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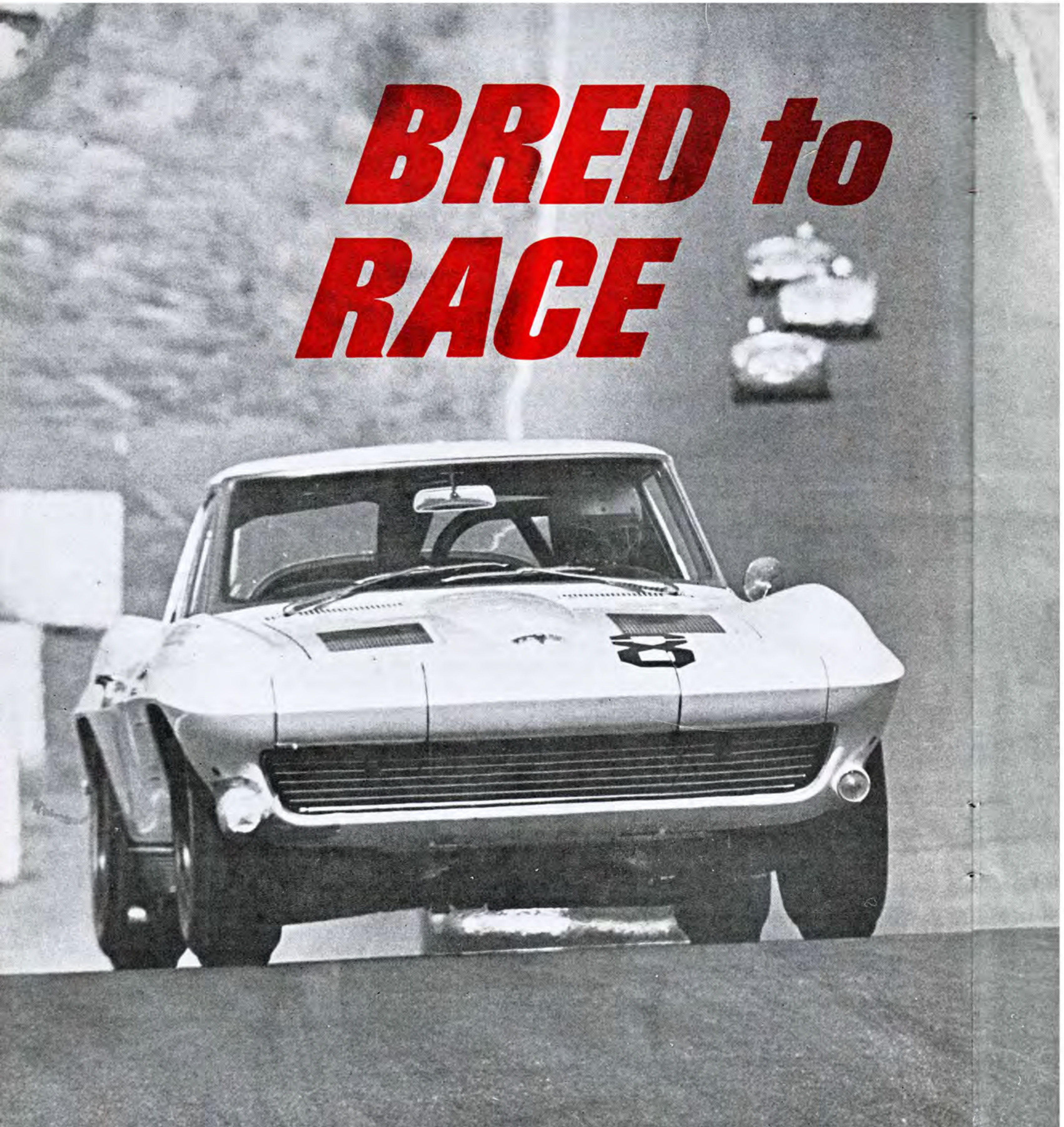
BRED to RACE



Corvette's independent four corners, equalized weight, wind-tunnel styling, and performance options blend its street tractability into the roar of high-speed competition

by Roger Huntington

FOR THE LAST FIVE YEARS, we've been bombarded with rumors of an "all-new" Corvette that was supposed to be just around the corner. It was going to feature just about everything that was new and exciting in modern sports car design. We waited anxiously.

There was no question about the *demand* for a new Corvette. In many ways the original basic chassis and body, in production with relatively minor changes since late 1953, were obsolete. It was just a question of how soon Chevrolet could afford a major tooling change – in view of the low production volume of 10,000 to 12,000 units a year. Only the naive hoped for an all-new Corvette every two or three years.

Well, we finally *have* our all-new Corvette. The 1963 line features a brand-new chassis from the ground up – new frame, completely new body (in both convertible and coupe) – and only the engine and transmission options remain from previous models. This is the one we've been waiting for. And it's all the rumors promised – and more. This is a *modern* sports car. In most ways it's as advanced as the latest dual-purpose sports/luxury cars from Europe – and this includes the new Jaguar XK-E, Ferrari GT, Mercedes 300-SL, and all the rest. The new Corvette doesn't have to take a back seat to any of them, in looks, performance, handling, or ride.

WHAT WERE THEY AFTER?

Chevrolet engineers assigned to the Corvette project, headed by the well-known Zora Arkus-Duntov, set down several basic design goals for the new car before they ever drew a line. One important aim was an improved *ride*. This may not seem vital in a sports car,

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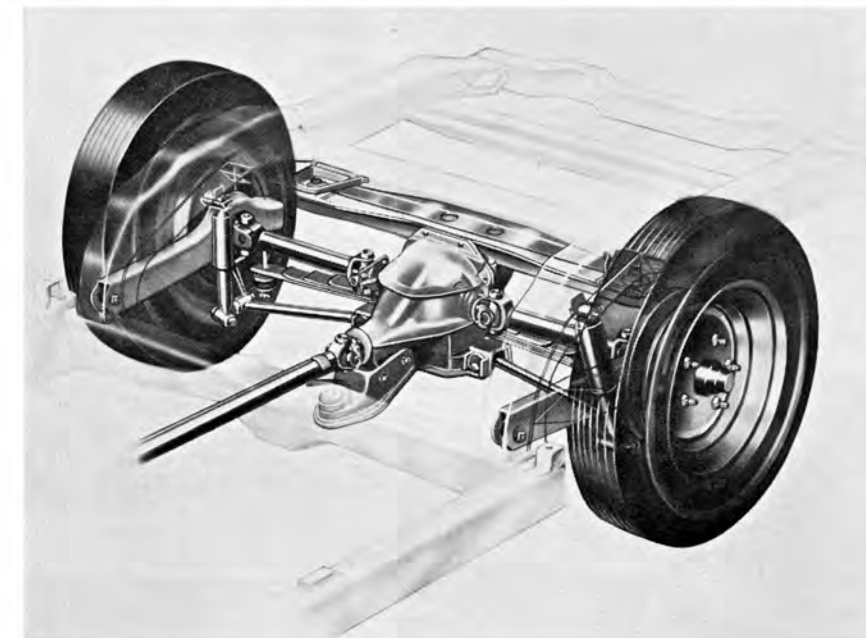
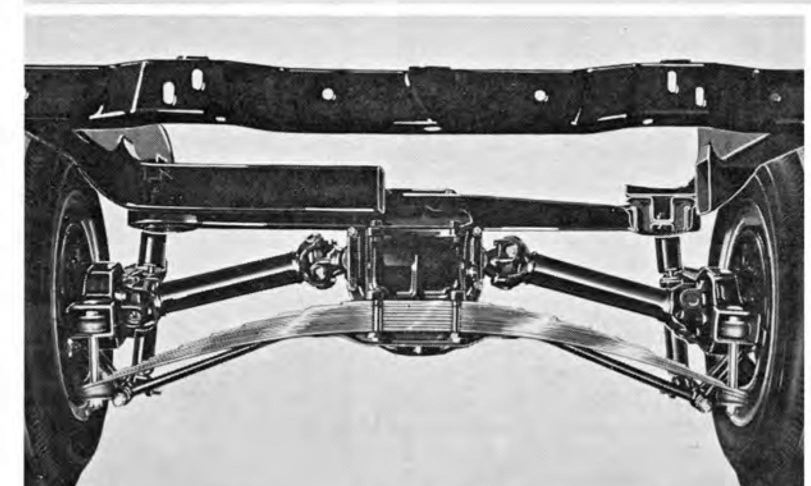




Radical independent rear-end setup uses inboard and outboard U-joints and a single transverse spring. Differential housing is mounted to frame cross-member. The wheels are kept nearly vertical under all driving conditions.

but you've got to remember that the Corvette is designed to appeal to a larger market than just the purists and the racing enthusiasts. Many Corvette owners use the car as they would a Thunderbird – as a two-seater personal car. These people want a plush ride. The early Corvette wasn't bad in this department, but this new one is unbelievable for a car of its weight and wheelbase.

A second basic aim was improved *handling* – roadability and cornering, both on the highway and on the race track. The early Corvette did a wonderful job in competition against all-out sports/racing cars. But its handling couldn't be described as "modern" or "advanced" in any sense of the words. There was too much understeer, or ploughing of the front end. You could wrestle it around a corner, but it wasn't an easy car to drive fast. One of Duntov's basic aims on this new chassis was to develop virtually *neutral* steer characteristics right up to the point of breakaway. In other words, there was to be no pronounced tendency for the front or rear end to wash out before the opposite end. He also wanted better wheel adhesion, or sticking, on rough corners and straight surfaces. The early Corvette left much to be desired in this area.

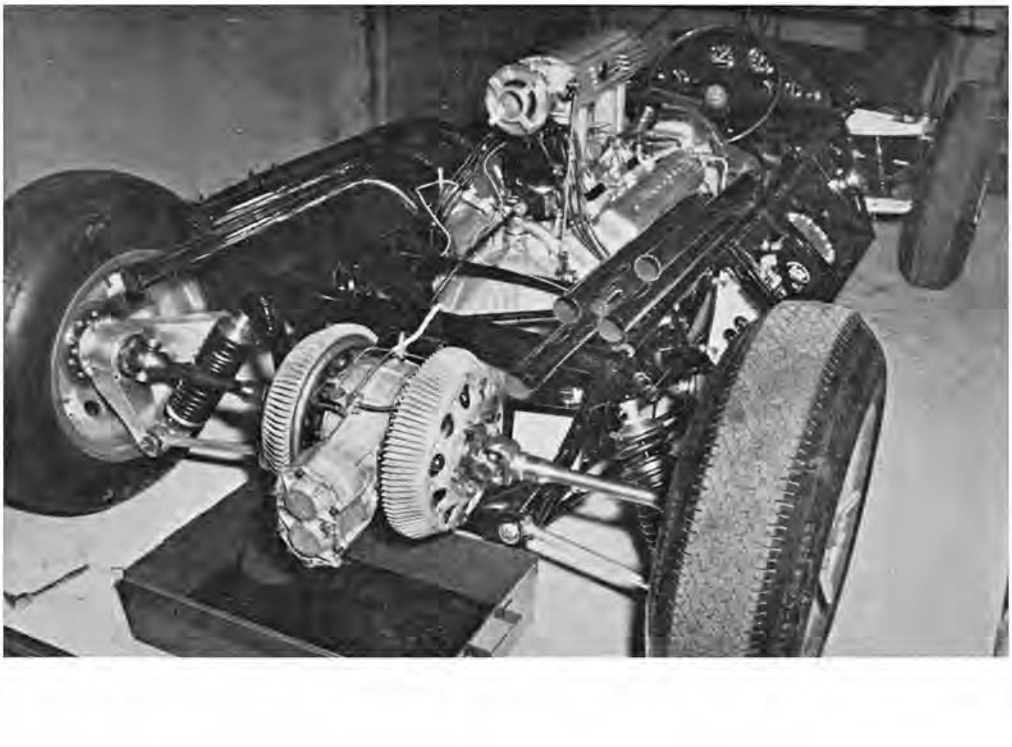
A final basic aim (though not related directly to the chassis) was to design a body that *looked* good and yet had less wind resistance and better aerodynamic stability. This wasn't as easy as it sounds. It's traditionally been tough to combine good lines and aerodynamic efficiency in the same body. One area generally has to be compromised – and it's usually the efficiency. But Duntov also knew that many buyers would be racing their Corvettes, and unnecessary air drag and poor aerodynamic stability would hurt lap times at the speeds of 130 to 150 mph reached on some of these courses. So they came up with the beautiful new fastback coupe body. These goals have been achieved very nicely.

HOW THEY DESIGNED IT

The general ride and handling characteristics of a given car are determined by many, many individual factors working together – and it's very risky to try to isolate any single factor as being the secret of a good-behaving car. But in the case of the new Corvette we must certainly mark down *reduction in unsprung weight* as a key factor in getting the desired effect.

"Unsprung weight" is the mass that moves up and down with the wheels as they pass over bumps. This would include the wheel, tire, brake, axle, part of the spring weight, and so forth. The vertical motion of this unsprung mass is resisted by the *sprung* mass, or the weight that's actually supported by the springs (body, frame, etc.). Obviously the greater the sprung mass in relation to the unsprung mass, the less wheel-hop we'll get, and thus the better the tire adhesion on rough surfaces. Also, the greater this sprung/unsprung weight ratio, the better the *ride* will be – simply because the sprung mass has so much more inertia than the unsprung that the vertical movement of the wheels can hardly budge the sprung mass, and it just glides over the bumps while the wheels go bobbing up and down. (If the sprung and unsprung weights are *equal*, the ride is terrible. Ever notice a small two-wheel car trailer with no load in it?)

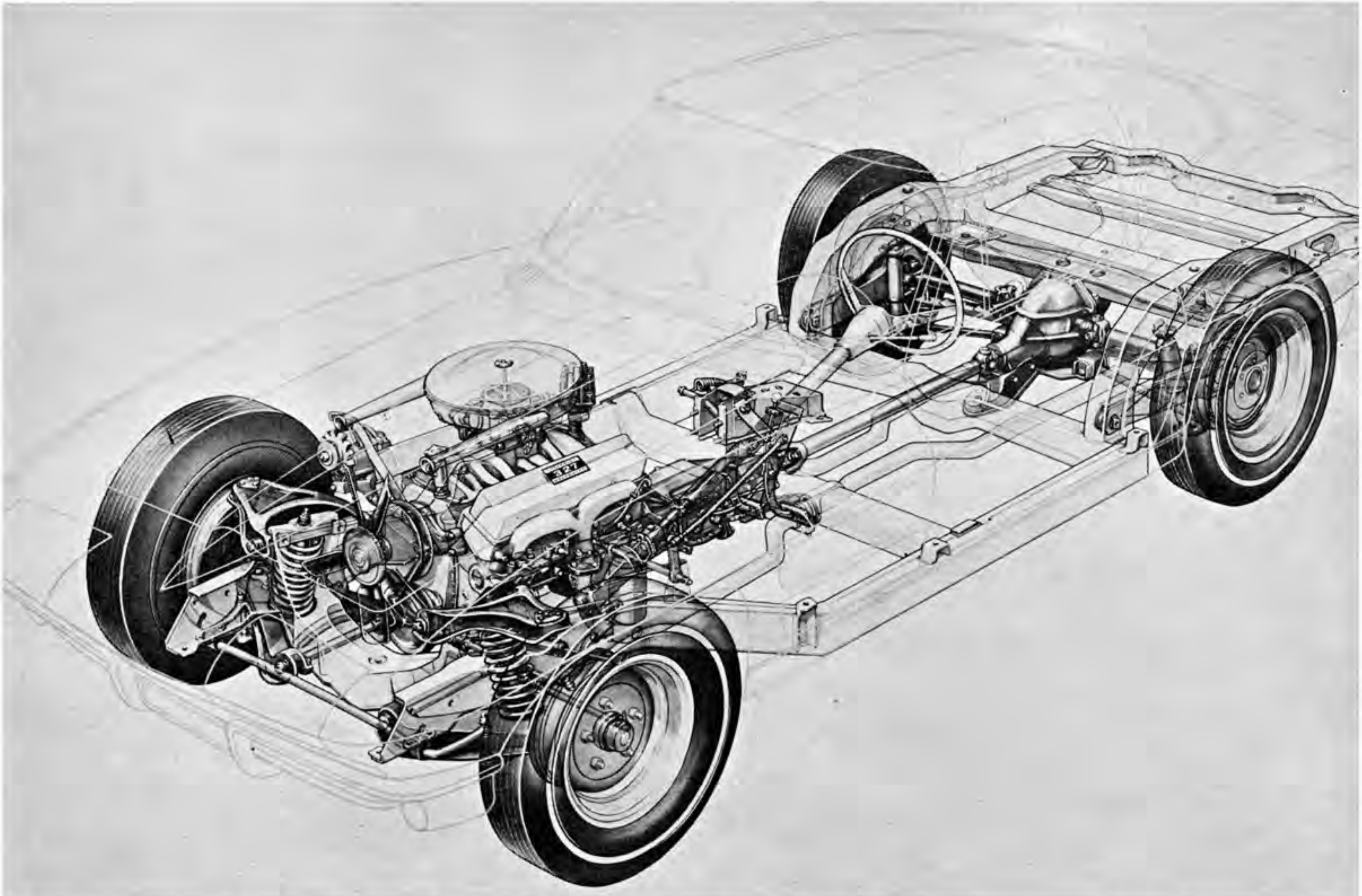
Unsprung weight is no problem on the front end of a modern car with independent front suspension. The wheels are carried on light arms, with a light coil spring usually between the frame and lower arm. And, of course, the heavy engine is on the sprung-weight side. But it's a different story at the rear end. Here we have a relatively light body weight, but with the heavy, "solid" rear axle bobbing up and down with the wheels. This combination is murder on ride and rear-wheel adhesion on rough surfaces. This was worse in the case of the early Corvette because, as car weight is reduced, the sprung weight has a tendency to decrease faster than the unsprung. That is, that early chassis used standard Chevrolet wheels, axle, etc. – and yet the Corvette's rear section weighed about 300 pounds less than the big Chevy. This made the sprung/unsprung weight ratio that much worse.



(TOP) *Zora Arkus-Duntov, developer of GM's CERV-I, was instrumental in designing the new Corvette, used many ideas from the experimental research prototype.*

(ABOVE) *Finned aluminum drums, researched on CERV, are now optionally available with sintered linings on Corvette.*

(RIGHT) *CERV-I had coil springs, inboard brakes, quick-change rear end. Injected Corvette V-8 was placed in rear of car.*



AERODYNAMIC BODY STANDS ON BOX-SECTION FRAME. ENGINE POSITION ON SHORT WHEELBASE GIVES 49/51 PER CENT WEIGHT DISTRIBUTION.

The obvious answer was independent rear suspension – with the heavy differential mounted right to the frame (as sprung weight), and driving the wheels through U-jointed half shafts. This system has more unsprung weight than in front, because of the drive components and the extra beef required in the control links to resist engine torque. But it's a fat 33 per cent less than with the old solid axle as unsprung weight. Chevy engineers quote a rear-end unsprung weight of 301 pounds for the '62 chassis with solid rear axle. It's only 200 pounds for the new '63. The effect of this reduction on ride and wheel adhesion must be felt to be appreciated.

Another important factor in ride is weight distribution, and the way the major masses are grouped in relation to the center of gravity. A front/rear weight distribution of 50/50 is about ideal for ride. The '62 Corvette had slightly more than half its total weight (50½ per cent) on the front wheels with two people in it. The new car has a 49/51 distribution, with about 80 pounds more on the rear wheels. This is still near ideal for ride, and helps the traction noticeably.

The main reasons for the greater rear-end weight is that the wheelbase has been shortened from 102 to 98 inches, which shoves everything back a little in relation to the rear wheels. Also, the single transverse leaf spring is situated directly *behind* the differential, which puts the effect of this mass back a few inches. This movement of major masses backward on the wheelbase has another beneficial effect: It increases the "flywheel effect" of these major masses about the center of gravity – which slows down the pitch rate of the car, and thus improves the ride. This, coupled with the reduction in unsprung weight, has given the new Corvette what seems like a Cadillac ride compared with the early design.

The suspension layout on the new Corvette is quite interesting. Up front, things are very conventional – lateral wishbones of unequal length (with upper arm tilted to give anti-brake-dive geometry), coil springs, and tubular shocks inside the coils. In fact, many of these front suspension components are interchangeable with Chevy passenger cars. An anti-roll torsion bar is used to give added roll stiffness in front. A new recirculating-ball steering gear is used, of conventional geometry, with optional overall ratios of 19.6 (standard) and 17 to 1 for racing.

The accompanying drawings show the rear suspension clearly. The differential section is carried on two frame crossmembers, front and rear, and is mounted through thick rubber biscuits to isolate vibration and road rumble. This is a very clever solution to this problem. Vibration has always been a headache with frame-mounted differentials. Chevy engineers have attacked it by carrying the rear of the differential on a *separate* bolt-on frame crossmember, then bolting this to the main frame through these thick rubber pads. This crossmember wouldn't contribute much to frame stiffness, but it ought to be very effective in isolating vibrations. (Corvair's transaxle is carried the same way.) The front differential mounting bracket is also at-

continued on page 94

BRED TO RACE

continued from page 43

tached to a main crossmember ahead of the wheels through rubber.

Springing is via a rather hefty nine-leaf transverse leaf spring bolted to the back of the differential case, and linked to the outer wheel hub sections through rubber-cushioned pillions. (The layout is just like the cross-leaf front suspension on the old '36-37 front-drive Cord.) This flexible mounting of the spring to the hubs means that the spring carries absolutely no driving or cornering loads — unlike longitudinal leaf springs on a Hotchkiss rear end. All the spring has to do is to provide the vertical suspension effect. Suspension links take care of wheel motion.

Some people question Chevy's choice of the "obsolete" multi-leaf spring on the new Corvette. Frankly, this was an economy move. The leaves are less expensive to make and assemble than the more complex coil-spring suspensions, with their extra brackets and fittings. Chevy engineers probably would've used coils or torsion bars on the rear if cost had been no object (in fact several early prototypes had coil rear ends); but the leaf spring was far more practical on the production line. Why didn't they use the more advanced *single-leaf* spring, like on the Chevy II? It would've been considerably lighter — and *seems* as if it would be cheaper. Chevy engineers won't say why they didn't.

The rear suspension linkage geometry is unusual. In operation it's similar to an unequal-length wishbone front end. The U-jointed axle shafts themselves act as the upper control arms. This is possible because these shafts have no slip joints. In other words, they hold a constant length, and their effective pivot centers are at the centers of the U-joints at each end. Then the lower control arms are simple rods that pivot at the differential case on the inner ends and at the hub sections at the outer ends. These four "links" completely control the lateral motion of the wheels. Fore and aft motion, plus driving and braking torques, are resisted by box-section trailing arms fabricated from sheet steel, and pivot ahead of the wheels on the frame. Tubular shock absorbers are attached to the frame at the top and to the bottom of the hub sections.

Rear suspension geometry is predetermined by adjusting the lengths, angles, and pivot points of these six control links. This is one of the keys to the good handling of this car. For example, the rear roll center (the point about which the sprung mass tilts in a turn) has been raised to 7.5 inches above ground level. This combines with a front roll center height of 3.25 inches (much higher than the conventional American passenger car) to give a relatively high roll *axis*. This, in turn, combines with the lower overall center of gravity of the car (3.3 inches lower than '62) to give a much shorter lever arm when centrifugal force tries to tilt the body about the roll axis in a turn. (This lever arm is the distance between the roll axis and the center of gravity.) This means a lower roll *angle* — which accounts for less weight transfer to the outside tires and less camber change on the wheels on hard corners. This new Corvette should show very little roll in the turns.

A common fault of many link-type independent rear suspensions is that they have such a relationship between roll center height (usually very low), link positioning, and static wheel camber that the wheel assumes a very steep *positive* camber as the body rolls in a turn. That is, the top of the wheel tilts outward. This has the effect of increasing the tire slip angle, and increasing the oversteer tendency. Chevy engineers have completely solved this problem. They put 1.5 degrees of *negative* camber on their rear wheels at normal load. Then this changes to only 1.5 degrees of positive camber when the body is under full roll angle in a turn. Thus the rear wheels are virtually *vertical* through the whole suspension travel — which is ideal from the standpoint of getting neutral steer characteristics. In fact, it wasn't necessary to design any appreciable *roll steer* geometry into the rear suspension because this thing was so neutral right up to breakaway. (Roll steer is when the suspension linkage causes the rear wheels to steer slightly one way or the other when the body tilts in a turn or under a cross-wind force.)

FRAME AND BODY PROBLEMS

No suspension system can work the way it's supposed to if you don't have a good, rigid frame to tie the four corners together. This "frame" can be either a good unit body or a basic sub-frame with body attached. It's well established that the welded unit body (actually a large box section) has more overall torsion and beam stiffness than most frame/body combinations. But, of course, the high tooling costs of such a body would rule it out for the low-volume Corvette.

Also the fiberglass body on the Corvette (another necessity because of low volume) contributes somewhat less to overall frame/body stiffness than an equivalent steel body. So Chevy engineers had to really get down to business on the new frame for the '63. It had to have absolute maximum beam and torsion stiffness in relation to weight — and yet had to eliminate the old X-crossmember to give more convenient floor wells for the new, lower Corvette body.

You can see the result. The new frame is a basic box configuration, with a very high kickup over the rear suspension and widespread side rails running under the outside edges of the body. There are five major crossmembers running straight across. Side rails are boxed for added stiffness. The new frame weighs almost exactly the same as the '62 – about 260 pounds – but it has slightly more beam stiffness and *50 per cent more* torsional stiffness. This increased torsional stiffness (resistance to twisting) should be noticeable to the racing boys on high-speed corners. This is bread-and-butter engineering at its best, when you can get more function from the same (or less) weight.

Unfortunately, it's hard to reduce weight on a car that has a massive sub-frame like the Corvette. This is a big advantage of unit and "monocoque" construction. The new Corvette coupe weighs about 100 pounds more than last year's convertible – which would be a hair over 3400 pounds with full gas tank and two people. Maybe this is one of the prices for progress.

The radical new fastback coupe body design was actually developed in the Cal Tech wind tunnel, using ⅜ scale models. GM stylist Peter Kyropoulos and his staff tried to get the best compromise between looks, wind resistance, and aerodynamic stability. The Chevrolet people aren't making any great claims for the result, but they do say that the total wind drag is well below last year's Corvette with hard top in place. And the drag coefficient itself is even less than that of the famous Sting Ray open competition car. (However, the frontal area would be more, so total air drag might be about the same.) Beyond this they won't release specific figures. We'll just have to wait to get some idea of the relationship between maximum speed and available horsepower on the fast race courses and at Bonneville.

And that leaves only the important subject of *brakes*. They're better on the new chassis. They retain the same 11-inch drum diameter, but the front and rear lining widths are increased by ¾ and ¼ inch respectively – which increases the total effective lining area from 157 to 185 square inches. Segmented sintered iron linings are still optional for racing, but the new optional finned competition brake drums are now cast in *aluminum*, with cast-iron liners. This combination of metallic linings and aluminum drums should completely eliminate any possibility of fade under *any* conditions. Optional aluminum knock-off wheels will further aid cooling. It's certainly obvious that Chevrolet intends to continue to go racing with the Corvette. /MT