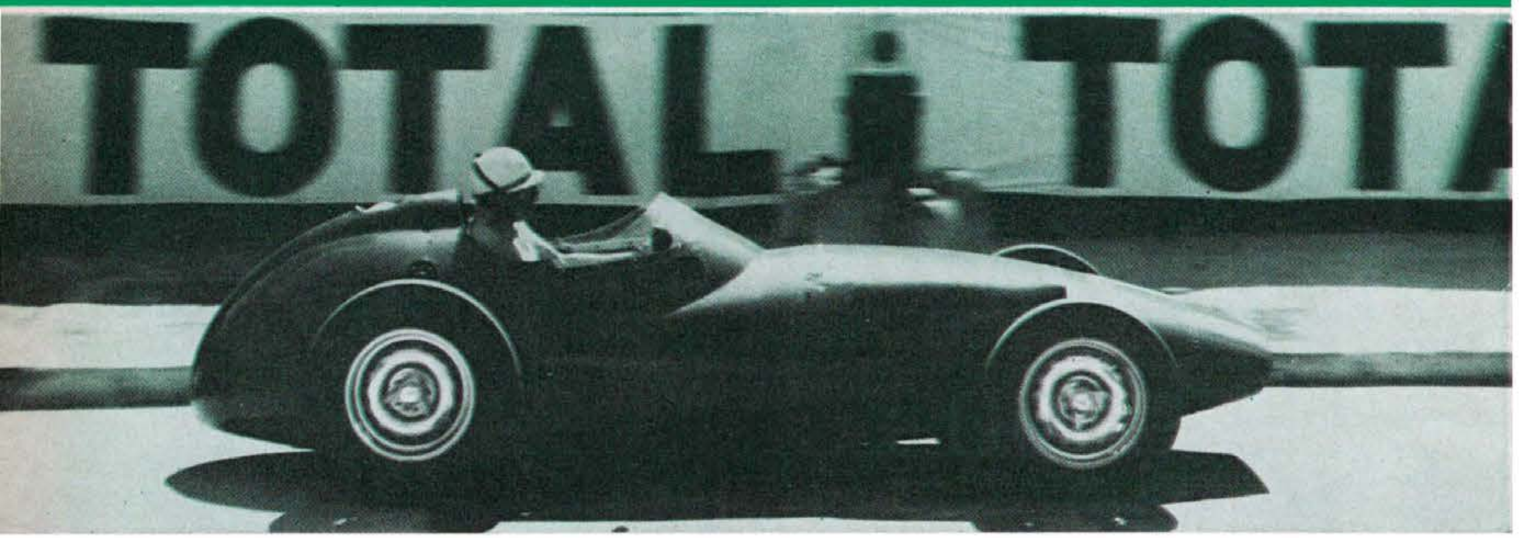
BRITTLE BUT RAPID MOTOR CAR



BY KARL E. LUDVIGSEN

THAT ear-splitting mechanism, the original V-16 BRM, found itself afflicted by two congenital ailments. One was a tendency to go blindingly fast and then break because this speed had been obtained by asking some small part to do more than it was able. The other was the most frustrating kind of brake trouble. By the time the show was fully rehearsed and ready to be performed reliably, everybody had tired of waiting and had adjourned to the next tent.

So far, history has viciously repeated itself. The present BRM has remedied only the first ailment; the second still exists. The car does have a basically sound design. Its crew, benefiting from increased experience, displays a "try anything" attitude unique to big time British racing.

Raymond Mays and Peter Berthon originally conceived BRM during World War II as a cooperative effort on the part of English automobile builders to put green cars on the front of Grand Prix starting grids. The remarkable thing was not that the complex dream car was actually built, but that Mays's persuasive talents had coaxed 160 member firms into the alliance. The shortcomings of this arrangement are worth not another story but an entire book, the upshot being that by the time the present Grand Prix formula came into being the BRM assets had been taken over by Rubery Owen and Company, one of the largest behind-the-scenes concerns in British industry and a major participant (frame construction) in the original project.

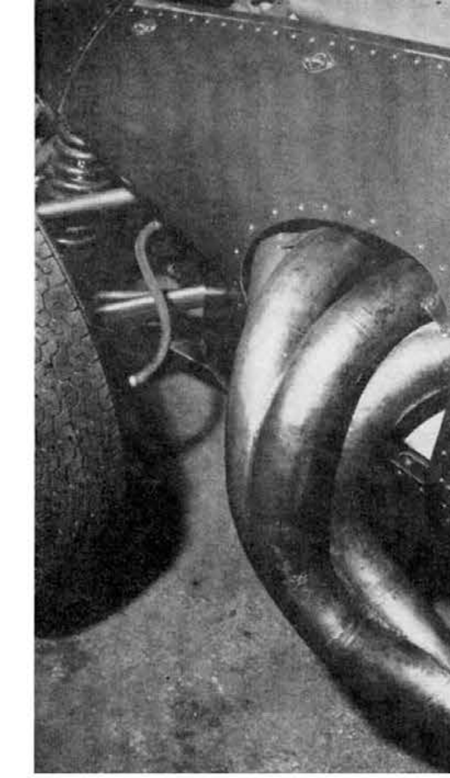
This sobered and reoriented group examined but rejected the tempting prospect of making a blown 750–cubic centimeter V-8 out of half the original engine, and, like all other serious contestants, plunked for 2.5 liters unblown. Though it is less obvious in this car, it has always been characteristic of BRM and, indeed, of most major British GP contenders to place the main design emphasis on the engine and drive train. Unlike (for example) Jano, whose original Lancia D-50 was, if anything, more imaginative chassiswise than under the hood, British draftsmen tend to pin their faith on established suspension and frame systems.

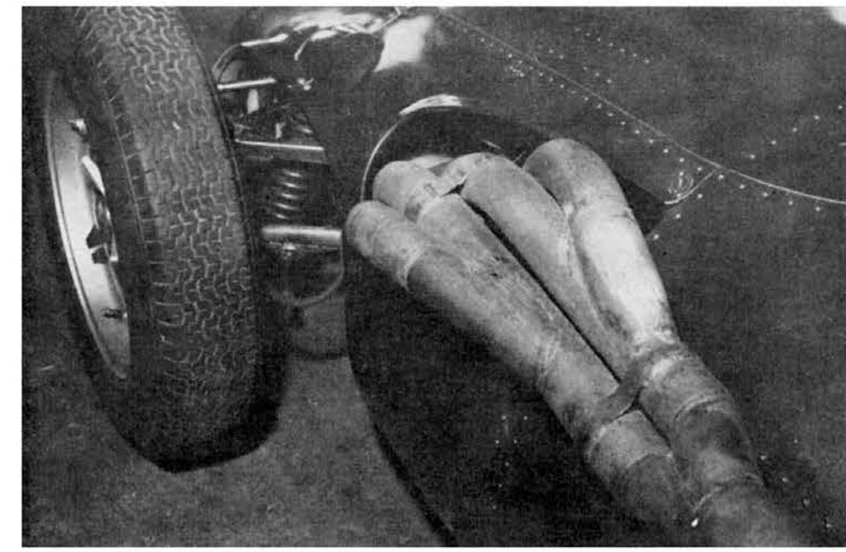
This story begins when a small but progressive firm (Connaught) went looking for a new GP engine. They engaged a chap named Tressilian to draw up one for them on trial, but when they were confronted with the enormous task of building and developing it, they turned to the Alta 4. It was not as promising but at least it was in the form of hardware already. Tressilian then had to find a market for his sheaf of drawings. Alfred Owen picked up the tab and used the design for his new BRM.

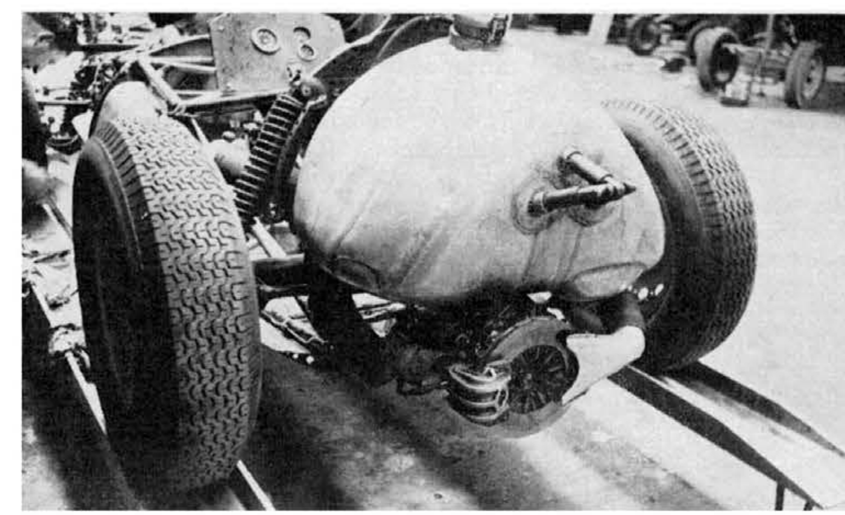
To simplify development this powerplant has but 4 cylinders in a row, but considerable effort was made both in the original design and in single-cylinder test engines to provide the largest practical piston area without the mechanical involvement of the old

The newer exhaust system, at right, replaced the one shown below and while it probably does the job as intended, over 30 separate welds can be seen in the photo. The seemingly extraneous welds might be explained by the desire to get at, and smooth, the inside seam of the necessary welded joints. Part of the old and new suspension members can also be seen with the newer car having front A-arms made of tubing rather than fabricated from sheet stock. The older arms were probably no stronger than the new and certainly not as neat.

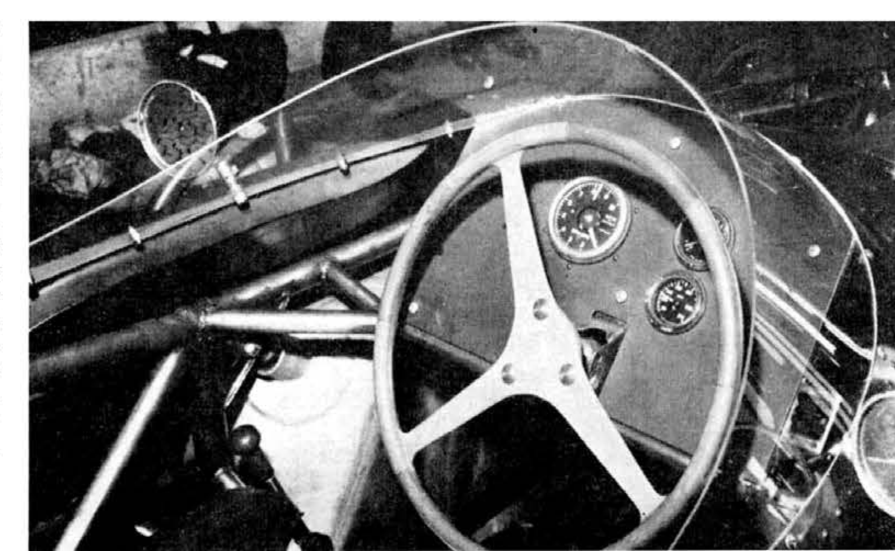
PHOTOGRAPHY: LUDVIGSEN, CAHIER

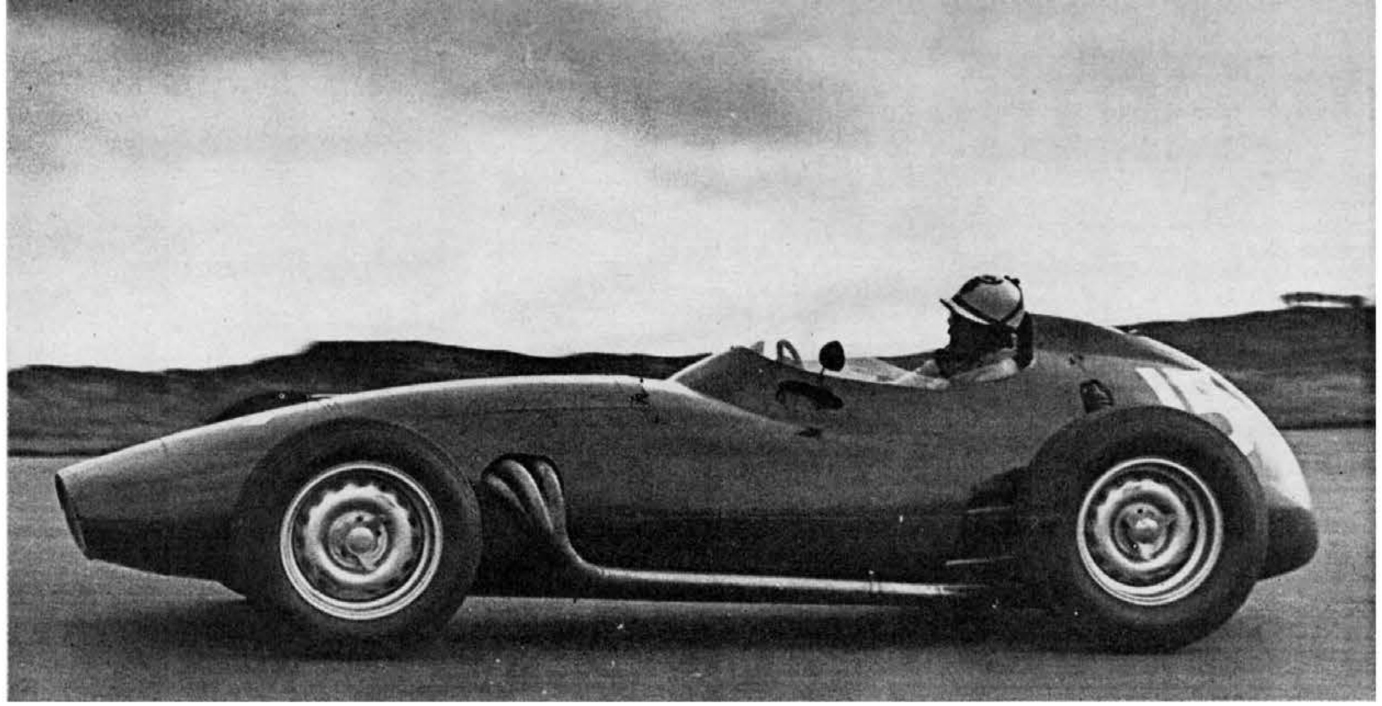






Exposed view of the BRM's stern shows triangulated tube members which support the fuel tank. They are attached to the frame structure behind the driver. Rubber sleeves between the tank and tubing prevent damage from road shock. Below the tank is the transmission-mounted disc brake with one duct directed at the brake caliper and the other, surprisingly, aimed at the periphery of the disc at the point where it should be exhausting hot air through its radial slots. The instrument panel is simple with only a tachometer (with the tell-tale needle stuck at 8500 rpm), temperature and oil pressure gauges to look at. Above right: rear view of the front A-arms.





V-16. Throughout the engine, we find casual similarities to the Ferrari Monza and Super Squalo series. The very first is the fitting of wet cylinder liners which screw into the aluminum alloy head at the top and are sealed at the bottom by twin O-rings reposing in grooves in the block. Unlike the Ferrari 4's, however, the outer water jacket is integral with the waffle-webbed crankcase rather than with the head. The latter detaches at a conventional high level, unusual precautions being taken to hold it in place. Studs extend down from the head around the outside of the water jacket, where nuts make a seal against Permatex. More conventional upright studs run down the center of the head between the cam housings, and then extend right through structurally to the main bearing caps.

Originally this engine had four main bearings, the usual one between No. 2 and 3 cylinders being omitted. For 1958, the crank and crankcase were revised to include this journal. Thanks to the very large bore, there is plenty of room for wide bearings, an opportunity which was undoubtedly not missed. The crankcase extends several inches below the crank centerline to give added support to the main caps, which are further bound in place by long through-bolts inserted from the left-hand side. This rugged bottom end is additionally stiffened by a shallow but heavily sectioned sump casting attached by a multiplicity of studs.

At the front, the block/crankcase extends out on both sides—more on the left—to provide engine mount points but also to contribute to chassis stiffness. Within this extension is a short train of accessory-driving spur gears turned by the crank. Above and to the left of the crank center are the twin 4-cylinder Lucas magnetos, supplying simultaneous sparks to two type-280 KLG plugs per cylinder.

Driven right from the crankshaft nose is the water pump, with a single central entry and twin exits. On the left, the pipe carries cool water all the way to the rear of the block, while on the right it is injected at the front. This thoughtful initial distribution layout is augmented by the internal head design, which has had more influence on the outside shape of the head than the appearance considerations which so often seem to govern Italian design. Like the Vanwalls, and unlike Modenese creations, hot water is drawn off above the exhaust valve seats and guides. It returns to a canister fitted with a pressurized filler cap and overflow pipe, then finally to a small, light, twin-core radiator. On the first cars the central duct was for engine ventilation (on the prototype for carburetor air as well), the hot exhaust from the cores being deflected away to the suspension openings at each side, but in the new editions, this subdivision has not been adhered to.

The BRM's complex oil circulation system is rife with innovations, not the least being a pressure oil pump mounted externally behind the left-hand engine mount extension. It is placed just under the exhaust pipes and a metal shield, and turned by an additional spur on the gear train to the magnetos. In unit with and extending back from this pump is a Purolator full-flow oil filter. Hung in the left rear of the engine room is an oil tank which is small by Grand Prix standards, and it will be noted that there are no obvious means, like radiators, for cooling the BRM's oil. The designers have taken a tip from marine and industrial practice, electing to attempt a heat balance between the oil and water systems. In the early cars, this was achieved by running that left-hand cool-water pipe from the pump to the rear of the block through the oil reservoir. In the 1958 version, a small oil/water heat exchanger is fitted in the lower tube from the radiator to the water pump. Both arrangements have insured adequate cooling and dispensed with the weight and drag of an oil radiator.

At the rear of the sump is a more conventional triple-gear, twin-entry scavenger pump, turned by a downward extension from another spur gear train at the back of the engine. This gear train also goes up to drive the twin camshafts, one idler on the left driving the mechanical fuel pump as well. Still relatively rare, this arrangement has the merit of applying the clutch and camshaft drive loadings to the same end or point on the crankshaft, thus simplifying torsional stress provisions. It has been subscribed to by the Alta, W-196 Mercedes and the V-16 BRM, among others.

For 1958, the entire cam and valve gear department was both overhauled and beefed up, the '58 engines being identifiable by cam covers which are bolted down around the edges instead of by extensions of the cam bearing studs. No actual change was made in the BRM's five bearings per cam. The bearing housings are exceptionally wide, the center three having six retaining studs (two major and four minor) apiece. To allow room for the valve springs, these housings are supported by considerably narrower pylons.

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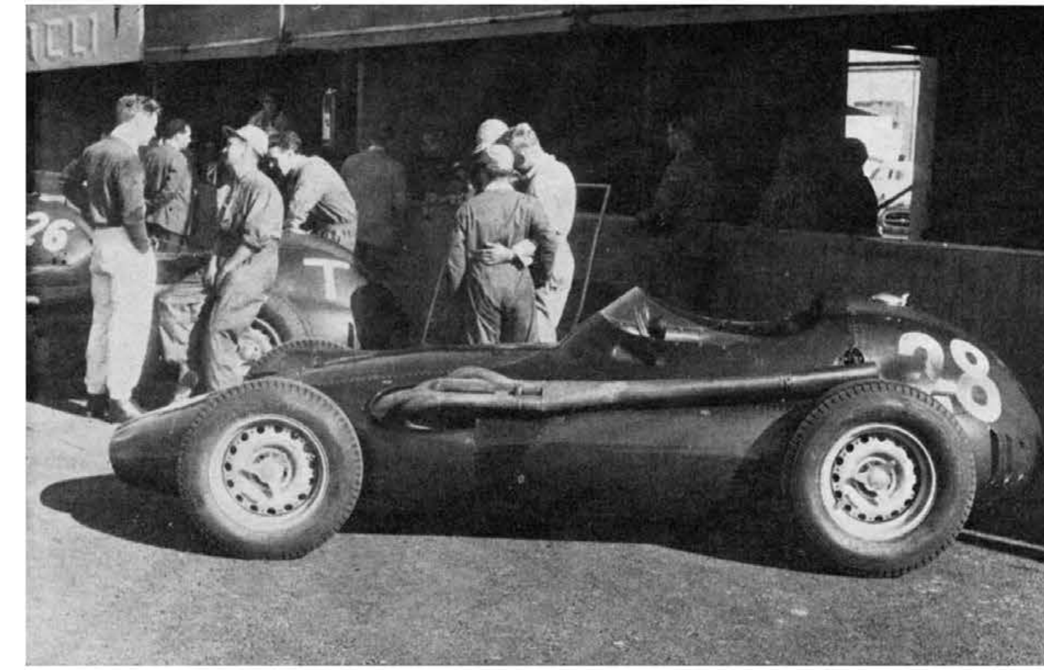
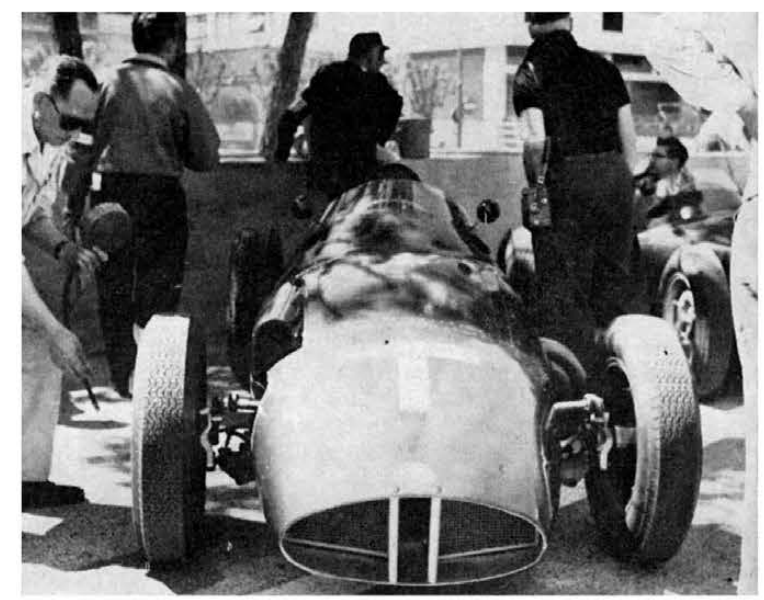
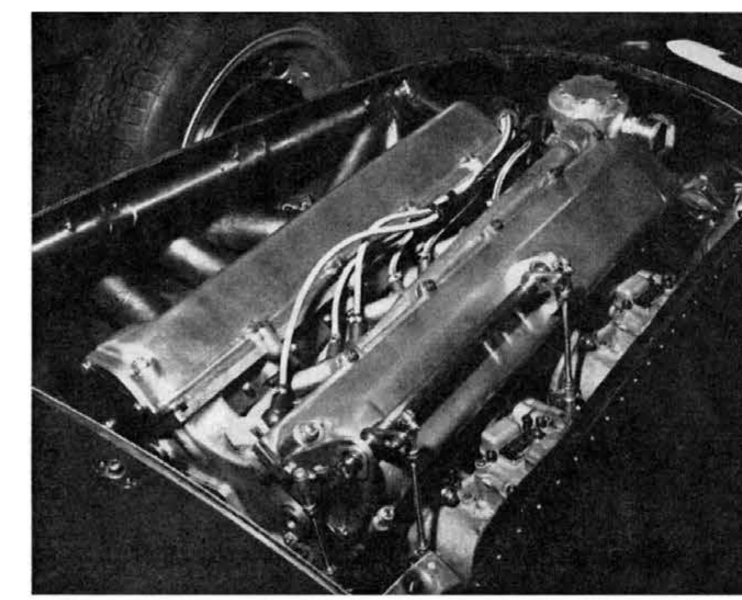
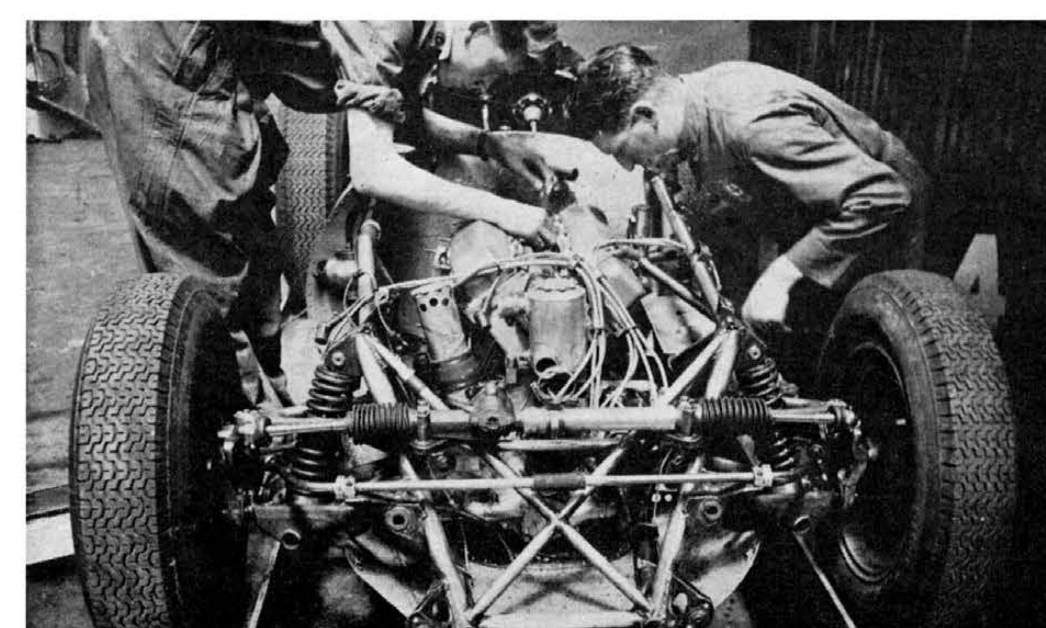
The newer car is shown (opposite page) at the 1958 Dutch Grand Prix, driven by Harry Schell. The front of the car is high because it is accelerating out of a slow curve. The older model, in the pits at Casablanca during the 1957 race, looks similar to the newer car but not quite as clean. This car was driven to third place by Trintignant and the race was won by Behra in a similar car. The divided radiator and air intake can be seen on the training car at the 1958 Monaco GP. The BRM's tires are Dunlop R5 racing.







Throttle linkage to the two twin-throat Weber carburetors is attached to the right-hand cam cover and connects to the foot throttle by a series of bell-cranks and rods. The top of the radiator overflow canister can be seen at the front of the engine. In the lower photo the details of the rack and pinion steering and anti-roll bar can be seen, behind which are the Armstrong coil spring/damper units which attach to the beefed-up lower A-arm assemblies.



BRM

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Oil for top-end lubrication is supplied directly from the pressure pump by external hoses to the front of the head.

The BRM valve gear is of the very popular (Maserati, Osca, Porsche, etc.) finger follower type, but it must surely be the most rugged and advanced interpretation yet seen. First, the cams themselves are about an inch wide and very radical in profile. The back or base circle surface is recessed in the center, leaving only about ⅛ inch of acting cam surface at each side. This unusual relief may aid in feeding oil to the cam ramps, or in equalizing cam surface loadings and consequent wear. The sides of the cam lobes are also lightly dimpled.

A single shaft for the finger pivots runs along the inward side of each cam box, and is carried by and pierces a series of machined projections. Each projection is placed directly opposite a valve stem. The fingers used are very wide—wider than the cam lobes, in fact, along the shank, which is a shallow U-shape in section. At the pivot end, the finger shank is deeply notched so that it can embrace the above mentioned projection, like a hinge joint. The final touch is supplied by a mousetrap-type spring with its end coils wrapped around the pivot shaft and its center section pressing the finger up against the cam.

Down below all this are two massive hairpin-type springs for each valve, placed in a fore-and-aft plane. As is well known, the BRM has very large intake valves, on the order of 2.25-in. head diameter. For some time they have been trying to perfect a valve in which not only the stem but also part of the head was hollow, the cavity being sealed off by a special disc. Finally, this seems to have been abandoned, as the valve heads no longer have the "pennies" embedded in them. Only the stems remain hollow.

The redesigning of the valve gear appears to be an attempt to control these necessarily heavier intake valves by exceedingly powerful springs, acting on fingers and cams which are big and rugged enough to take it. The separate finger spring is a new addition, probably suggested by the added weight of the new finger—and so the cycle goes. That this strong-spring idea is sound was intimated by the sight of mechanics working away with emery cloth to retard severe scoring that had begun on the peaks of the cam lobes. The rev limit is back up around 8500 again, and that's what counts.

From its inception, this potent 4-banger has featured large intake and exhaust systems to complement the big valve size. Like the Vanwall and its antecedent, the Norton, intake ports are angled mildly to the rear to induce turbulence in the chamber. This causes the slightly staggered carburetor placement, which is augmented by a downward slant toward the intake valve. The flexible sections included in the first carburetor-mounting stubs were eliminated in the early '58 engines, but later reinstated.

Carburetors are, of course, by Weber. On last year's cars they were 52-millimeter, but now they're the biggest Weber makes: 58 mm. With such big venturis, the BRM might be expected to lack low-speed torque, but this couldn't be farther from the case. The cars can be tooled like Bentleys through postrace traffic and burst out of slow corners with a savage violence. Looking back, the same size carburetors were used on the Ferrari type 553 or Squalo, which had a bore only 2.8 mm smaller than the BRM and an intake valve of about 2.125-in. diameter—really very similar. It would seem that the accumulation of know-how on port and cam design has allowed BRM to make the most of these carburetors, which may have been used prematurely on the Ferrari.

Such know-how includes exhaust tuning, which has always figured prominently on the BRM. The original "tortured hand" manifolding has been replaced by a neater, lower-placed system which retains the original lengths and junction placements. A very gentle megaphone is formed by the last couple of feet of the big collector pipe. The manifolding is mounted firmly to the chassis but not to the engine, since there are telescoping joints adjacent to the exhaust ports.

Thanks to its wide valve angle, short stroke and dry sump, this engine is unusually shallow and, in keeping with the car, just as light. In 1957, it delivered 280 brake horsepower on fuel that was mostly methanol; with the revisions made, it must be pressing close to 270 on gas this year. The power is led away by a 7.25-in. Borg and Beck twin-plate racing clutch in unit with the engine. There is no housing as such; the clutch shaft bearing is supported by a tripod of cast arms which leaves lots of ventilation area. Having some distance to travel at high revolutions per minute, the propeller shaft is divided into two sections and given a center bearing.

Since the gearbox on the V-16 BRM was essentially a copy of one of the most elaborate things Mercedes ever did, it was a surprise and pleasure to find a uniquely neat and simple transmission in this car. As in the now-neglected Pegaso layout, the box is wholly behind the final drive gears and has three shafts extending rearward, one above the other. The drive comes in on the bottom shaft and passes directly up to its neighbor, thus providing a low propeller shaft line and a pair of gears which can be quickly swapped (two hours). An extension of this lowest shaft drives the scavenger and pressure oil pumps, which bathe the gears with engine oil through a series of jets.

The middle and top shafts comprise an all-indirect gearbox of the type made familiar by Cord and VW, the upper shaft being straight-bevel-geared to the ZF differential and the half-shafts. Constant-mesh straight spurs for the 4 forward speeds are engaged by dog clutches. First and 2nd are chosen on the middle shaft, and 3rd and 4th on the top one. The selectors are on the left side, from which a much angled and U-jointed push-pull control shaft leads forward to a stubby, non-gated lever.

A single, simple casting with front and back covers houses the whole box and differential, and the entire weight is hung from the frame through the front cover alone. The half-shafts now have two Hooke-type U-joints and a ball-bearing sliding spline, replacing the troublesome pot-type inner joints used until the middle of '57.

Joined directly to the rear wheels through the axles, differential, top gearbox shaft and a gear set at the back is the BRM's distinctive single rear brake disc. Inevitably a center of controversy, this is an ingenious weight-paring device which has no mechanical—as opposed to thermal—drawbacks. The entire brake system is by Lockheed. Their patents are apparent in the finned, single-cylinder calipers with rectangular friction pads. Twin master cylinders are worked directly by the pedal and supplied with fluid by a small reservoir on the firewall.

All the brake discs are of cast iron, those at the front being solid and on the thin side by present racing standards. Because it is shrouded and must do the work of two, the rear disc has cast-in centrifugal vents which are fed with air from a cowl scoop (oddly in opposition to the centrifugal flow), as is the rear caliper itself.

Before signing on with Maserati in 1956, Stirling Moss tried out the Connaught, Vanwall and BRM to see if one might be worth his further attention. Still with its original hollow valves, the BRM impressed by its acceleration but the car was unstable. In those days, corrections were attempted by clamping on iron weights here and there, and the stability problem persisted until Colin Chapman was consulted in 1957. His advice, now well backed by his Vanwall experience, guided the design of the 1958 chassis.

The BRM's ball-joint front suspension has always been very neat and compact, the wishbones being short and close together. The steering knuckle and spindle are a light, rugged and well integrated piece of work, with a U-section through the vertical portion. Only the upper ball is formed as part of the knuckle. The upper ball cup is vertically placed and the lower one horizontally carried by the knuckle and facing inward toward the wishbone. Originally fabricated of sheet stock, the upper wishbone had become distorted by constant alterations and has been replaced by a cleaner part made of tubing. The longer, wider bottom arm is welded up on oval-section side members and tubular cross-bracing to stiffen its union with the short coil/damper suspension unit.

An anti-roll bar is now placed between the wishbones instead of below them, and is connected to the bottom arms by very short links. On the new cars the lever ends of the anti-roll bar are smoothly tapered down from the center section to the small linking balls on the ends—a very finished touch, and lacking on the old cars.

Short, husky, forward-facing steering arms are joined by Lockheed tie rod ends to a superbly machined BRM-built rack and pinion steering gear. Helped by universal joints, the steering column finds its way forward down the right side under the carbs.

The world's best steering is of no avail if the back end is not perfectly predictable. De Dion suspension has been given a new lease on the BRM, but the old axle tube is superseded by a smoother-curved three-piece fabrication. Lateral location is by means of the increasingly popular Watts linkage, the short vertical link being center-pivoted from a bracket below the tube to provide a lowered roll center. Parallel radius rods handle the remaining forces. Much longer Armstrong coil/damper units take care of springing at the back and are steeply "sea-legged" inward. Remaining features are 1.5° of negative camber and, recently added, a small amount of toe-in.

About the best that could be said for the original 4-cylinder BRM chassis frame was that it was light. Otherwise, it was a collection of curved tubes of countless sizes welded haphazardly to punctured boxes. It gained much needed strength through extensive use of stressed skin, a theoretically commendable practice which is still used on the firewall of the new machine.

The latest frame, a true space-type job, was fabricated by means which illustrate the new free-wheeling attitude of the BRM design team. They simply got a good idea of what was required, and then welded up a tube framework in reference to bulkheads erected along a surface plate. Now, while the cars are running and placing well, they're making up the drawings for the record.

Upper and lower frame side members are widely spaced, the top ones running by the cockpit at shoulder height giving added driver protection. There are three main torsion-resisting sections. At the front, a light, diagonally strutted tube network joins with the front engine mounts and crankcase to provide rigid alignment for the suspension assemblies. In the middle there is the stressed firewall, pop-riveted to a tubular cowl structure, and finally behind the driver's back there is an X-braced rectangle which accepts the rear spring loadings at its top and the gearbox weight at its bottom. In fact, this represents the end of the frame proper, the main fuel tank being pierced by a tubular tripod which bolts to this rectangle. Supplementary fuel tanks are carried on each side of the cockpit, the desired tank being selected by a valve just ahead of the driver's seat.

There are a couple of incongruencies. One is that the upper right front frame must be kicked up from its proper line to clear the big Webers. The other is the use of small tubular triangles to hold the de Dion radius rod pivots a short distance out from vertical frame members which, if properly placed, could seemingly have done the job unaided. Otherwise, the whole car looks very right to the engineering eye.

Considerably cleaned up in detail, the bodies retain the oval air intake and the permanently attached high cockpit fairing first added at the end of '56. A detail note is that the new carb air scoops simply feed cool air into the open engine room in the region of the velocity stacks, while the older ones were ducted and sealed off to create a ram effect from forward motion. Junior-sized stacks into the duct pressurized the float chambers the same amount, they hoped. This, as I have often maintained, was probably more complication than it was worth. At Spa and later races in 1958, some cars used the original ducting system from the central front scoop opening.

BRM joins Vanwall as one of those anomalies of Grand Prix racing in the Fifties: the racing car builder who has no direct interest in constructing sports or passenger cars. Because of this, we cannot look forward to the 2-liter Grand Touring edition of the BRM, however appealing a prospect that might be. In recompense, we can surely expect Rubery Owen to learn a great deal about theory and practice in the "advanced class," information which can only improve the production British sports car. There is another angle, too. The husky, shirtsleeved figure of Roland Bugatti has recently become a fixture of BRM pit areas. If his firm were really serious about a comeback, he could hardly choose a stronger ally. Anyway, BRM (along with Vanwall, Cooper and Lotus) has finally helped do what it was founded to attempt: to raise British prestige in Grand Prix to hitherto unequaled heights.