SCI Technical Report: CORVETTE SS

By KARL LUDVIGSEN, SCI Tech Editor

REMEMBER the fable of Tantalus? This unfortunate gent was doomed to stand in the midst of a sea with clear, cool water right up to his neck and boughs laden with succulent fruits hovering over his head. When he bent down to drink the sea rushed temptingly away, and the boughs always swung just beyond his reach. This sounds like a rough life, but it's Paradise compared to what GM's been doing to you and me – and to everybody that feels that American cars should be well represented in international racing.

Take a look at the machine laid out on the center spread. It's not a four-alarm advance over all existing equipment, but it is basically a good car. Given more than half a chance and some intensive track testing it could compete on level terms with the world's best—Sebring practice proved that. In view of this highly publicized fact it must have been extremely disappointing to many to hear that it wasn't to go to Le Mans. Perhaps most disappointing to knowledgeable Europeans who felt that Sebring was just a trial outing and expected a full team and all-out effort for the 24-Hours. We won't try to estimate the effect a "no-show" could have on American prestige abroad.

Of course, we can now sit back and see what it was actually all about. We can see that the men who built the Corvette SS were intensely sincere about the job, both as it was specifically outlined to them and as they hoped it might develop. The fine detail design and clean fabrication tell us this, as does their desire to see it compete seriously abroad. We can also see that the management of GM and Chevrolet had only one thing in mind all the time: to bask in all the publicity and excitement that they knew such a sensational Sebring entry would shine down upon them, and then to forget about it except possibly for some minor events in this country. Also, naturally, to "show the world that GM could really clean up if they wanted to."

They warned us that this was all. When the SS was announced Chevy General Manager Ed Cole "emphasized that it is a research project to study advanced engineering characteristics in the field of performance, handling, braking and *other* safety features". The word we italicized is Chevy's loophole in case another Congressional committee shouts "Speedmonger!" This was all they did and do intend, but they led many people on for too long, even poor Zora Duntov, who will probably take some of the public blame for the defection. Even Briggs Cunningham, who was scheduled to run the SS at Le Mans, wasn't told "no" until a month and a half after Sebring. And mostly they led on the rest of us who'd like to see these cars go out and DO something.

How did the car get built in the first place? A couple of top-level minds happened to click and the whole thing was shoved through as a triple-priority crash program with Sebring as a definite deadline. Now there's no more deadline—no place to go. The next may be the SCCA Nationals, or perhaps Bonneville. Money is available, but authorization to use it is being withheld until Chevrolet does better in this little sales tussle with Ford. Some may say that race wins by the SS would boost Chevy sales, but we don't think so. Production Corvettes might get a little more play but hardly enough to pay for the racing operation.

No, GM had every justification for handling the SS this way. We can only wish that there had been less pomp and a little more circumstance at Sebring, if that remains the only major appearance of the SS. We can also hope that the work of Duntov and his crew will be invested in future production Corvettes, since the present four-year-old chassis may be pushed hard by the new Mercedes 300SL Roadster and the Jaguar XK150. In any case the SS gives us a window through which we can see what Chevy Engineering has up its sleeve.

With only five months to design a raceable car, the SS project was definitely a rush job for GM. As a result, Duntov had to rely heavily on components which had been thoroughly tested before, and could only lighten them if possible and fit a new framework around them. Fortunately a lot of miscellaneous information had been compiled from experimentation and racing with stock Corvettes and the special SR2 versions.

For one thing, they knew pretty well what the 283-inch V8 could and could not do. When the displacement was boosted from 265 there were some misgivings about the crankshaft, but undercutting the fillet radius at the journals has kept this glued together at 7000 and up. A weak point did show up at the wrist pin bosses in the piston, which distorted at high revs—notably in the badly overrevved SR2 at Nassau—and came apart. A little more meat around the boss cured that. Development on the SR2 for Daytona also led to the 40 inch tuned exhaust length that was incorporated in the SS. Racing during the winter helped to shake down the Rochester fuel injection system and determine its limitations.

Pressure of SCCA "Production" racing had forced the development of a four-speed gearbox, which with the use of an aluminum alloy case was just right for the SS. The iron case box, by the way, was available as of May first for $189 extra, or about the markup asked for the automatic transmission. Sounds encouraging.

The rush program for Sebring in 1956 turned up the sintered metallic and ceramic brake lining that's been used on most racing Corvettes with considerable success. They're fine if you don't mind replacing the drums fairly frequently and *warming up* the brakes before using them hard. A type of drum finning was also devised that appeared to give good results.

With these for a start Duntov had to build a light, compact car with handling of a very high order. Since time was short the 300SL frame was elected as a good pattern to follow, and the placement of the main SS chassis tubes resembles the SL very closely—NOT the D-Type Jaguar, as the rumors have run for so long. When the major members were set smaller tubes could be added for the particular requirements of this engine and suspension and to add stiffness where stress tests showed it to be needed. Big cross tubes connect the abutments for the front and rear coil springs, the rear mounts being nicely curved and drilled towers. Where parts like the brake servo cylinders are attached the frame tubes are square, to ease mounting, but otherwise they're round and about an inch in diameter. Particularly reminiscent of the Mercedes are the pyramided tubes at the cowl and the truss structure under the doors.

Front suspension resembles that of Chevy passenger cars in that the non-parallel wishbones are welded up of steel pressings, but the whole assembly is scaled down. Ball joints are fitted at the outer ends, and the wishbone frame pivots are rubber bushed. With more time metal-to-metal bushings might be installed for more precise control. A small-diameter anti-roll bar crosses the chassis under the suspension and is connected to the bottom wishbones by short links.

Nobody interested in fast cars will be shaken by de Dion rear suspension, but it is a novelty for Detroit machinery (except for notable show cars like the Le Sabre, Firebird I, the La Salles and Pontiac's Club de Mer, only two of which ran). Though the rear end looks confused, the curved one-piece de Dion tube is fabricated and located very neatly indeed. There are four tubular trailing arms, two of which are rubber-bushed to the frame just forward of each rear wheel. The upper arms angle slightly outward and are ball-jointed to the tops of the hubs. The lower arms however converge to the center of the axle tube and are fixed to the underside of the tube by ball joints at that point. A rigid yet light three-point location resulted, the frame mounting of differential and brakes relieving the tube and arms of drive and braking torque reactions.

The arrangement of the bottom trailing arms was one of the few brand-new features of the SS, but it's worth remembering that this was the source of one of the failures that

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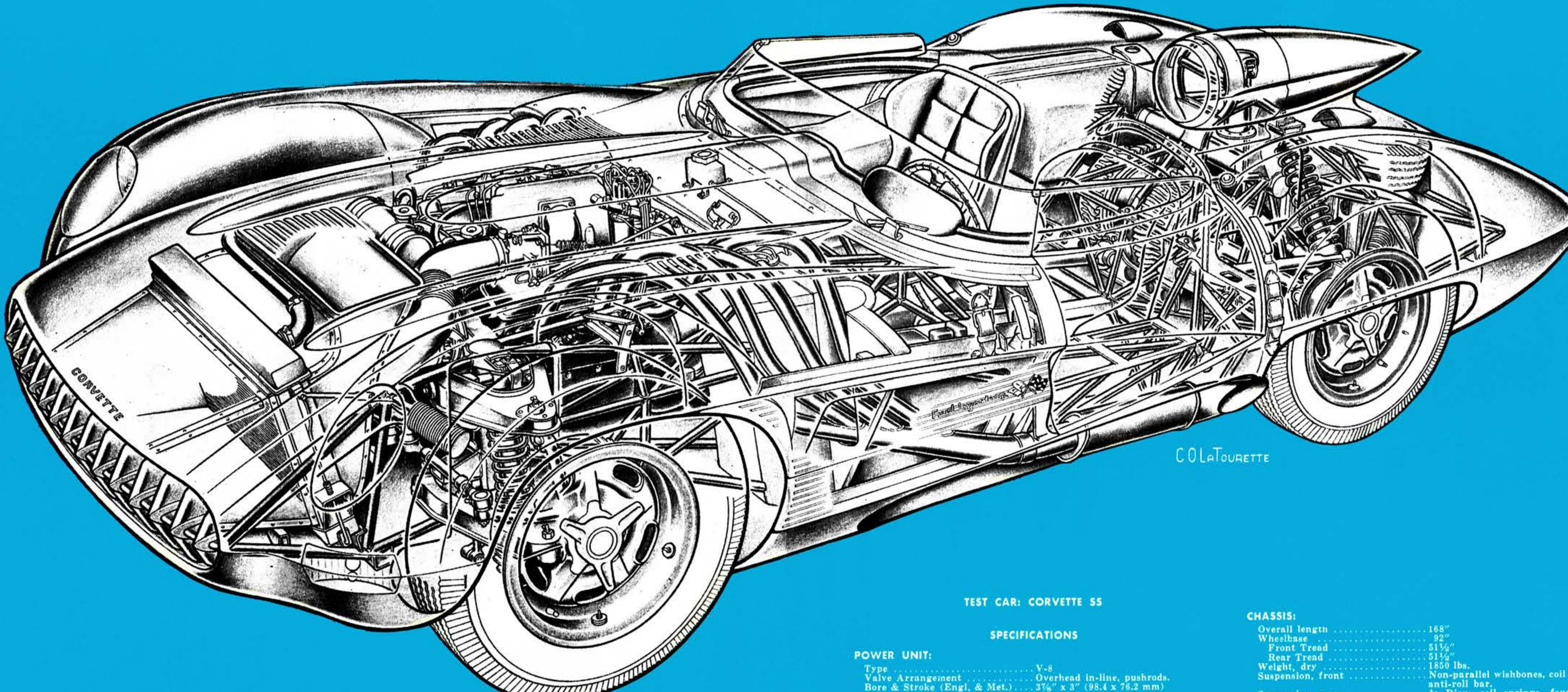
CORVETTE SS — too little time, too many cooks, but . . .



TEST CAR: CORVETTE SS

SPECIFICATIONS

POWER UNIT:

Type	V-8
Valve Arrangement	Overhead in-line, pushrods.
Bore & Stroke (Engl. & Met.)	3⅞" x 3" (98.4 x 76.2 mm)
Stroke/Bore Ratio	0.774/1
Displacement (Engl. & Met.)	283 cu. in. (4640 cc)
Compression Ratio	9/1 (11/1 optional)
Carburetion by	Rochester constant-flow fuel injection
Max. bhp @ rpm	310 @ 6000
Max. Torque @ rpm	295 @ 4400

Camshaft: Chain-driven "Duntov", 0.398" lift, solid tappets

Valves:	Intake	Exhaust
Opens	35° BTDC	76° BBDC
Closes	72°ABDC	31° ATDC
Diameter	1.85"	1.625"

DRIVE TRAIN:

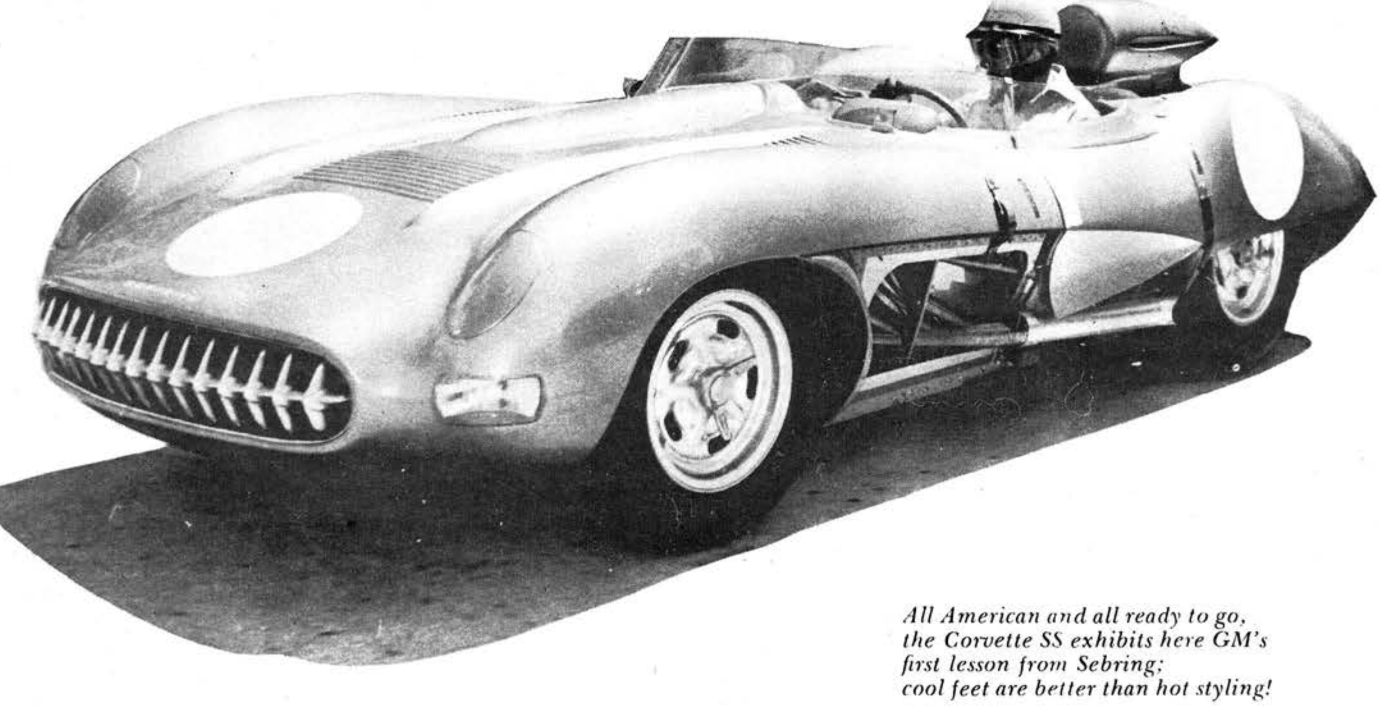
Transmission ratios	
I	1.87
II	1.54
III	1.22
IV	1.00
Reverse	1.87
Final drive ratio	3.87/1 with Halibrand quick change, Positraction differential.

CHASSIS:

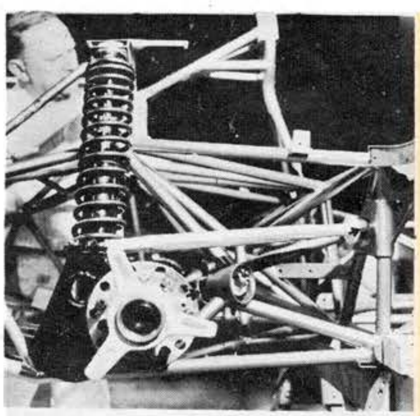
Overall length	168"
Wheelbase	92"
Front Tread	51½"
Rear Tread	51½"
Weight, dry	1850 lbs.
Suspension, front	Non-parallel wishbones, coil springs, anti-roll bar.
Suspension, rear	de Dion, coil springs, four radius rods.
Shock absorbers	tubular, in unit with coil springs.
Steering type	Saginaw recirculating ball, three piece track rod.
Steering ratio	12/1
Brake system	One master cylinder, two separate servo systems.
Brake mechanism	Chrysler Center-plane 2LS with 12" x 2½" drums and Cera-metallic linings.
Wheel	cast magnesium with knock-off hubs.
Tire size	6.50/6.70 x 15 front, 7.10/7.60 x 15 rear.
Fuel capacity	43 U.S. gallons.

RATING FACTORS:

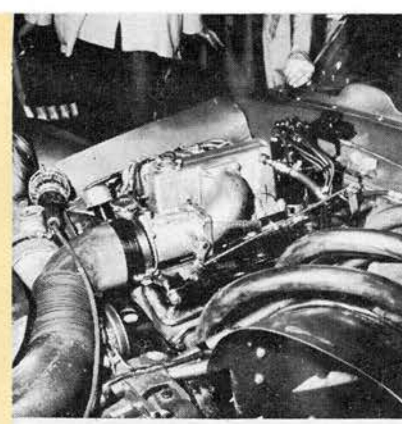
Bhp per cu. in.	1.096
Bhp per sq. in. piston area	3.30
Torque (lb-ft) per cu. in.	1.04
Pounds per bhp—test car	6.6
Piston speed @ max bhp	3000 fpm



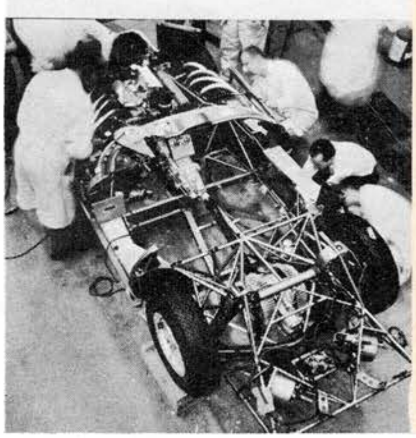
All American and all ready to go, the Corvette SS exhibits here GM's first lesson from Sebring; cool feet are better than hot styling!



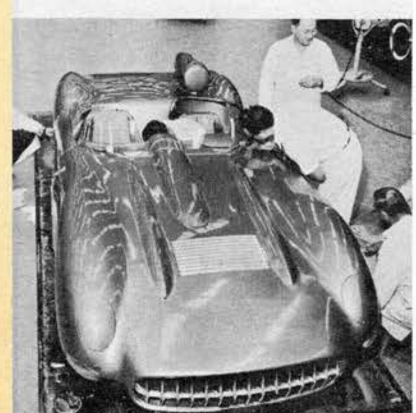
There are rubber bushes which eventually caused GM to retire the SS in early hours of race.



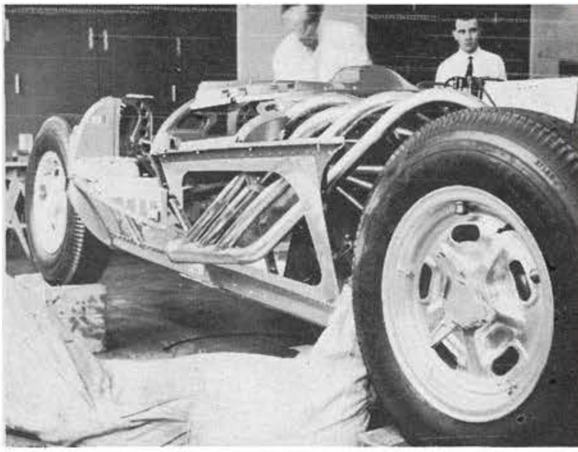
Forward facing air metering valve leads cool air from Fiberglas duct to plenum chamber of injector.



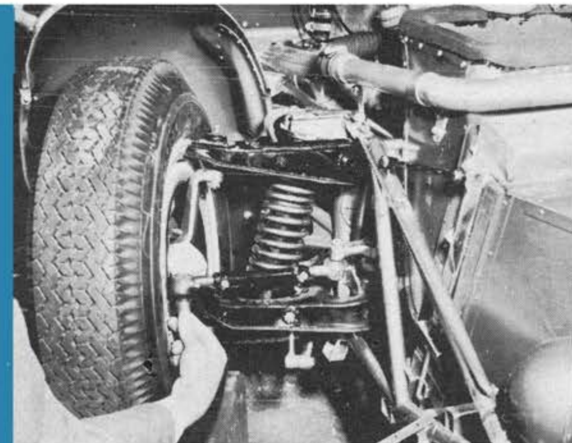
Everybody hustles to finish Chevrolet's activated dream car in time for debut at the Florida Grand Prix.



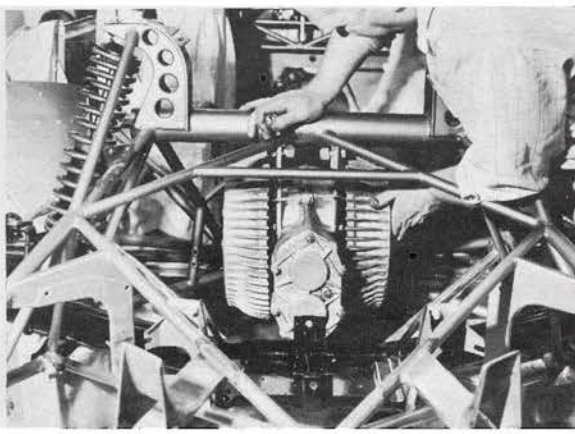
Details of finish are attended to with concern that might embarrass some Concours d'Elegance entrants.



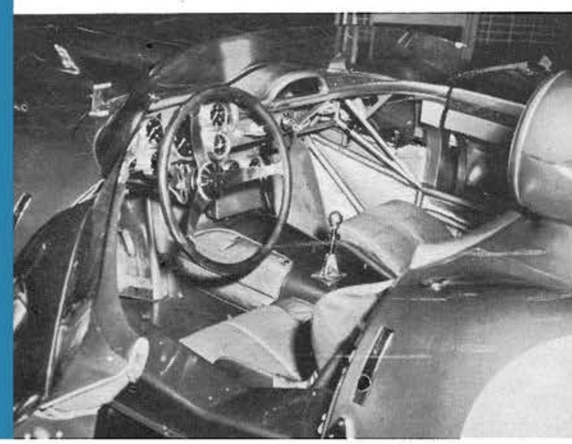
Forty inch tuned exhaust headers arch high over frame tubes, then down and aft. Rear ones got cockpit too hot so they'll be moved forward.



Radically finned aluminum muff on the cast iron drum acts as an impeller because it's so closely shrouded by the rim of the magnesium wheel.

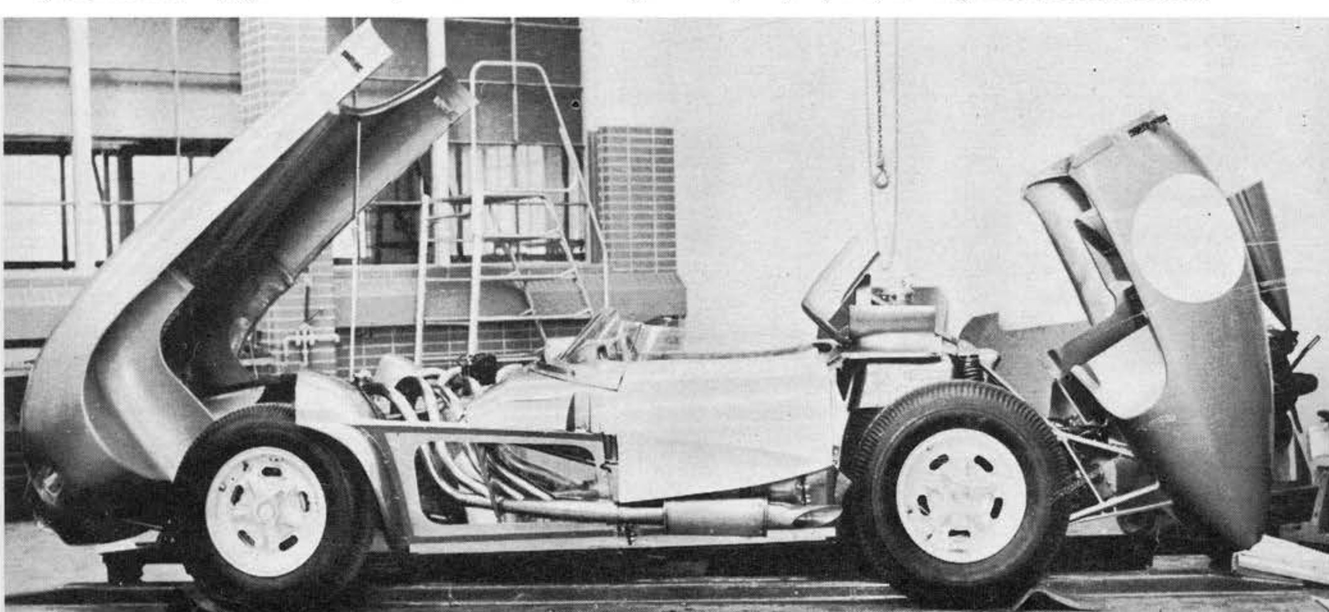


De Dion layout on SS includes inboard mounted Chrysler Center plane brakes, and Halibrand quick change rear. Brake linings were cerametallic



Styling department gave Corvette interior a typical dream car look. Exhaust heat, cleverly channeled into driver's compartment made cockpit unbearable.

Hinged body sections afford excellent accessibility to all components of car. The latest in production design, it is typical of such cars as D-Jags and Loti. Specials have been using similar plan for years, although not as well executed.



Horses Part II

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and moderate ramping with mild springs, some quite hairy opening diagrams can be recorded this way.

Faced, in 1954, with a GP formula in which only unblown engines had a look-in, the Mercedes engineers realized that valve timing would have to be taken much more seriously than in the past. As mentioned earlier, also, the use of fuel injection meant that compression ratios could rise, which in turn would mean that there'd be much less space at the top end for floating valves to wander around in. They also wanted big valve area, without the port restriction of the old four-valvers. The only answer was to make the valve motion independent of valve gear weight and the whims of springs, so they set about developing a positively-closed poppet system.

Coined "desmodromic," the Mercedes device was the first practical manifestation of a long-cherished concept. To each valve they gave two cams, side-by-side on the same shaft. One, looking quite normal, opens the valve via a conventional tappet. The other cam is literally up wherever the opening cam is down, and presses a pivoted lever which pulls the stem up at the proper time, being notched into a necked section. Between them the two cams put the valve just where it's wanted at all times, which was a great relief to Uhlenhaut, Neubauer and Fangio, among others. *(For details see Sports Cars Illustrated, May 1957)*

With this under their belt, the M196 engineers could turn loose some formidable figures, one result being that the valves were seated just 228 per cent faster than the heaviest practical springs would allow. In fact, Uhlenhaut said, spring pressures of *1000 pounds per valve* would be needed to duplicate their speeds.

Desmodromic actuation is yet another valuable Mercedes feature which few have been able to adapt to their own purposes. This is for the very good reason that it's a complex, finicky and expensive devil to make, even for Daimler-Benz. Knowing that the stroked 300SLR engine wouldn't be capable of the same revolutions as the GP powerplant, they tried to save themselves some trouble by using ordinary springs on the prototypes. It worked, but the safety factor given by the positive rig was too inviting to pass up.

Only other firm to progress along this line is Osca. The Maserati brothers have done extensive testing with a valve gear very much like that of Mercedes, with the addition of rollers on the tips of the valve closing levers. Their method of clearance adjustment is different, as is their valve opening tappet. When this is going it may restore Osca to the Class F championship.

Even with the intake and valve gear problems solved, two horses per inch are far away unless the combustion chamber, exhaust and mechanical layouts are right. In the next and final installment we take up these important aspects of racing engine design.

—Karl Ludvigsen

Corvette

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retired the car at Sebring. Rubber bushings are suspect in a suspension anyway, if very good steering is the goal, and one of them here did shift and destroy the alignment. Since this didn't show up on the much-flogged "Mule" it could well have been a material fault.

Springing at all four corners is by coil-shock units. The long small-diameter coils are carried in cups attached to the body of the tubular shock and its piston rod, giving a quickly demountable unit with a built-in bump stop. Rebound is limited by fabric straps. At first there was an additional housing around the coil, but this was tossed out to cut weight and allow quick access.

Probably the highlight of engine development on the SS was the use of aluminum cylinder heads for the basically stock 283 inch engine. These heads are very similar in design to the stock part, with only a slight repositioning of the intake ports to take advantage of some Weslake gas flow theories. They are definitely designed and run *without valve seat inserts*. Using the stock valve spring pressure of 210 pounds open and the slightly tuliped valves of the SS, pounding-in of the seats was very slightly more than normal, but not enough to cause any concern at all. If this technique can be reproduced, it could open up a brand new field in special heads for OHV engines. Only major structural change to accommodate the heads is the use of necked-down studs to compensate for the greater expansion of aluminum.

At Sebring it seemed that cooling troubles could be blamed on poor head gasket sealing, but it now looks like a subcontractor was to blame. Construction of the remote-mounted radiator header tank was farmed out, and a flow-control baffle was so misplaced that it cut off two thirds of the planned circulation. The tanks were peeled open and the baffles put in right. After that the ducted aluminum radiator performed as expected, as did the oil cooler incorporated in its base.

To the left of the radiator a Fiberglas duct scooped cool air into the Rochester injector machinery. The big air metering valve was faced forward instead of sideways to simplify the ducts and throttle control as much as possible. This injector requires a small air bleed to each nozzle for vaporization and idling, which is usually supplied by small pipes from the air cleaner. In this case there's a tiny individual filter for each adjacent pair of nozzles.

More important, nozzles for Chevrolet injection are now being built by the Diesel Equipment Division of GM, and are improved in two ways. First, the all-important nozzle size is determined by a thin calibrated disc instead of a lengthy sized hole, giving benefits in accuracy of distribution (which is still not so good with this system as it might be). Nozzle jet size is now .0135 inch instead of .0110. Second, each nozzle now incorporates a filter screen in addition to that at the pump. This has just about eliminated the chance of stoppage.

We weren't alone in wondering about the flex cable drive to the injection pump, *(SCI June 1957)* but this has been reliable except when the pump begins to jam, in which case the drive goes out before major damage is done.

The clutch and four-speed box are regular Corvette units, with the exception of the alloy housings that we mentioned, and the drive shaft is open with two universals. A late-model Halibrand center section houses a straddle-mounted pinion, helical quick-change gears and a Chev "Positraction" differential. Torque goes from here to the wheels through open axles with Hooke-type universals and sliding splined joints.

Since the differential is hung solidly from the spring support cross tube, it's tempting to mount the brakes inboard too and reduce unsprung weight. Duntov succumbed to this, as have many other designers, but Aston-Martin gave up this layout in 1953 for the good reason that heat from the brakes gets the differential hot, and vice-versa. It's not surprising that the same trouble is cropping up with the SS, but it can probably be licked by much better air venting down there. Additional scoops at the front end duct cooling air down into funnels attached to the backing plates.

As we've mentioned it was expedient to use two-leading-shoe Chrysler Center-Plane mechanisms to get brakes of the proper size and type in a hurry. GM devised their own drum design, though, which has also turned up on another Corporation product. The drums have a cast iron face and working internal surface, plus an aluminum finned muff which is locked mechanically to the outside of the working surface. 120 small holes are punched through the periphery of each drum, and when aluminum is cast around this it fills the holes and becomes a mechanical part of the cast iron. You can see also that the resulting internal drum surface will be dotted with little aluminum spots which can carry heat right out to the fins without passing through the iron at all! It's simple — almost crude — but it seems to work. Biggest danger is possible heat spotting from insufficient drum stiffness and uneven expansion.

These drums are 12 inches in diameter and 2½ inches wide. It was just recently announced that the Buick "75" for 1957 will be equipped with aluminum-finned drums of exactly this construction on the front wheels only, which have just the same drum dimensions. There's no reason to believe that it isn't the same part. So, if you'd like SS Corvette brake drums for your Chrysler, De Soto or '56 D500, go bang on the door of your Buick dealer!

Also interesting is the front/rear brake proportioning device used on all the Sebring Corvettes. This depends on two vacuum servo cylinders, mounted in the rear with the lightweight battery for convenience. The simple cowl-mounted master cylinder has a direct hydraulic connection to the right-hand servo cylinder, which in turn power-brakes the two front wheels directly. This requires two chassis-length hydraulic lines which are coil-wrapped for protection. In any case, then, the front wheel braking will always be proportional to pedal pressure, and will still be there if the vacuum fails.

Now, the hydraulic output of the left-hand servo cylinder is piped straight to the rear brakes, but the vacuum section is so linked to that for the front wheels that the two operate sympathetically. In other words, front brake force is directly controlled by the pedal, and rear braking is proportional to that at the front due to an air link between the respective vacuum cylinders. The basic front/rear proportion for the SS was set at 70/30.

Okay so far. The air pipe that connects the two vacuum cylinders can be sealed off by actuating an electric valve—undoubtedly a solenoid—which leaves the cylinder for the rear wheels completely isolated in whatever position it was when the valve closed. The electrical impulse is released by a mercury switch, mounted in the cockpit where it's handy. This switch is angled forward so that the mercury will slide up toward the end a given distance for a given quantity of car deceleration. When the mercury hits the end, in a stop of a preset negative "g", the solenoid is closed and rear braking force stays just as it was then— it can't increase; it doesn't go down. Front wheel force can then continue to rise in proportion to pedal pressure, but it's absolutely impossible to lock up the rear wheels no matter how hard you try! They're isolated from the circuit until the mercury switch and the valve open up again. With that mercury switch at just the right angle, braking at all four wheels can be fully used much more often than at present, when ultimate deceleration is limited by rear wheel locking. The switch angle could also be changed during a race to compensate for wet roads or different surfaces, or changing fuel loads. We've ridden in a car equipped with this rig, and think it's very promising.

If it gives more devices like these a try-out, the SS Corvette will be well justified as a rolling test-bed. Testing at Sebring before, during and after the race turned up a few basic faults in the SS' layout that are now being reworked. One, of course, was the extreme heat in the driver's compartment. To relieve this the front and rear pipes in the exhaust manifolds are being brought closer to the center pair, to pull the rear pipe away from the fire-wall. The pipes also curve more quickly to the outside of the magnesium body.

This manifolding, by the way, gave a big boost in power. The compression ratio on a competition version of the Chev V-8 had to be taken to 11/1 to get 310 horses, while the SS delivers the same amount on a 9/1 ratio with this exhaust.

On the bright side, there now exist three SS tube frames in addition to the "Mule" and the race car—a total of five possible machines. There are still a lot of guys at Chevrolet that believe in the SS and what it can do, and there's always a chance that Chevys will sell better in '58! Let's hope so, because this one is too good to be sent to the showers so early in the game.

—Karl Ludvigsen