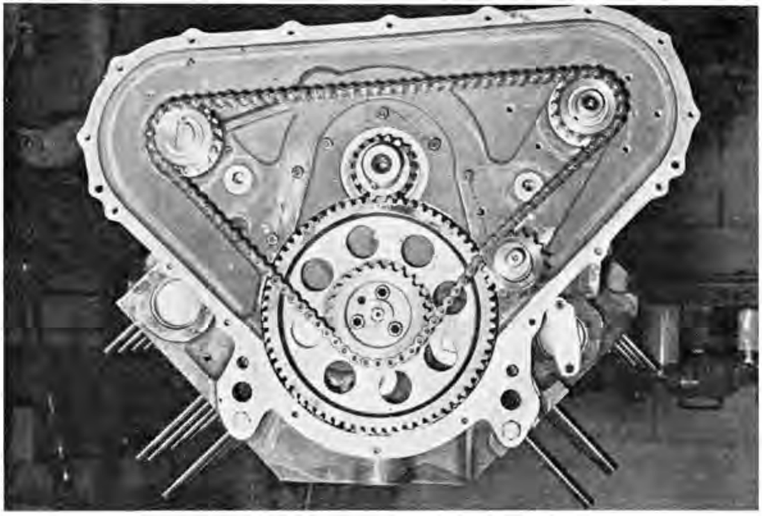
All parts in the crankshaft and rod and piston assemblies were balanced by Autotronic Balancing Company in Long Beach, California.

Mickey and his crew encountered several problems with the engines before they finalized their design but all but one of these were quickly solved. Less than a month before May 1, when the cars were scheduled to be at Indianapolis for the start of the practice session, Mickey hadn't decided on the camshaft he was going to use. Camshafts had been an important part of the dynamometer test program that had been started several months before but still no decision had been made.

Camshafts that would let the engine deliver the power it needed had been tested but all that had been learned was that the extremely high pressures exerted by the multiple springs and the harsh action these cams exerted on the lifters, caused something in the valve mechanism to break before the engine had run very long. The pattern of breakage became so pronounced that the fellows doing the testing could predict with remarkable accuracy just when something would let go. This was when the engine was being operated strictly within the rpm range in which it would deliver power. Exceeding this range by just a few rpm would cause the valves to float so severely that power output would fall far below the practical range and multiply by many times the possibility of destroying the engine.

Results of the dynamometer testing were verified by actual use during the early part of April when Mickey took some of his new cars to the Speedway for chassis tests. During the test runs several valve action failures were experienced. As had happened with the dynamometer testing, the crew became highly accurate at gaging the number of miles an engine would run before something in its valve action let go. Mickey resigned himself at this time to the fact that running the engine 500 miles with one of these camshafts would be impossible.

While Mickey was at the Speedway, Roger Flores and several other fellows were trying to finish the piston and camshaft tests at home. As a last resort for the camshafts they decided to test one of Bus Schaller's quarter-speed, double-lobe shafts. They had obtained the quarter-speed shaft some time previously but it had spent the intervening time on the shelf because after examining it they had decided it wouldn't work. With curiosity rather than hope in their minds they installed the shaft, with the single low-pressure springs that came with it, and fired the engine. The first thing they noticed, during the warm-up period, was that the engine ran and accelerated much more smoothly than it had before and that the benches and shelves in the dynamometer room weren't vibrating. Secondly, it was noted that the engine was much quieter mechanically than it had been.



TOP – This double-row roller chain, driven by a sprocket bolted to the cam, drove engine fuel, oil and water pumps. CENTER – Rings formed from copper wire and installed in grooves in the aluminum heads improved gasket sealing. BOTTOM – Aluminum rockers rotated on needle bearings.

When the engine was power-timed, the crew found that between 48 and 50 degrees of spark lead, compared to the 36 or 38 degrees that had been necessary previously, was required for maximum power. This is a characteristic of the quarter-speed camshaft some fellows think isn't right, but the fact that the engine delivers maximum power with this much lead proves it is right. If the greater lead caused pre-ignition, as it would with a conventional camshaft, less lead would be required for maximum power.

Things really became interesting when the first full-power

TOP – Schaller quarter-speed, double-lobe camshaft was the only shaft of many tested that would allow the engine to deliver enough power to make the race and to finish it. CENTER–Injector had long tapered passage, each cylinder. BOTTOM – Schiefer roller tappets and steel retainer straps.

runs were made. Power output throughout the engine's crankshaft speed range was higher than it had ever been. The increase was greatest above and below the crankshaft speeds at which maximum power had been obtained with the half-speed shafts. Maximum output, with methanol, was 364 hp at 7200 rpm. But of greater interest than its maximum power output was the engine's flat torque curve. Torque is the force that rotates a car's wheels. The higher it is at any engine speed, the better the car will accelerate at that speed. Between 5100 and 7200 rpm, which was presumed would cover the engine's operating range on the Speedway, the torque varied only 19 pounds-feet. At 7600 rpm it dropped 31 pounds-feet from the 7200 rpm reading. But this was at a speed 400 rpm higher than any other camshaft that let the engine develop anywhere near enough horsepower for the Speedway would even let the engine run because of severe valve float. Horsepower at 7600 rpm was 338.

The valves were never floated with the quarter-speed shaft, even when the engine was operated for a short time at 8200 rpm. This was a full thousand rpm higher than the half-speed camshaft that had delivered the best power output would run without causing valve float.

After seemingly endless running on the dynamometer and then the actual running at the Speedway during practice, it became apparent that the valves and their actuating mechanism had become the most reliable parts of the engine. There just wasn't any more parts breakage in the valve mechanism, regardless of how tight the engine was turned or how long it was run.

Any of the currently available roller tappets can be used on the quarter-speed camshaft but because of their excellent design and their bronze guides, Schiefer tappets were used. Their guides made these tappets especially suitable for the aluminum block because they eliminated the possibility of the tappets wearing the block's tappet bores. Special tubular pushrods were made by Smith Brothers Manufacturing Company in West Covina, California.

When the dynamometer tests were first begun, considerable trouble was experienced with the standard Chevy rocker arms. When the engine was operated for any length of time at crankshaft speeds above approximately 5800 rpm, the pivot seats in the arms and the balls on which the arms pivoted would turn blue and gall, and occasionally a pushrod would force its way through its arm seat. The troubles with the pivot surfaces were caused by the high valve and tappet spring pressures necessary with the half-speed camshafts being tested at that time. The cause of the pushrods punching through the arms was the combination of high spring pressure and mild, yet positive, valve float that occurs with many half-speed shafts at these engine speeds. Efforts to reduce the friction between the arms and the pivot balls were made by hard-chrome plating the mating parts, molybdenum coating the parts, Lubriplating the parts, lubricating the pivot areas with direct oil streams, etc. Nothing helped.

The answer to the rocker arm problem was a special forged aluminum rocker arm Mick's group designed. This arm has a hardened steel pushrod socket and a hardened tip that contacts the end of the valve stem. It rotates on needle bearings supported by a pin that slips over the standard rocker arm stud on the head.

The aluminum arms functioned perfectly, even with the excessively strong valve and tappet spring pressures required for the half-speed camshafts. Another of their advantages was found to be that they don't require as much oil as standard arms. This allows an engine to be operated with less oil in the rocker arm and valve areas which is a definite improvement. Because of the limited oil drainage facilities in Chevy heads, too much oil sometimes collects in the rocker arm covers if oil flow to the rocker arms isn't controlled correctly.

One of the quarter-speed camshaft's many good features is that it doesn't require high valve spring pressures. This was proved to everyone's satisfaction during Mickey's dynamometer tests but, because of the fatigue and breakage problems that were experienced with the stiff springs that were required by the half-speed shafts, Mickey insisted that dual springs that exerted more pressure than was necessary

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be used in place of the recommended single springs. The theory was that even if the springs did lose some pressure during the race they would still be enough to operate the valves satisfactorily. The total pressure of special inner and outer springs he had made was 110 pounds with the valves on their seats and 250 pounds with the valves open. Springs Schaller recommends, that are giving good service with the shafts in all types of installations, have a valve-closed pressure of 90 to 100 pounds and an open pressure of approximately 180 pounds. Spring retainer washers machined from titanium bar stock and stock Chevy split locks secured the springs to the valves.

One of the first of the many special parts made for the engine was a magnesium accessory drive assembly. Mickey, his Chief Engineer John Crosthwaite, and Gordon Schroeder, who has a machine shop in Burbank, California, where he builds equipment of this type, collaborated on the drive assembly. It consisted of a magnesium plate that bolted to the front of the cylinder block in place of the regular timing gear cover and a magnesium cover. On the plate and cover were mounting pads for two oil pumps, a Hilborn fuel pump, a tachometer drive, and a water pump. Inside the cover was a double-row roller chain driven by a sprocket bolted to the front end of the camshaft. The chain rotated two sprocket and shaft assemblies that drove the various pumps. The tachometer cable was driven directly by the front end of the camshaft. The driven sprockets and an idler that was adjustable to eliminate slack in the chain were supported by ball bearings.

When the switch was made to the quarter-speed camshaft, new accessory drive plates and covers had to be made because the original ones wouldn't fit around the larger camshaft gear. Because of the camshaft's slower rotational speed, its gear must be larger than one for a half-speed shaft and the crankshaft gear that drives it must be smaller. Making the new covers took valuable time and cost quite a bit of money but it was well worth being able to use the quarter-speed camshaft.

The fuel pump was bolted to the forward side of the lower right corner of the triangular-shaped accessory drive assembly and the water pump was bolted to the forward side of the lower left corner. Behind the water pump, on the assembly's rear side, was one of the oil pumps and behind the fuel pump was the second oil pump, which was actually two pumps in one. The two oil pumps, which were of the gear type and were made by Schroeder, were necessary for the dry-sump system.

Lubricating oil for the engine was carried in a flat tank mounted high in the frame, just below the body's skin, ahead of the driver. It flowed through a suitable hose to the pump on the left side of the accessory drive assembly and the pump forced it under pressure through hoses that connected first to a Porsche cleanable-element filter and then to an opening in an aluminum plate secured to the block over the standard oil filter opening. The opening in the plate communicated with the cylinder block main oil gallery. Oil that entered this gallery flowed through various other passages to lubricate the engine's many parts and then gravity carried it into the oil pan bolted to the block's lower surface. A by-pass valve in the pump maintained 65 psi.

The oil pan sump was removed to reduce the pan's overall height, thus permitting the engine to be installed lower in the frame. Special baffles, with hinged sections that allowed the oil to flow only in the desired directions, were welded to the pan's bottom.

In 1962, on the Buicks, Mickey tried what he called a "ram injector" fuel injection setup he designed and that was built by Stu Hilborn. This setup didn't work as well on the Buicks as a standard Hilborn injector but one of the same type worked great on the Chevys. This year the magnesium housings for the injectors were cast in Mickey's foundry and Hilborn did the finish machine work and installed the nozzles, fuel valve, etc. The ram injector differs from the standard Hilborn setup by having longer passages between its throttle valves and the ports in the cylinder heads. Also, the passages have a tapered shape, with their throttle valve end considerably larger than their port end. On the dynamometer it was good for quite a few horsepower.

Two types of headers, identical except for the sizes of their pipes, were tried. Pipes in one set had an inside diameter of 1½-inch and those in the other set were 1⅝-inch. Each pipe was approximately 30 inches long, from the exhaust port in the head to the 2¾-inch i.d. collector for each cylinder bank.

Dynamometer tests showed that the headers with the 1½-inch pipes gave more power between 5000 and 6200 rpm than those with the larger pipes but over 6200 rpm those with the larger pipes gave the most power. Test runs after the cars got to the Speedway proved the smaller pipes best for racing.

Mickey wanted to run Mallory Mini-Mag ignition systems on the engines but when he switched to the quarter-speed

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continued

camshaft the standard mag wouldn't work because of the slower speed the camshaft rotated it. Boots Mallory bailed him out of this predicament in a hurry by making special mags that incorporate a pair of teflon gears, in an offset housing, that boosts the speed of the upper end of the mag's driven shaft from one-quarter to the standard one-half crankshaft speed. These mags functioned perfectly.

Heavy-duty spark plug wires Mickey sells in his speed equipment store connected the Mini-Mags with Champion HO-3 spark plugs. This is a fairly hot plug but it performed very well.

Behind the engine was a special 9-inch-diameter Schiefer forged-aluminum flywheel and a three-plate multiple-disc clutch assembly. Driven discs in the clutch rotated the input shaft of a Halibrand rear drive assembly that incorporated a two-speed transmission, quick-change gears, and a German-built ZF limited-slip differential assembly.

One car, which had 15-inch wheels, had 3.78 to 1 ring and pinion gears and a final ratio of 3.40 to 1. Because of its 12-inch wheels, the other car had 3.19 to 1 gears and a final ratio of 2.66 to 1. During practice and qualifications, gears with numerically higher ratios were used and the engines were run consistently at 7200 rpm. For the race the gear ratios were dropped so the engines could run at about 6800 rpm. With a half-speed camshaft that would let the engines deliver the power they required, the valve action wouldn't have lasted one lap at 7200 rpm. With the quarter-speed shaft the engines would run all day at that speed without any sign of difficulty, with a safety margin in the form of at least another thousand rpm. Not having to keep one eye on his car's tachometer lets a driver keep both eyes on the track. This can't help but let him drive better. Also, eliminating the possibility that he'll put himself out of the race by breaking something in the engine if he does exceed the tach's red-lined setting can let him concentrate on more important matters.

Before the question comes up, no, you can't buy one of the aluminum blocks or a pair of the aluminum cylinder heads like those in these engines. Mick plans to run again at the Speedway in '64 and he may need all the blocks and heads he has, and there aren't any plans to make more of them. All the parts in the engines that Mick manufactures are in his catalog, and the quarter-speed camshafts are available from Schaller Cams, San Jose, California. ■■