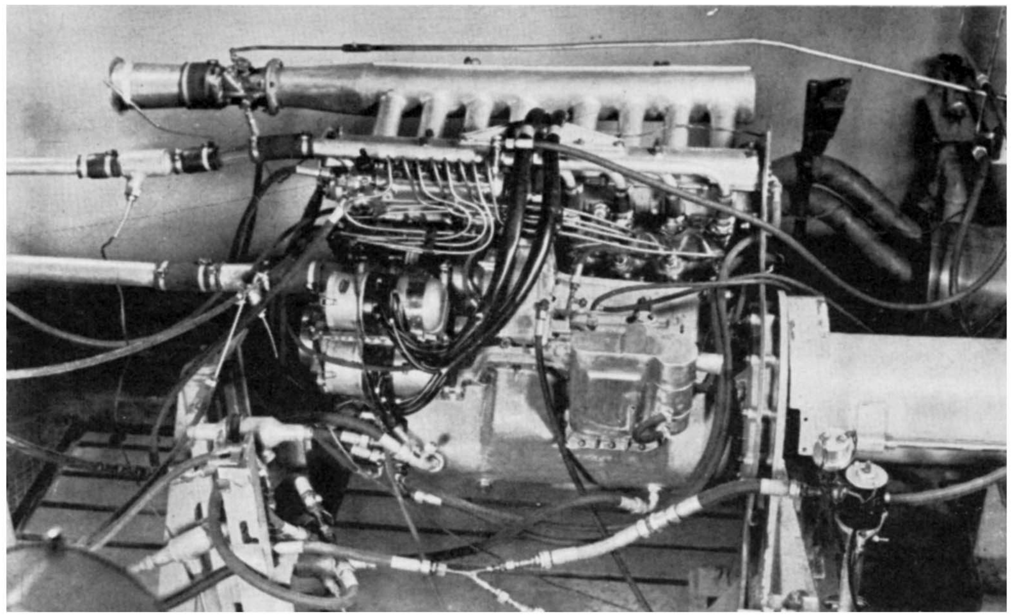
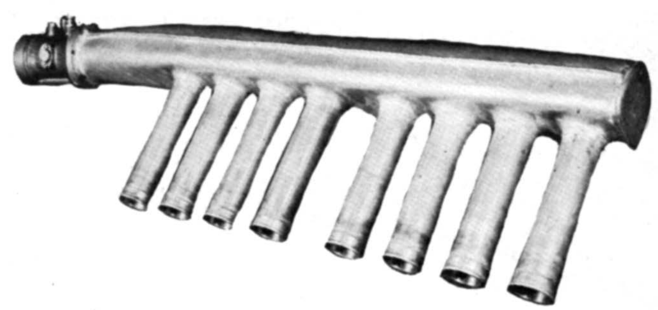
M 196 MERCEDES HOTTEST ENGINE



This seemingly complex mass is probably the most potent powerplant for its size yet devised. It's an early 1955 version of the welded-block Mercedes GP engine, on test at the factory. We hope this story will bare most all of its "mysteries".

At left below is air plenum chamber with curved tuned pipes, used on '54 GP mills and early '55 300SLRs to get smooth body lines. Less concerned with aesthetics in 1955, straight rams at right were adopted, giving boost to entire range of power.

By KARL LUDVIGSEN, SCI Tech Editor

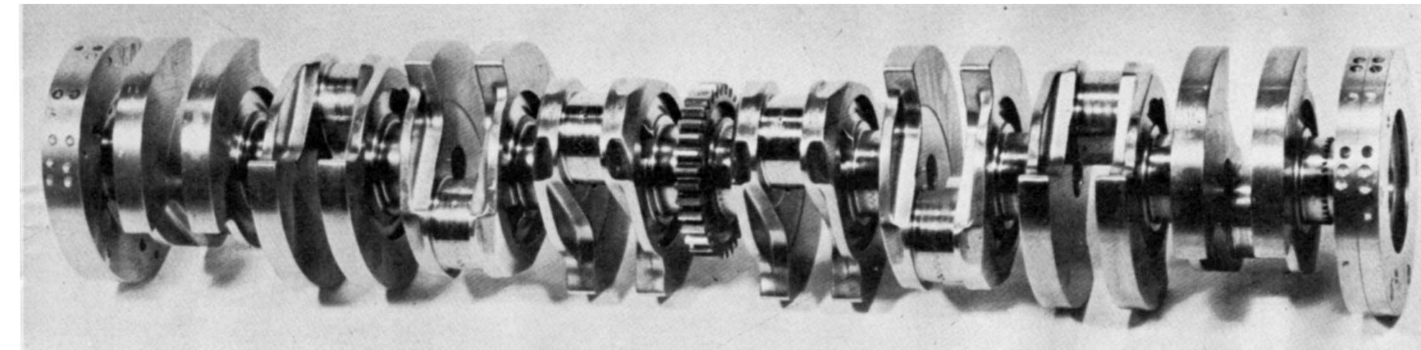


IF YOU'VE been able to tear your eyes away from all the machinery surrounding these remarks, you deserve praises for courage and a few kind words. We don't pretend to have been in on this work from the start, or to be on hail-fellow terms with Scherenberg and Uhlenhaut, but we're just as curious as you are about their design ideas.

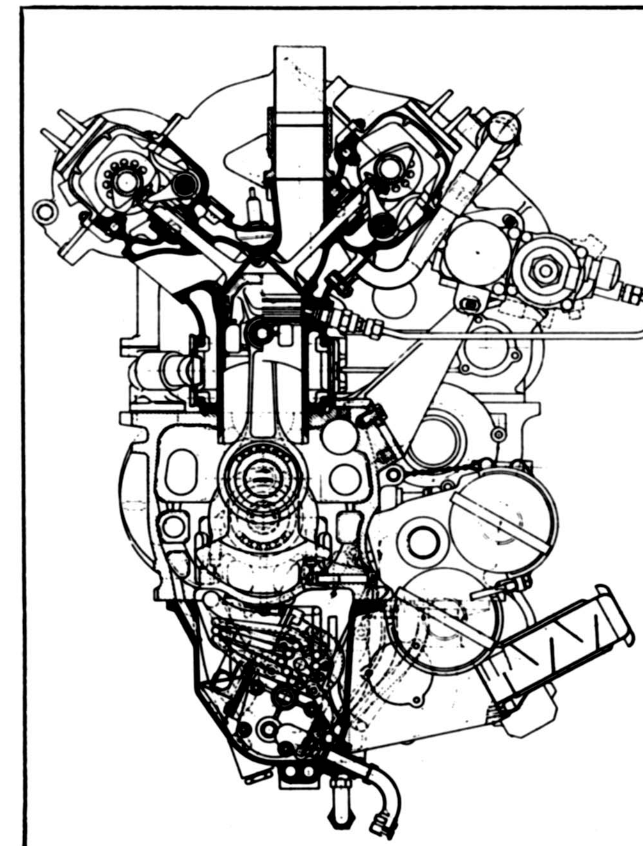
Now that Mercedes has been out of racing for a year and a half, they've seen fit to release reasonably complete drawings and photos of their equipment. It took a long world war and a team of British intelligence experts to get them to be as revealing about their prewar cars; times have indeed changed. Material like this makes news in the world's automotive press, and Daimler-Benz waited long enough to build suspense without losing impact. We could, like others, say that this dope is obsolescent, and is only turned loose because Mercedes has progressed farther, but we don't feel that that's the case. They're still experimenting like beavers with the M196 powerplant, trying to simplify and silence it as installed in their brace of SLR coupes. Many of these drawings date from April, 1956, and show very recent changes. It's a very live issue indeed, so here's your chance to match wits with the world's top design team.

Though in many respects the 196's seem wildly unconventional, Mercedes has always stolidly refused to employ any technique that wasn't thoroughly familiar to them. They can draw on experience with everything from power plants to fighter planes, and have plenty of time to test out new ideas thoroughly in the racing shop.

For this reason their well-tried welded cylinder block construction was resurrected again for the new racing engine. Totally unsuited to mass production, it nevertheless is reasonably light and gives perfect control of wall thicknesses. The two four-cylinder fabricated blocks were bolted to the cast crankcase by serrated nuts against a heavy flange at the bottom of the cylinders. Likewise, cast valve gear boxes had to be bolted to each head. This was not a totally rigid assembly, and the built-up blocks were very susceptible to vibration, so pressed alloy sheets were used to join the open ends of the valve gear vee (they're joined at the center by bridges over the cam drive housing; these have been both webbed and U-shaped in cross section). The welded rigs were good in small quantities and over the 300 mile G.P. distance, but the engineers were just waiting for a chance to put their now-proved new ideas in a modern cast framework.



Superb finish of M196 crank is strictly for go, not for show. Serrated joints of Hirth construction can be seen, as can central drive takeoff and twin vibration dampers.



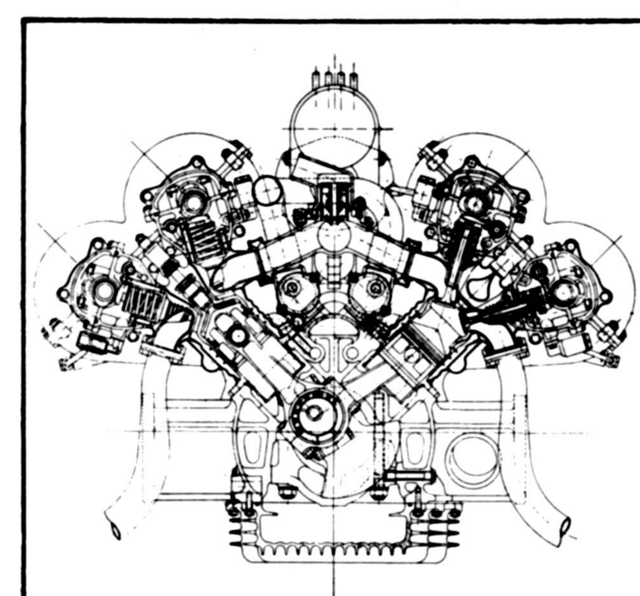
Cross-section of latest S196 sports engine shows intricacy of cast block, solidity of crankcase. Access plate above exhaust valve guide could serve as water outlet for vertical mounting, or as intake for direct cooling jet. As installed, engine is canted sharply to left. This is worth much study.

The chance came after the '54 season, when larger numbers of 300SLR's had to be readied for long-distance sports car racing. A pair of very nice cast alloy blocks was designed, with integral camshaft housings and access plates on both sides of the cylinders. One plate is heavy sheet stock, while the other is fabricated of two thin layers which form a water intake manifold. These plates weaken the outer block walls somewhat, and are an indication that wet cylinder liners are not used. In fact, there are no dry liners either, the piston rings running directly on the alloy walls, which are probably chrome plated as in the Porsche. Ferrous inserts are used throughout the engine, for the plug and injector holes as well as for accessory attachments. The valve seat inserts are deep, but narrow to conserve space.

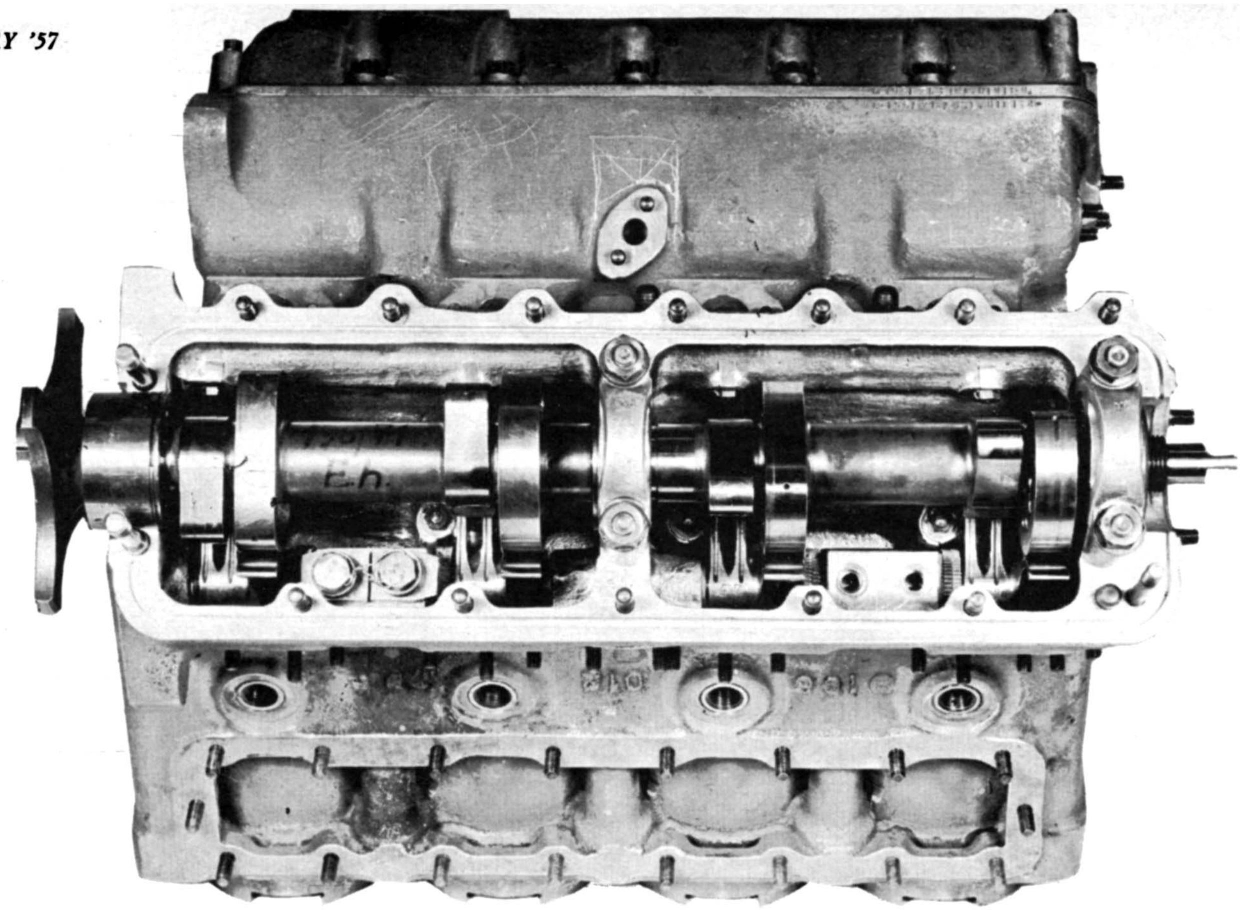
Cooling of the plugs, injection nozzles, and valve seats and guides is excellent, as always, thanks to the use of integral-head construction. The exhaust valve and port in particular are well cared for. They didn't hesitate to add access holes in the head if foundry core shifting could be absolutely prevented. As a result, there are water offtake ports in the intake side of the head, for inclined mounting, and additional ports high on the exhaust side if vertical mounting is ever needed.

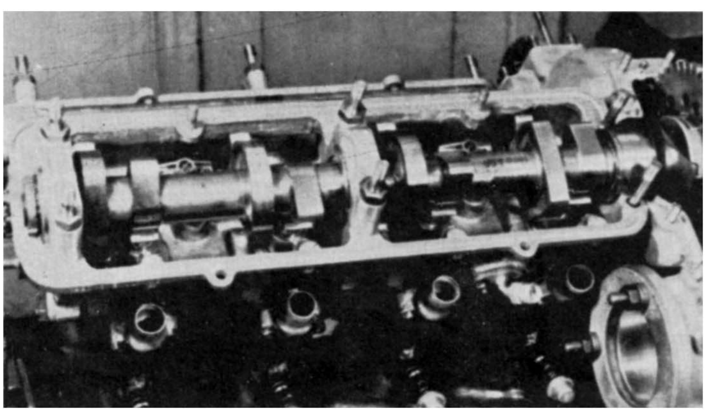
Instead of joining block and crankcase at a flange, and stressing the cylinder walls heavily, the ten studs for each block extend all the way from the very deep main bearing caps to the center of the vee between valves. Compact and deeply braced inside, the crankcase comes down just low enough to enclose the crankshaft entirely. The main caps are closely fitted on three sides, and have two lateral bolts each in addition to the studs mentioned above.

In the bearing department Mercedes also defied current practice, to make sure they knew what they were doing. Every other G.P. builder has found that the latest Vander-



Mercedes designers wanted to avoid construction, valve gear, and accessory drive complexity of pre-war vee-type layouts like this 1939 1½ liter V-8. This was a blown four-valver, with welded-up head and block.





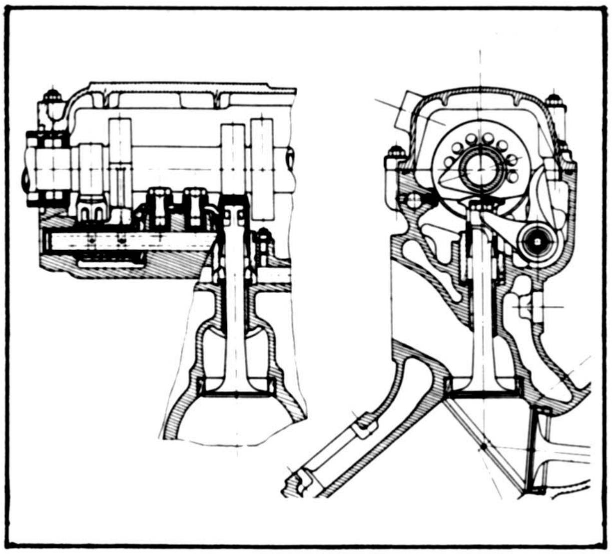
Above, for your minute inspection, is the rear block of four cylinders from the very latest three liter straight-eight. The holding clamps have been removed from the right-hand pair of valve adjusters, showing the serrations for locking the clearance. Also visible are lifting rockers and hold-down nuts for tappet guides. Compare shot of front block of 1954-type GP engine at left. Cams are wider spaced; rockers and shaft are at top instead of bottom, and block is fabricated instead of cast. Assembly at left is #8, above is #71! The design is NOT dead.

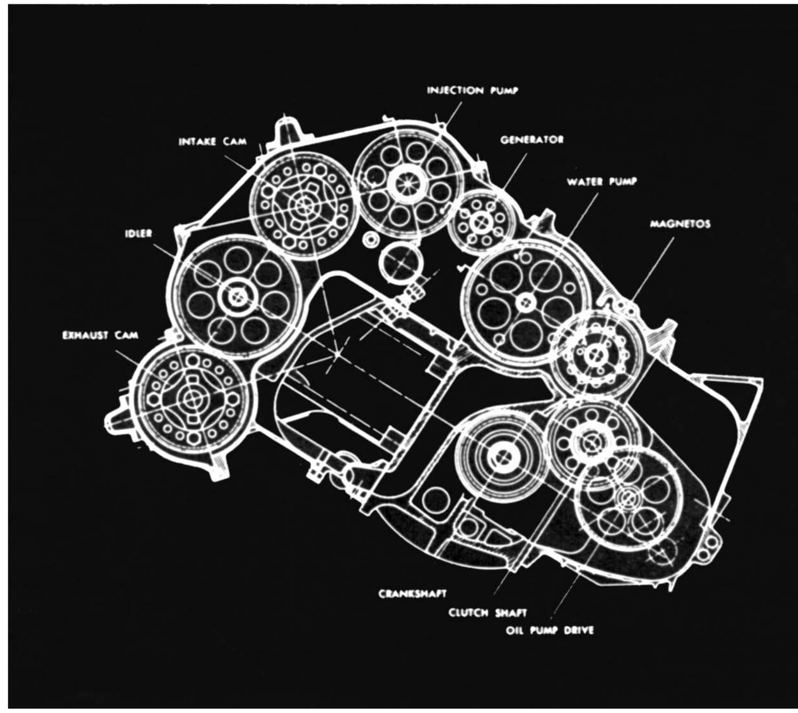
vell thin-wall bearings equal or exceed balls or rollers in efficiency, but all the prewar Mercs had used rollers throughout, so these were retained. Before the war they had a one-piece crankshaft, which required split duralumin cages. These had to be replaced frequently to avoid disintegration, and even then the designers wanted to switch to a built-up crank, as made then by Mahle for Auto-Union. More recently the Hirth crank rig has been perfected with the help of Porsche, and Mercedes chose this for their new engine. With this system the individual crank webs were joined by serrations in the center of each journal, which allows some choice in crank throw position and firing order. They've tried several sequences, the latest of which is illustrated here.

The crank is symmetrical about the central 33-tooth spur drive gear, and has a vibration damper at each end. Its finish makes it a thing of beauty, but the shapes are strictly functional. Lubrication to the mains is via a tubular gallery bolted to the bottoms of the main caps, and supplied by a pump running at 0.272 of engine speed. As the oil escapes from the sides of the main journals, and is flung out by crank rotation, it's caught by slinger rings in the webs which in turn feed the big end rollers. This arrangement avoids crank drilling, and is another design heritage.

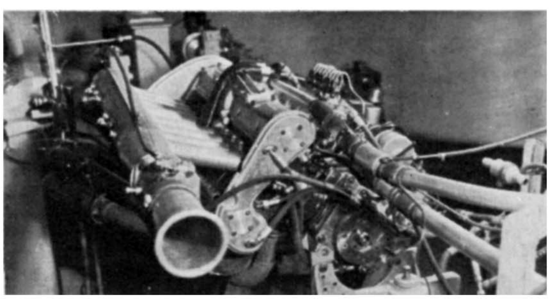
Each running directly on 44 rollers, the one-piece rods are fully finished and deeply webbed, having a conventional H section. They aren't drilled, so the needle roller wrist pin bearings are splash lubricated. The piston itself is of full skirt design, made by Mahle. Its crown is very heavy and well braced, and below it are four rings. The top two are widely spaced and just cover the injector aperture on the intake side. Third ring is a combination compression-scraper, while the fourth is a genuine vented oil ring.

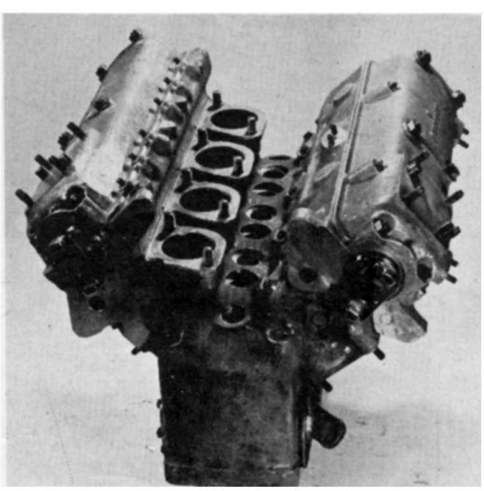
Back at the crank, the central gear drives a spur placed close to the parting line of crankcase and cast sump — this twirls a big tubular shaft to the flywheel and single-plate clutch, which run at 0.94 engine speed. A smaller pinion here drives the oil pumps, while the main gear drives the twin Bosch magnetos at engine speed. Again, a smaller gear on the magneto shaft turns the big water pump gear at 0.442 of crankshaft. This is the last pinion to be mounted on the crankcase, the rest being housed in a casting between the cylinder blocks. On the S196 (300SLR engine)





For reference from text, above is drawing of desmodromic valve gear, from two views. Eccentric sleeves under closing rocker, at left. Layout of cam and accessory drive is very clever, many details being shown at right. Upper five gears are in own case, with two removable covers.





Assembled 1955 GP engine on test bed above. Compare with early prototype SLR front block casting at left. Bolting to crankcase differs, as do most other construction fine points. Intake ports are large, plugs at angle.

Alloy cage locates rollers, which run direct on surface of crank and rod big-end. Construction of rod needs little comment. Very slight valve cutouts are needed on piston dome.

a small idler gear above the water pump runs the generator at a reasonable 0.857 of engine rpm. Next up, on the same parting line as the cover for the intake cam gear, is the half-speed drive for the injection pump. Then there's the intake cam gear, an idler, and the exhaust cam pinion. Except for that idler, every single gear does a job and does it as simply as possible. One of the major reasons for choosing a straight-eight was that its accessory drives are simpler than the comparable vee-type engine, and the designers have certainly driven this point home.

Each cam gear is bolted at four points to a spider on the rear cam. Two dogs on each front cam mate with holes in the spider, giving a margin of fore-and-aft flexibility. Each of the four cams runs in three bearings; the four of these next to the drive housing are retained directly by the camshaft cover. The other eight have separate caps.

Though some photos and rough descriptions have been released, the details of the Mercedes mechanically-closed-valve system have been strictly *verboten* until now. We're happy to present you with the assembly drawings on these pages. The reasons for this expedient have been raked over and over in the press, but to review: It allows practically free choice of valve opening and closing rates, with as big and heavy a valve as is necessary, and without the huge space requirement of adequate valve springs. As a result, gas flow is far better, and the combustion chamber shape can be refined, since big valve cutouts in the piston heads are no longer needed. Valves don't hang up if Uhlenhaut misses a shift — in short, it's worth it.

Opening the valve is done with a minimum of fuss. Slipped over the thick end of each heavy valve stem is a simple tappet, shaped on top like a rounded shoe. The opening cam, wide and conventional except for its extreme ramping, drives this tappet directly. Clearance is set by shims between stem and tappet.

Adjacent to each opening cam is a closing cam lobe. This drives a bell-crank rocker, pivoted on a shaft running the length of each cam box. The finger of this rocker extends up to the cam, roughly parallel to the valve stem, while the working arm of the rocker is forked. These forks engage two notches in the sides of the valve stem, just below the top of the stem. The tappet is cut away to allow the fork to pass through to the stem, and in turn the fork

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acts as a positioner and prevents the tappet from turning. The sole job of this fork, otherwise, is to pull the valve back up to its seat, just as the peak of the opening cam is passed. To do this, then, the closing cam starts to rise from its base circle just as the opening lobe rides past peak. When the ramp of the opening cam brings the shoe tappet back to closed position, the closing lobe has reached its peak and, through the bell crank, has pulled the valve closed. Actually, all the opening cam had to do was get out of the way as the fork pulled the stem back up.

Then, for the long closed period, the closing cam is at its peak, and the valve is actually being held shut by gas pressure, under power or compression. When the opening cam again starts to push down the shoe tappet, the closing lobe turns past its other peak and allows the finger and fork to follow the stem to open position. Since the working surface of the finger is roughly 75 degrees out of phase with the shoe tappet, the opening and closing lobes are displaced by the same amount on the camshaft.

Between these two cams and drive mechanisms, each valve is kept under perfect control every step of the way. Only by complete breakage or a severe strain could a valve head touch a piston, and the size of the parts was such that this never happened. The closing cam is a big, heavy devil, so it's been drilled fore-and-aft for lightness. It also has oil outlets at each of its two sharp radii.

The shims under the tappets that we mentioned before actually adjust the main static clearance between the tappet, with valve seated, and the back face of the opening cam. There's another clearance to be considered, that affects the running free play in the valve gear. It can be expressed as the accumulated clearance along the closed circuit of opening cam, tappet, valve stem, bell crank fork and finger, and closing cam—the first and last being on the same shaft. This clearance is very cleverly and closely adjusted by moving the vee of the bell crank toward and away from the cam and tappet group.

As mentioned above, a single rocker shaft runs parallel to each cam, and is hollow and drilled for lubrication. Between each bell crank rocker and this shaft, there are two concentric sleeves, free to be rotated, and running at as close a total clearance as can be devised. Each of these sleeves is machined to be very slightly eccentric—that is, the inner and outer cylindrical surfaces are slightly offset with relation to each other. Thus, by rotating these sleeves under the bell crank, either individually or together, the working pivot location of the bell crank can be slightly shifted in any desired direction. This sets clearance, to sub-micrometric tolerances.

We haven't told you yet how they keep the eccentrics from turning, once the clearance has been set. Each eccentric sleeve has a collar on one end, the two collars for one pair of sleeves being right next to each other and of the same diameter. The outer edge of each collar is serrated. Each pair of serrated collars is kept from turning by a toothed, L-shaped clamp, held down by a single bolt. The clamps for adjacent pairs of valves are placed next to each other, the original idea being that one light, fabricated clamp and bolt would suffice for the serrations of two valves. This was done on early engines, and in fact through the entire 1954 season. At Monte-Carlo in 1955, though, these were the bolts that broke loose and ran wild inside the engines of Simon, Fangio and Moss. The latest versions use two separate machined clamps and two bolts, tightly wired in place. This gave no more trouble.

One other major change in the layout, which appears to have taken place during the 1954-55 winter, involves the position of the rocker shaft. On early engines, the shafts were so placed that the closing cams rotated "into" the bell crank fingers—in other words, from the finger tip toward the pivot point. This isn't the best from the loading and wear standpoint, so the whole works was switched around to allow the big cam to drive from the pivot out.

As the engine is placed in the chassis, the early shafts were on the "lower" side, and they're now on the "upper" side. The cams turn counter-clockwise, as viewed from the front, and, as a matter of fact, so does the crankshaft. Rotation of the driveshaft has been kept clockwise, as in most cars, to have someplace to start.

To take the lifting stress of the rocker fork, plus the opening forces, the end of the valve stem has been forged larger than

Fierce But Friendly

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tremendous area, the shoe having an effective width of 2.250 inches and the drum having a diameter of 12 inches.

The Engine

The power plant that delivers torque so impressively is the work of Max Balchowsky, a long-time Buick enthusiast. In discussing the Morgensen engine with Max, the impression came through strongly that this particular engine has suddenly and startlingly borne the fruits of all he has ever learned about Buicks. It idles from 300 to 400 rpm and will actually pull 8000 in third. Hauser will not admit to the use of more than 7000, however. The fact that on a course such as Paramount only a second a lap would be lost if you threw the gear lever away is a healthy endorsement of Max's methods and makes a close look at this engine worth while.

The cylinder block, the heads, and crankshaft assembly are '56 Buick V-8. The stroke, of course, is the stock 3.2 inches but the cylinders have been bored to 4.125 inches, an increase in bore of .125 inches and an increase in the swept volume to a total of 342 inches. Jahns pistons are used and supply a compression ratio of 9.25 to one. Ignition is by a Buick unit modified to Harman Collins specifications with dual points and two coils. The oil sump has the stem itself. This, plus non-detachable head construction, complicates installing the valves. The trick lies in having removable *split* valve guides. The upper end of each half-guide has an integral collar, which is both held down and kept from rotating by the bottom end of the inserted tappet guide. One side of this guide is also cut away to allow the fork to reach the valve stem. Finally, the tappet guide is held in by a nut and washer, placed at one side. To review, the nut and washer hold down and locate the tappet guide, which in turn holds down and places the split valve guide.

Lubrication up here is thorough and studied. One gallery runs the length of each cambox, at the base of the tappet guides and through holes in the latter. There's also the supply to the rocker shafts that we mentioned. In addition a gallery runs along each cambox, at the level of the tappet shoe and on the opposite side from the bell cranks. Just opposite each tappet a hole is drilled and tapped, and a calibrated jet is screwed in and locked. This gives precise control of a jet of oil aimed right at the working surfaces.

With the racing versions of the 196 engine, noise was not a problem. This being the case, the valve gear covers were held down both by studs around the outside, and by nuts on extensions of the cam bearing cap studs. This held the covers on well, but transmitted a lot of operating noise to the surface of the cover and on to the ear. In the present search for silent running, the bearing stud extensions have been eliminated and the number of surrounding studs increased from four, on the earliest engines, to thirteen on the latest. To "economize", the two cam covers on each block are interchangeable.

Frankly, we could go on forever analyzing the unusual features of this powerplant. You can see a lot more in these drawings: The fabricated breather baffling, the complex oil distribution system, the ducting of cool water through the center of the crankcase casting, and the gasketing and sealing methods. General opinion is that this engine will never be produced in anything like its present form. We just wonder, though, when we see the steady, directed research that is still being carried out, side-by-side with the development of new production models. If anyone can do it Mercedes can and if it's necessary for either publicity or competition they won't hesitate.

Karl Ludvigsen

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been enlarged to ten quarts and the oil temperature is controlled by a seldom-seen method. Fixed in the pan is a layout of .750 inch diameter tubing that circulates water from the radiator through the oil. This warms up the oil quickly on starting and tends to maintain a temperature balance between water and oil on long runs.

The top end of the engine shows Max's reluctance to go along with what others are doing, and results show that in engine building too there is more than one way to skin a cat.

The heads have not been radically reworked. The ports, other than nominal cleaning up, have not been touched, although the combustion chamber is pol-

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