FIRST LOOK: 1968 CARS

ICD

CAR LIFE

50 CENTS
AUGUST 1967

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Saga of the Sandstormers

HOLMAN & MOODY
FoMoCo South, A Going Concern

FORMULA I FORD
An Aluminum 3-Liter for Lotus

BARRACUDA SX
Plymouth's New Tomorrowcar

TESTS: TWO FIREBIRDS, MERCURY MARQUIS, FURY III

CAR LIFE

August 1967
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DEAN BATCHELOR
Editorial Director

DAVE EPPERSON
Managing Editor

JON McKIBBEN
Engineering Editor

BARBARA FORTON
Editorial Assistant

CONTRIBUTORS
Frank Beaumier, Jack Brady,
Alice Bixler, Chan Bush,
Robert Durbin, Paul Hansen,
Martin Allan Jackson,
Michael Lamm, Bill Libby,
Joseph Lowrey, Scott Malcolm,
Charles Malone, Howard R. Miereaneau,
Ed Newton, William F. Nolan,
David H. Ross

HAL CRIPPEN
Art Director

BILL MOTTA, LEO BESTGEN,
RAMONA BOLHOUS
Art Associates

JOHN and ELAINE BOND
Publishers

JEAN WHITE
Publishers' Assistant

DAVE BLACK
Production Manager

JONATHAN THOMPSON
Editorial Research

RAY POWERS
Circulation Manager

PATSY COOPER
Advertising Assistant

ABC

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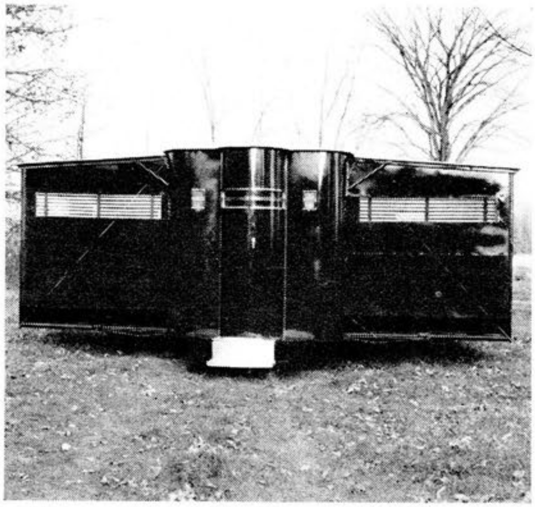
FEATURES

TECHNICAL

DEPARTMENTS

COVER: A beauteous Barracuda from Plymouth's styling studio



HE IMAGINED IT ALL

He designed Scarabs, Skycars, Railcars. He built improved motorbikes, and worked on things that might fly like insects. His imagination was an invitation to creation of transportation. He went camping in that very odd vehicle, pictured at the left. For more on this workmanlike wizard, transport to Page 54.

PREVIEW: 1968 CARS

Sting Ray, Continental, Charger and Javelin Generate New Model Year Excitement

BY FRANK BEAUMIER

ILLUSTRATIONS BY ED NEWTON AND HOWARD R. MIEREANU

NEW-CAR BUYERS this fall will find the majority of changes in 1968 intermediate-size cars at General Motors, Ford Motor Co. and Chrysler Corp.

Standard-size cars receive minor identification changes in grille and rear areas; the sporty cars, Mustang, Camaro, Barracuda, Wildcat and Cougar also are given minor distinguishing changes. The exception here is the Corvette, which comes on strong with complete new body configuration.

All of the new cars feature well-padded interiors; most have restyled, safety door handles; instrument panels and instrument control knobs also are redesigned with safety in mind.

Generally, 1968 cars offer more, and will cost more. Estimates of price increases range from a minimum of $100 to as high as $150 per car. While safety additions account for most of the cost increase, part could be justified by larger-sized intermediates, and more power in models throughout GM, Ford, Chrysler and American Motors Corp.

General Motors:

GM intermediates get the full corporate treatment in 1968. Each division offers two different-size-wheelbase intermediates—112 in. and 116 in., compared with the 115-in. standard of 1967—and each division will feature notchback and fastback models. Generally, the cars follow Camaro's styling theme with longer hoods, shorter decks and rather pregnant side lines. The Oldsmobile 4-4-2 takes on the Toronado look; the Pontiac Tempest assumes characteristics of the Firebird and the Chevelle has somewhat the look of the Camaro. Moving up from this size, GM offers little change except some new power, identification grille and bumper and taillight changes. Front vent windows are eliminated and recessed windshield wipers are added on most corporation standard-sized cars.

Chevrolet Division: Chevelle and Corvette take the spotlight at Chevrolet. The Corvette is especially impressive with its long, sloping front and symmetrical fenders. (Fenders are not as large or accentuated as some published sketches might indicate.)

Chevelle has two new body sizes and styles, the 2-door hardtop is in fastback styling on a 112-in. wheelbase, and a 4-door sedan is available on a 116-in. wheelbase.

Standard Chevrolets have taillights set into the rear bumper, rather than in the car body, and the bumper is slightly larger and higher. In front, new, smaller square grilles replace the wrap-around style of 1967. The hood slopes down to dominate the front and appears to extend beyond the grille about 3 in. to form a cap over twin headlamps. The heavy, molded body line, which runs from extreme front end to rear at the belt line, is unchanged.

Top-of-the-line Caprice has headlamps concealed in the fenders; hood and fender line slopes up from the grille and headlamps, and the overall silhouette is very similar to 1967.

Chevrolet will offer a new standard V-8 engine with about 225 bhp, compared with 195 in 1967.

Though Corvair is being merchandised for 1968, as yet there are no visible signs of an advertising campaign. Without basic advertising backing, the Corvair will die a lingering death, which must be GM's plan.

If the Corvair does survive 1968, and it probably will, the guess is it will be given a new engine in 1969 and possibly new mechanical considerations to line it up with other small Chevrolets. The new power most likely would be the 220-bhp engine, flat-Six block with belt-driven overhead camshaft on each bank that Chevrolet has shown in its latest idea car, the Astro I.

Chevy II receives only slight modifications in styling.

Pontiac Division: Tempest has a new design, resembling the Firebird, or strongly influenced by the sporty new car. The top Tempest has optional dual air scoops on the head, and the intermediate comes in two wheelbase sizes as mentioned—112 in. and 116 in.

Standard Pontiac models are relatively unchanged in styling, though vent windows are out and the center section of the famous Pontiac split grille is even more prominent that it was in 1967.

Added power comes from a new 448-cu. in. V-8, which will be optional in 1968.

Buick Division: Without a contender in the Camaro-Firebird class, Buick concentrates on jazzing up its intermediates. Yet styling of the Special, while retaining divisional identification in front grille and at the rear, moves closer to the undulating "Coke-bottle" lines of Camaro. This is especially seen in the hood and rear deck and body sheet metal.

Standard Buicks are practically the same as in 1967, with a bit more power and, of course, recessed windshield wipers and minus vent windows. Buick is working on a new version of its 340-cu. in. engine and should be ready to go with a 350-cu. in. engine in the 1968 LeSabre.

The trend to more power is forcing Buick to abandon its V-6 engine production. A guess is that Buick will pick up the inline-Six from Chevrolet.

Riviera will go with 1967 styling, augmented with new grille and taillights, but will be given new body work next year, plus addition of a 4-door model.

Oldsmobile Division: Olds F-85, in its two new sizes, emerges with larger fender and body lines, but retains an uncluttered look front and rear. Divided headlamps are continued inset in a thin-line grille. A fastback model is offered on a 112-in. wheelbase.

Oldsmobile has minor front and rear work, but the body still features 1967 lines by Fisher. The same is true of the front-drive Toronado.

Cadillac Division: After an exciting addition to the line in 1967, Cadillac stands pat for 1968 with minor changes. Cadillac Division is the author of change by evolution, and the policy continues at the same slow pace with 1968 models.

However, Cadillac will show more power. An increase in engine displacement from 429 cu. in. to 472 cu. in. is expected to result in 10% added bhp.

The basic news at GM, then, is from the intermediates: In 1967 GM had a standard 115-in. wheelbase on the middle-ground cars. For 1968, the 112-in. line features fastback styling, and the 116-in. models move GM's intermediates closer to standard car competition.

Ford Motor Co.:

Intermediates Fairlane and Comet have all-new sheet metal in unit body construction. (Ford plans to change to frame-body construction by 1970.)

Falcon has a sporty new split grille; Mustang and the standard Ford and Mercury models are not radically changed, though there are some new roof lines, and grille and taillight work.

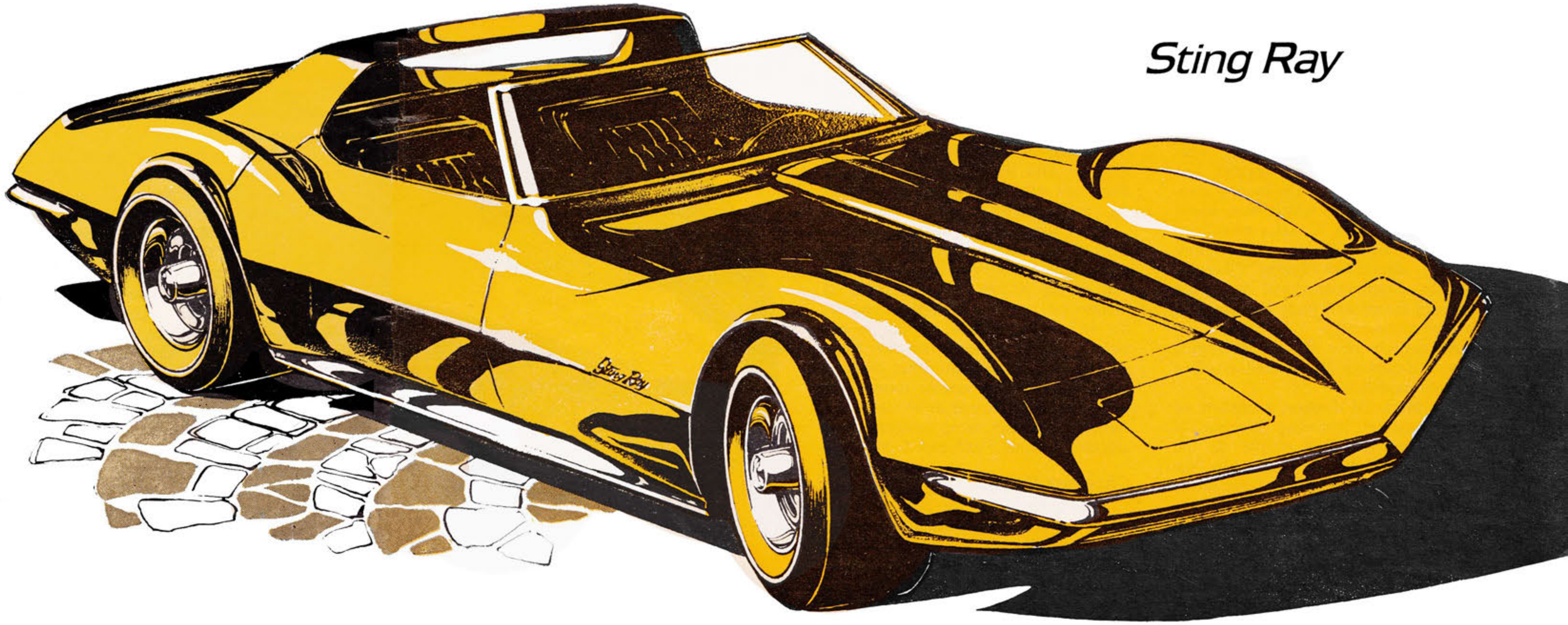
Ford Division: Fairlane is longer by 6 in., extending it to more than 200 in. The longer car was imperative to provide more room in the fastback model, which, incidentally, has almost identical styling lines in the rear as the fastback Mustang of 1967. Dual headlamps in the Fairlane are separated by heavy grille bars.

The standard Ford 2-door hardtop has been given a new sloping rear deck treatment for a faster look. This is the major, almost only, change in the line. Falcon, Thunderbird and Mustang also must wait another year for major styling consideration.

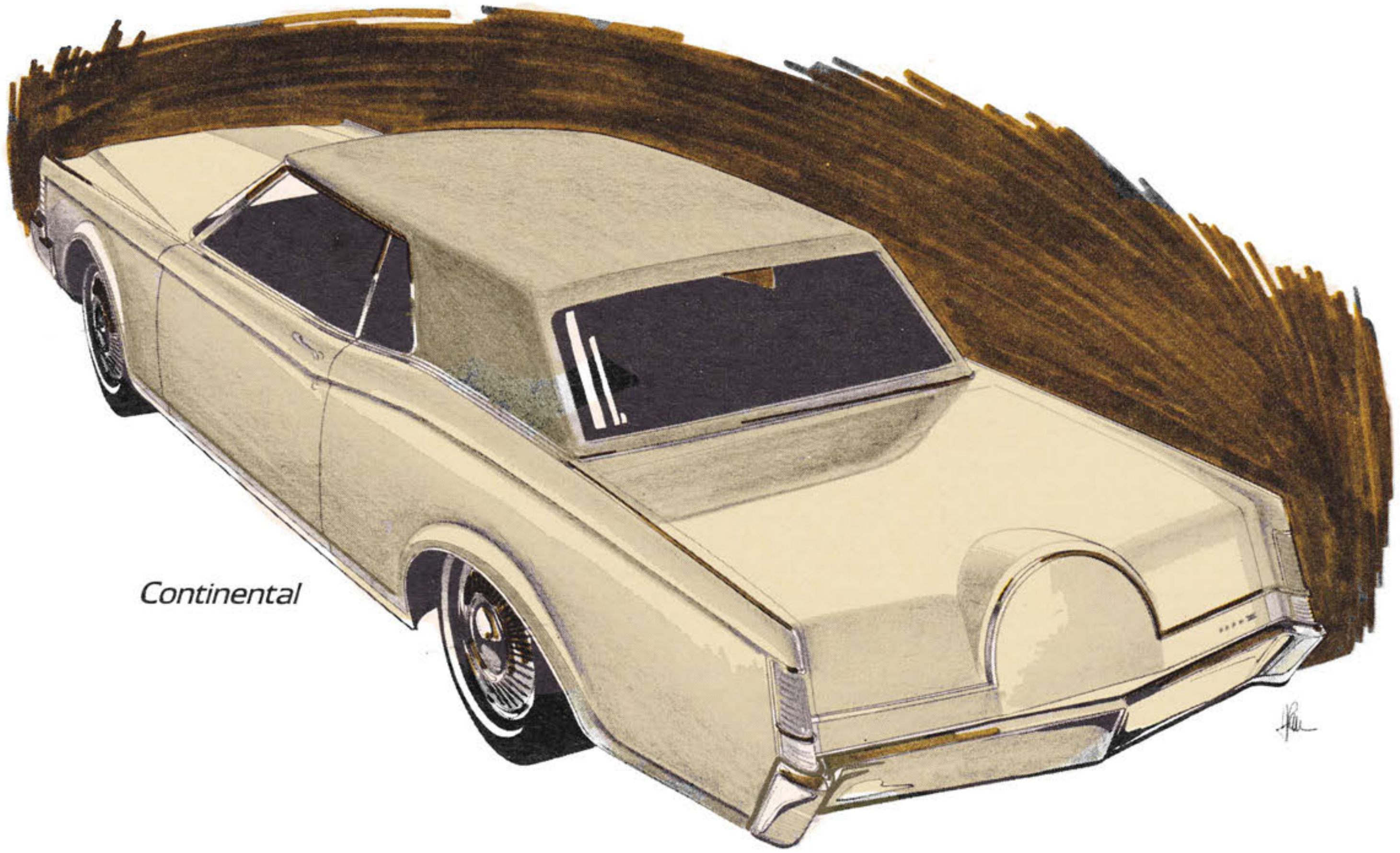
Lincoln-Mercury Division: Rather than adopt Cougar styling, as might be expected, Mercury Comet takes on more of the full-size Mercury appearance in 1968. The image is enhanced with a Mercury-like grille and wide, almost flat, hood. The identity is less apparent in the fastback model. As in the Fairlane, front vent windows are history.

Cougar and Mercury are close to the 1967 models in appearance.

The first half of the division provides the news for 1968. Lincoln has ▶



Sting Ray



Continental

PREVIEW 1968

the non-secret Continental Mark III (confirmed by Henry Ford II, himself) ready to unwrap shortly after Christmas, or after the regular line has been absorbed by the buying public. The Mark III, which was under wraps as the Mark X, has a wheelbase of 120 in. and will ride on the Thunderbird torque-box frame. (Regular Lincoln Continentals will be given separate frame and body construction in 1969.)

An entirely new 462-cu. in. engine powers the Mark III, as well as other Lincoln models.

The Mark III displays a mixture of classic styling, including Lincoln. It has a dash of Rolls-Royce in the unique, old-fashioned grille. In the "Continental Kit" simulated tire cover at the rear, stylists return to a Lincoln feature of a decade past. Hidden headlamps are positioned on each side of the massive one-piece grille; turn signals are built into the narrow front and rear fender lines. A slight hop-up of the rear fender relieves long, straight lines from the front. Price is estimated at $8000, plus change, which would move it into cost competition with the front-drive Eldorado. The new Lincoln also has some Cadillac in its overall appearance.

One point to note: Photos of the Mark III reveal no windshield wipers and they do show vent windows. Side vent windows are supposed to be eliminated on the majority of 1968 models. And there has been no leak that Ford will recess windshield wipers on 1968 models, as GM is doing.

Other Lincolns are unchanged.

Ford has been preparing a new 3-engine line for the past 18 months and will spring it for 1968. Lincoln, as mentioned, receives the largest engine, the 462-cu. in. A new 393-cu. in. engine is to be standard on the Ford models and optional on other division lines. A 430-cu. in. engine rounds out the triumvirate. It will be available on standard-size cars, as an optional powerplant, at both Ford and L-M.

Chrysler Corp.:

The corporation is pulling back from the extreme fastback look to feature conservatism in its new styling. However, the power increase continues with a new 340-cu. in. V-8 which is expected to be standard on Chrysler and Dodge cars and optional on Plymouth cars. Generally, the restyled intermediates are larger and have as much room as competitors, or more.

Chrysler is swinging to the 2-way action tailgate which Ford introduced in 1967 station wagons. However, Chrysler adds a new twist or two with an inside opener, and a safety inspired washer-wiper to keep the rear window clean.

Chrysler-Plymouth: Chrysler has hidden headlamps in the 300 series and new grille and taillight, to somewhat change the overall appearance of the new models. Sheet metal is curved about the same, however. This also is true of the Imperial line, which has been relegated to a minor role in future corporate thinking, and will probably become more of a top-of-the-line Chrysler in 1969.

Plymouth Belvedere models are longer by up to 4 in. and rooflines are faster without going all the way to pure fastback, as the competition is doing. New styling gives Belvedere more of a modern long hood, short deck outline and several rooflines provide model identification.

The Barracuda gets minor treatment this year after a big going over in 1967.

Dodge Division: Dodge Coronet, which shares the basic body with Belvedere, gets the big corporate change in 1968. Most apparent, and perhaps most difficult to explain, is the changed Charger. For 1968 it becomes just another Coronet with a notch cutting into the meat of the fastback of 1967. The notch gives the upper deck area the look of 1967 GM intermediates. While losing its fastback, Charger retains its place at the top of the Coronet line. The rear of the car appears to have undergone most styling treatment. Down from the notchback there extends a new thin rear bumper, built into the car, giving the front and rear somewhat similar appearances.

While Ford and GM offer fastbacks in the intermediate class for the first time, Chrysler, which generally appears to copy its competitors, backs away from a fastback model. The difference between Coronet and Charger in 1968 is therefore less than in 1967, but rooflines save the image, giving each a distinct look.

Dodge comes in for new grille work and a few rear touches.

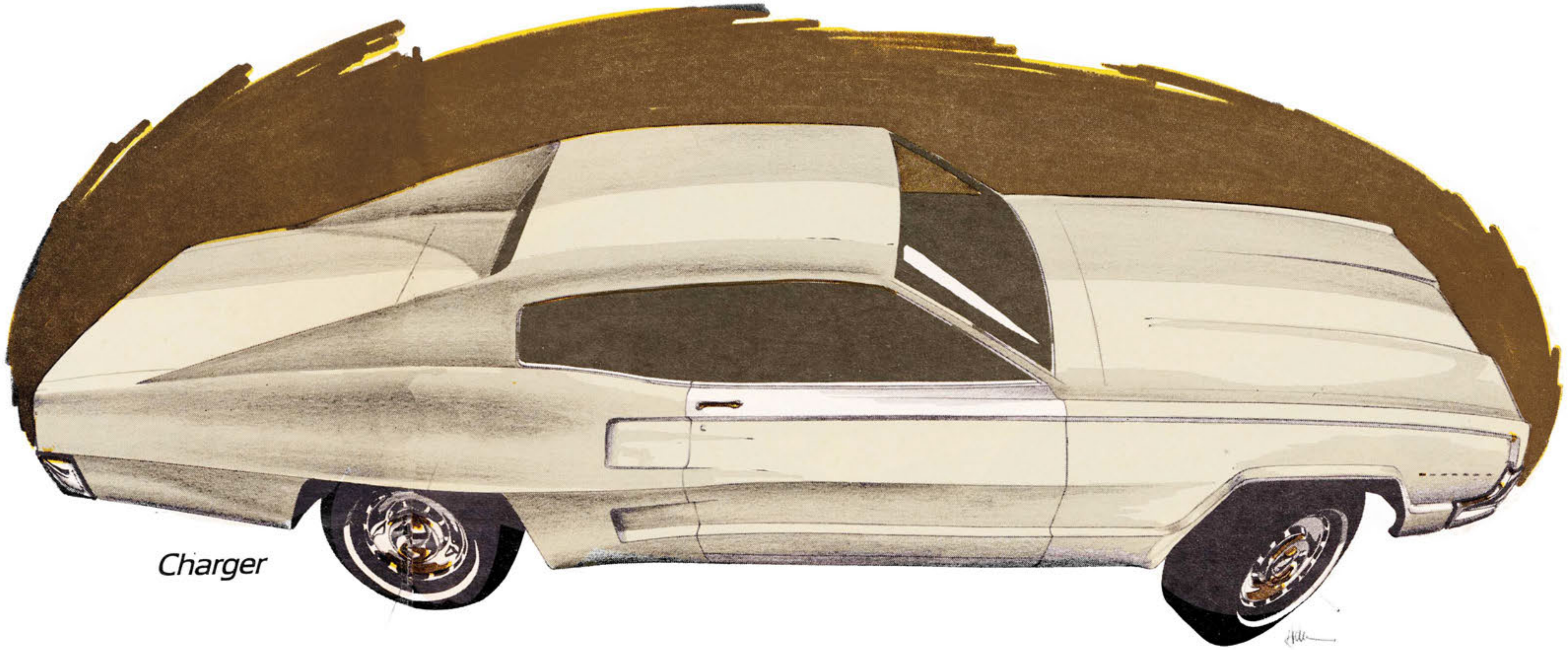
American Motors Corp.:

Although AM is making a small splash in the sales puddle, it is capturing the 1968 automotive news with two new sports cars, the Javelin and AMX. The corporation is basing its future on the small car field, which saved it once previously. New emphasis is on sporty, expensive models, rather than the austere automobiles of the past. This time around, AM will find more established competition, including Mustang, Camaro, Cougar, Barracuda and Firebird. One thing going for AM is that none of its competitors is having more than once-over-lightly styling changes for 1968. This leaves it with the only new looks in the field. If this isn't enough advantage, the corporation is in for more trouble.

The Javelin is a $2500 sports car, 190 in. long. Its cost is approximately that of its competition. And the Javelin is 6 in. longer than the Mustang. A split grille gives Javelin some of the Pontiac look forward; a short sloping rear, made popular by Buick's Riviera, adds to the modern appearance of the car. Large windows, without front vents, and indented door handles are styling touches of note. The indented door handles are featured on the majority of AM cars for 1968. The corporation says they are a safety measure.

AM plans to produce from 40,000 to 50,000 Javelins in 1968. The car will be on a 109-in. wheelbase, compared with the 106-in. wheelbase of the economy line American.

AM will follow the Javelin presentation with the AMX, which may be re-named for an early year introduction. (Arrow?) Suspension, drive train and underbody components of the Javelin will be used to make up the AMX, but the cars bear no family resemblance. The AMX will go for $3500 ▶



Charger

PREVIEW 1968

and production is tentatively set at 1000 per month. A new 400-cu. in. engine will make AMX the fastest thing at AM since George Romney.

In styling, the production AMX is closely related to the AMX show car, but the open "ramble" seat has been converted to closed quarters.

AM is not as secretive about leaking new model news as it once was. The short happy rule of Robert Evans did much to change the policy. Evans talked to newsmen about 1968 models as he was showing 1967 wares. Leaking information, he believed, did not harm sales, and in some cases, wisely used, as with the Mustang, leakage proved a major sales boost.

Other AM cars receive minor facelift treatment.

Safety:

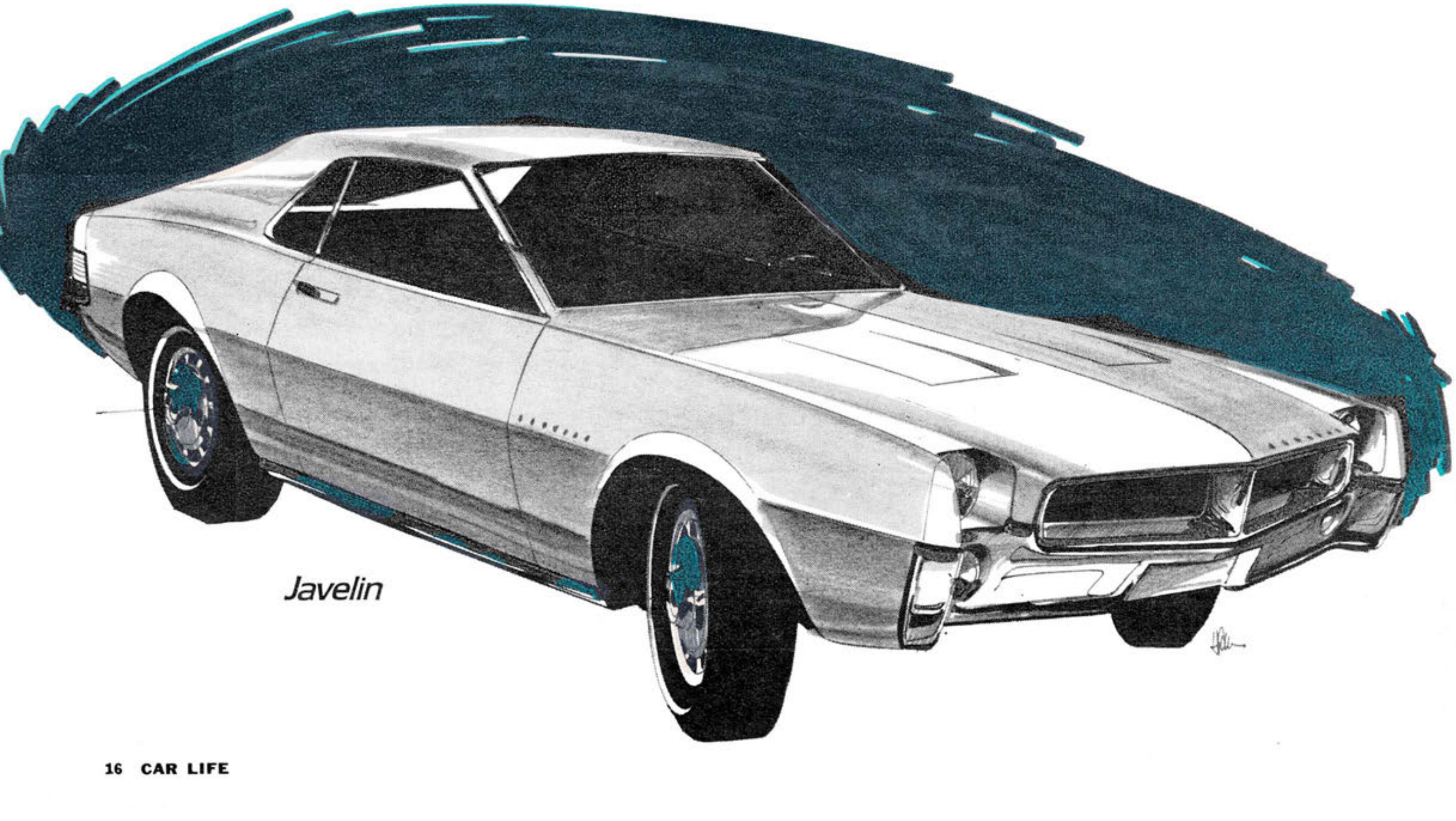
Styling and power increases again should be the primary selling points for 1968 model cars, but possibly for the first time in this decade, safety will be on sale, also. And it is expected to add at least $100 to the average car price.

What the public gets in safety includes new lighting in the form of easier to see turn signals and some wrap-around styling of signals and taillights. Fuel tanks are more protected, in some cases, to prevent rupture; there are mandatory smog control devices (Pages 17-20); recessed outside door handles, and restyled or redesigned inside door handles on most models. Protruding, blade-like wheel discs are outlawed.

These changes are not overly apparent to the average customer perhaps, but inside the car, changes are most easily detected—in fact impossible to overlook. Instrument panels are heavily padded and there are recessed, padded and restyled controls; pillars and backs of front seats receive extra padding. Driver and right front seat passenger are given shoulder harness to augment seat belts. In all, six sets of seat belts are required on a 6-passenger car and two sets of shoulder harnesses are standard. This is an addition of two sets of seat belts, plus shoulder harness over 1967.

New belts and harness are expected to add about $30 to the retail price of any given 1968 car; collapsing steering columns, smog devices, padding, extra power, larger cars, all increase the total cost. New models will go on sale in the last week of September. Assuming there is no general or prolonged labor strike, auto executives are predicting a good fourth quarter.

It will be interesting to see if the added costs of safety will affect purchases, as the lack of safety devices has been said to slow sales. Will the public go along with the cost of shoulder harnesses, when only 1% bought them as optional items at $25 extra per car in 1967? The question may be partially answered by imagining public sentiment against paying up to $50 for smog-fighting devices, when the buyer's area is relatively smog-free. It seems a sure prediction that safety will be a controversial issue in 1968. ■



Javelin

CHAN BUSH PHOTOS

CAR LIFE

ROAD TEST

THE SPRINT AND THE 400 FROM AMONG PONTIAC'S FIVE FIREBIRDS

A BRACE OF BIRDS

"EUROPEAN-STYLE grand touring car, the last word in sports cars." The deep, resonant voice from the television set extols the virtues of two of the five Firebirds available from Pontiac.

CAR LIFE tested two members of the Firebird flock, both claimed to be high-performance vehicles, but with emphasis on different bands of the spectrum. The Firebird Sprint is intended as the domestic answer to European Grand Touring machines, presumably Jaguar, Porsche and Mercedes, but at much lower cost. The Firebird 400 is, simply, a Supercar of somewhat diminutive proportions.

In both cases, the term "sports car" provokes critical, offended shouts from purists. Actually, in terms of straight-line performance, handling and occupant comfort, both Firebirds surpass many accepted "pure" sports cars, particularly of vintage configuration, i.e., Austin-Healey 3000, MG Midget and Datsun SPL-311. It seems strange that Pontiac, which commands a wealth of excellent engineers, should produce a 1967 automobile that evokes the adjective *vintage,* but that overworked term frequently came to mind in testing the Firebirds.

Both 'Birds have virtues, and both have deficiencies, the balance between resting upon driver opinion. Of the major objections to Firebird ownership, some could be rectified by intelligent option selection, some could be removed by minor reworking, and some are so basic that nothing short of complete rebuilding could alter them. Of the virtues, some are outstanding, some are inconspicuous and some would be virtues only to a particular type of consumer.

From the cowl rearward, Firebird sheet metal is identical to Camaro. The major objection to Firebird appearance was that, "It looks just like a Camaro." While there is no question as to the validity of this statement, the Firebird, taken on its own, is a well styled vehicle whose appearance promises performance in every sense of the word. The huge, flaring fender contours manage to make even E70-14 Wide Oval tires, standard on all Firebirds, appear slightly narrow. The test Sprint was equipped with 185R-14 radial ply tires, recently made available by Pontiac as a handling option. These tires were noticeably narrower in section than the Wide Ovals, and gave the car an almost "narrow track" appearance.

Firebird's extended nose, most noticeable departure from Camaro styling, was viewed with mixed emotions by observers. The general consensus seemed to be that the long, pointed nose furthered the long hood look-of-power profile which has come into vogue with Ponycar packages. A minor parking shunt proved the protection afforded by this armored snout. Prospective Firebird owners are hereby advised that the front of this car is much farther away than is apparent from the driver's seat.

BOTH TEST Firebirds featured exterior sheet metal relatively free from useless ornamentation. This was observed with pleasure by *CL* staff members, and greatly enhanced the functional, sporty nature of the cars. Except for the double-scooped hood of the Firebird 400, compared with the unscooped, peaked hood of the Sprint, the two test cars were virtual twins. The Sprint's hood announced the presence of a "3.8 Liter OHC" engine under its sheet metal, in European style. The 400's hood described just that, a 400-cu. in. high-performance engine, ▶

with displacement units more familiar to American drivers.

Both test Firebirds were equipped with optional hood-mounted tachometers. This unique location not only proved convenient for driver viewing, but prompted all sorts of observer reaction. Hood-mounted tachometers may be the greatest piece of automotive showmanship to come from Detroit. Usefulness of the tachometer was marred somewhat by the unit's attraction for early morning dew, dust and raindrops. Night lighting was not particularly bright, but the brilliance of tachometer lighting was tempered by the presence of the unit in the driver's line of sight. Too much tachometer illumination would prove irritating at night. For some reason, the tachometer light in the Sprint was much dimmer than in the 400. In neither case did tachometer lighting become annoying, and the brighter light of the 400 was preferred.

The great visual attraction of the test Sprint was aided by audible magnetism. There is something almost musical about the exhaust note of a highly tuned 6-cyl. engine, and the Firebird Sprint exhaust system does little to suppress this sound. While certainly legal, the decibel level of the Sprint exhaust adds to the European, sporting nature of this automobile. The system consists of two manifolds feeding into exhaust pipes which merge into a common pipe running to the transverse rear muffler. If that lovely blonde alongside doesn't notice a Sprint pulling up, a blip of the throttle is guaranteed to attract her attention.

ONCE INSIDE either test Firebird, the driver was greeted by a blend of black paint, black vinyl and imitation wood finishes which were done in a simple, but pleasing manner. All Firebird instrumentation is grouped into two circular clusters in front of the driver. The test Sprint had the optional right-cluster instrument package, adding ammeter, oil pressure and water temperature gauges to the fuel gauge of the 400's standard package. The optional instruments are highly recommended, as driver anxiety during vigorous driving is greatly reduced if visual assurance of proper engine operation is present.

Seats in both Firebirds were very attractive, an appearance which was unfortunately not totally matched by their comfort. Cushions were rather thin and hard, and back angle too vertical. Seating position was judged poor, with respect to driving comfort. Steering wheel location was in the GM tradition, close to the driver's chest. If seat adjustment permitted full depression of the clutch pedal, the driver's arms were bent at much too great an angle to accommodate the too-close wheel position. It seems apparent that Detroit's "sports car" designers haven't spent much time in real ones.

Gearshift location was fairly convenient, but selector motion was unpleasant. Instead of an easy, fore-and-aft motion, the Firebirds required a lifting motion to negotiate the 2-3 shift. Effective efforts to shift the excellent Muncie transmission were much too high. The Sprint was equipped with a console through which the shift lever protruded. A hard plastic sliding panel in the console caused an unpleasant amount of rattle, squeak and grind when running through the shift pattern, and apparently added its resistance to the shift mechanism. The 400, sans console, was a much better shifting automobile, and exhibited none of the noises of the Sprint. Effort in the 400 was about half that of the Sprint, and shifting the 400 was much more pleasant.

WHILE ON THE subject of transmissions, a prospective buyer would do well to carefully consider the near-$200 cost of the 4-speed transmission fitted to both test cars. Both the Sprint and 400 engines proved to be very flexible powerplants, with broad

1967 PONTIAC

FIREBIRD SPRINT 2-DOOR HARDTOP

DIMENSIONS

Wheelbase, in.	108.0
Track, f/r, in.	59/60
Overall length, in.	188.8
width	72.6
height	51.5
Front seat hip room, in.	20.2 x 2
shoulder room	56.7
head room	37.0
pedal-seatback, max.	39.6
Rear seat hip room, in.	48.6
shoulder room	53.6
leg room	29.5
head room	36.7
Door opening width, in.	38.5
Ground clearance, in.	6.2
Trunk liftover height, in.	29.1

PRICES

List, FOB factory	$2817
Equipped as tested	3724

Options included: AM/FM radio, Sprint package, Rally wheels, radial tires, Custom trim package, power steering, disc brakes, Injector Exhaust Control, tilt wheel, tinted glass, tachometer, limited slip dif., console, tinted glass.

CAPACITIES

No. of passengers	4
Luggage space, cu. ft.	9.9
Fuel tank, gal.	18.5
Crankcase, qt.	6
Transmission/dif., pt.	2.5/3
Radiator coolant, qt.	12.1

CHASSIS/SUSPENSION

Frame type: Unitized, front subframe.

Front suspension type: Independent with s.l.a., ball joints, coil springs with telescopic shock absorbers.

ride rate at wheel, lb./in.	85
antiroll bar dia., in.	n.a

Rear suspension type: Hotchkiss type, single leaf springs, two trailing arms with windup bumpers.

ride rate at wheel, lb./in.	115

Steering system: Coaxial assist recirculating ball gear, parallelogram linkage behind front wheels.

overall ratio	17.5:1
turns, lock to lock	3.4
turning circle, ft. curb-curb	38.5
Curb weight, lb.	3470
Test weight	3770
distribution (driver), %f/r	56.3/43.7

BRAKES

Type: Two line hydraulic, disc front, cast iron drum rear.

Front rotor, dia. x width, in.	11.1 x 1.75
Rear drum, dia. x width	9.5 x 2.5
total swept area, sq. in.	323.6

Power assist: Integral vacuum.

line psi at 100 lb. pedal	800

WHEELS/TIRES

Wheel rim size	14 x 6
optional size	none
bolt no./circle dia. in.	5/4.75

Tires: B. F. Goodrich Radial 990.

size	185R-14
normal inflation, psi f/r	24/24
Capacity @ psi	n.a.

ENGINE

Type, no. of cyl.	ohc IL Six
Bore x stroke, in.	3.88 x 3.25
Displacement, cu. in.	230.087
Compression ratio	10.5:1
Fuel required	premium
Rated bhp @ rpm	215 @ 5200
equivalent mph	108
Rated torque @ rpm	240 @ 3800
equivalent mph	79

Carburetion: 1x4 Rochester

throttle dia., pri./sec.	1.38/2.25

Valve train: Belt-driven overhead cam, hydraulic finger-type followers.

cam timing deg., int./exh.	14-50/52-12
duration, int./exh.	244/244

Exhaust system: Dual manifold, Y-type single exhaust, transverse muffler, single tailpipe.

pipe dia., exh./tail	2.25/2.00
Normal oil press. @ rpm	26 @ 2800
Electrical supply, V./amp.	12/37
Battery, plates/amp. hr.	54/44

DRIVE TRAIN

Clutch type: Single dry disc, disc spring pressure plate.

dia., in.	10.4

Transmission type: Manual, four synchromesh forward speeds.

Gear ratio 4th (1.00:1) overall	3.55:1
3rd (1.47:1)	5.22:1
2nd (2.20:1)	7.81:1
1st (3.11:1)	11.03:1
1st x t.c. stall ( )	

Shift lever location: Console.

Differential type: Hypoid, limited slip.

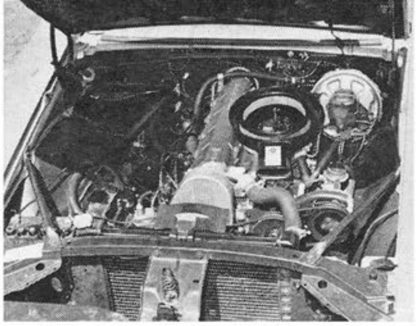
axle ratio	3.55:1

torque range. In all-out dragstrip competition, a 4-speed transmission has a slight advantage in keeping an engine near its power peak over a larger portion of the strip. In city traffic operation, however, four gears become a bit redundant, and the driver is likely to find himself skipping one or more ratios. With the flexibility Pontiac engines offer, a 3-speed transmission is more than adequate and costs less. The 3-speed fully synchronized transmissions installed as standard equipment in all Firebirds are very satisfactory units, with well chosen ratios for each powerplant. Floor shift, standard with the two test engines, is advisable both for sporting feel and shifting ease.

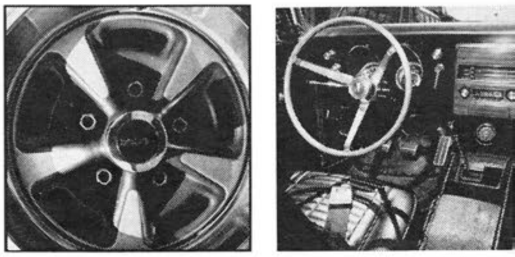
Both test cars were equipped with optional power disc brakes. These brakes were judged overly sensitive, requiring low pedal pressure to lock the wheels, and were poorly balanced, front to rear. One of *CL*'s standard brake test procedures consists of determining maximum deceleration rate from 80 mph. This test proved thrilling: Rear wheel lockup was almost unavoidable when high deceleration rates were attempted. Normal fade testing was not performed, because the question of brake fade seemed academic in view of the almost total loss of vehicle control encountered during initial hard stops. Some means of preventing rear wheel lockup is mandatory, if high-speed, high-deceleration stops are to be made acceptable.

Power steering was also fitted to both test cars. Steering effort required with this system was very low, too low for *CL* drivers' tastes. The fast ratio and extremely low-effort steering promoted over-correction when driving at high speeds, and lacked enough feel of side-force propagation. Overall steering ratio was considered to be a very good compromise, as fast as typical American drivers are likely to desire, and fast enough for rapid consecutive cornering maneuvers. If the present ratio were maintained, with a bit more effort and a lot more road feel, Firebird steering would be much more inviting to the sporting driver.

Another option worthy of comment was the tilt steering wheel installed in the Sprint. Standard wheel positioning in Firebirds is fairly low. This position is desirable to many drivers, but most unpleasant for entry and egress. The tilt wheel swings up on depressing the ▶



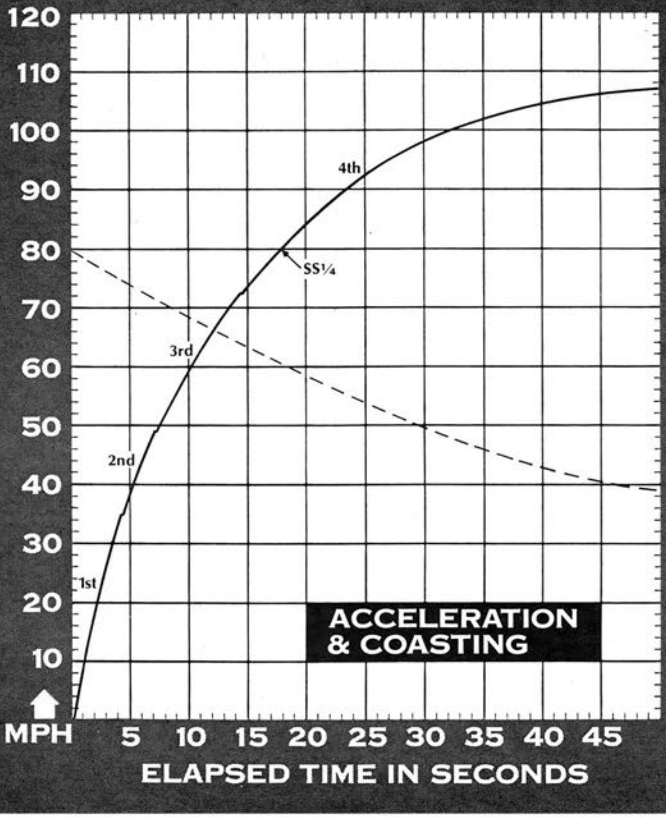
SPRINT 6-cyl. engine featur
belt-driven overhead camsh



SPORTING image of Sprint's interior, exterior was marred by difficult gear changing.

BIRDS

CAR LIFE ROAD TEST



CALCULATED DATA

Lb/bhp (test weight)	17.5
Cu. ft./ton mile	102.3
Mph/1000 rpm (high gear)	20.7
Engine revs/mile (60 mph)	2900
Piston travel, ft./mile	1570
CAR LIFE wear index	45.6
Frontal area, sq. ft.	20.8
NHRA-AHRA Class	G/S-I/S

SPEEDOMETER ERROR

30 mph, actual	31.0
40 mph	40.5
50 mph	50.3
60 mph	60.0
70 mph	69.1
80 mph	78.9
90 mph	88.3

MAINTENANCE

Engine oil, miles/days	6000/n.s.
oil filter, miles/days	6000/n.s.
Chassis lubrication, miles	24,000
Anti-smog servicing, type/miles: replace PCV valve/12,000, tighten belts, 12,000, tuneup check/12,000.	
Air cleaner	clean, 6 mo.
Spark plugs: AC 44N	
gap, (in.)	0.035
Basic timing, deg./rpm	5/700
max. cent. adv., deg./rpm	20/6000
max. vac. adv., deg./in. Hg.	20/12
Ignition point gap, in.	0.016
cam dwell angle, deg.	31-34
arm tension, oz.	19-23
Tappet clearance, int./exh.	0/0
Fuel pressure at idle, psi	4
Radiator cap relief press., psi	14-17

PERFORMANCE

Top speed (5200), mph	108
Test shift points (rpm) @ mph	
3rd to 4th (5200)	73
2nd to 3rd (5200)	49
1st to 2nd (5200)	35

ACCELERATION

0-30 mph, sec.	3.6
0-40 mph	5.3
0-50 mph	7.4
0-60 mph	10.0
0-70 mph	13.4
0-80 mph	17.5
0-90 mph	23.0
0-100 mph	32.5
Standing ¼-mile, sec.	17.5
speed at end, mph	80
Passing, 30-70 mph, sec.	9.8

BRAKING

Max. deceleration rate from 80 mph ft./sec.^{2}	25
No. of stops from 80 mph (60-sec. intervals) before 20% loss in deceleration rate	
Control loss?	severe
Overall brake performance	poor

FUEL CONSUMPTION

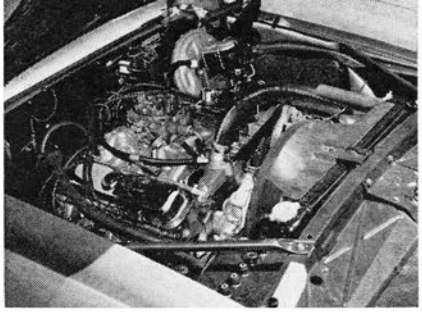
Test conditions, mpg	13.6
Normal cond., mpg	12-16
Cruising range, miles	220-290

GRADABILITY

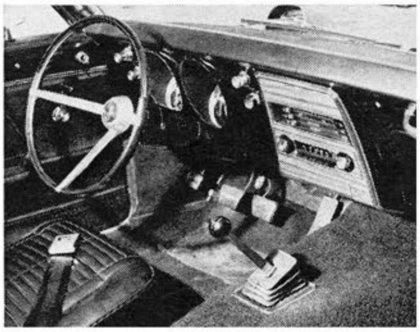
4th % grade @ mph	13 @ 51
3rd	19 @ 42
2nd	27 @ 39
1st	30 @ 32

DRAG FACTOR

Total drag @ 60 mph, lb.	122



FIREBIRD 400 engine provided smooth, exciting acceleration.



SUPERCAR performance supported brutal look of 400. Gearshift operation was easy, positive.

BIRDS

turn signal lever, and is out of the way of driver's thighs while climbing in and out of the car. Once in, the driver may drop the wheel to a position suitable for spirited driving. At $42.13, this is one of the more functionally desirable options on the Firebird list.

Before leaving the interior, a word of caution is due. One should not purchase a Firebird (or Camaro) with the intention of carrying four people of average size any distance. Rear-seat room is minimal, adequate only for children, or adults over short distances and smooth roads.

Power trains in the test Firebirds were intended for different purposes, and had distinctly disparate performance characteristics. The Sprint's ohc Six incorporated 4-barrel carburetion, 10.5:1 compression, high-performance camshaft and the aforementioned split exhaust system. On paper then, one would expect a free-breathing, high-revving engine with substantial power output. In practice, valve float occurred at approximately 6100 rpm, well short of the tachometer redline at 6500. Acceleration from 5000 rpm upward was slow, and felt flat. Torque at low speeds was adequate, perhaps more than would be expected from engine specifications. Power at high engine speeds, however, never developed. The engine had a feeling of being just about to "turn on," but never did. In fairness to the test Sprint, its previous history was one of abuse and improper break-in. Also, the Sprint engine was equipped with the full California emission-reduction package. Whatever the specific cause, the test car did not perform up to our expectations.

HANDLING IS supposed to be the Firebird Sprint's forte. The test car did exhibit superb stability on smooth roads. Steering response was excellent, with handling characteristics varying from slight understeer at low speed and moderate cornering loads, to oversteer on harder cornering. Firebird suspension apparently is set up for an appreciable amount of roll oversteer. Extremely light steering accentuated this roll oversteer, with the result that a typical American motorist will find himself quickly correcting out of vigorously entered turns. At high speed, near neutral handling results. Hard driving over smooth roads was just plain fun in the Sprint. Rough surfaces emphasized the high unsprung weight and stiff springing of the Firebird Sprint suspension system. Rear wheels tended to skate across rough

1967 PONTIAC
FIREBIRD 400 2-DOOR HARDTOP

DIMENSIONS

Wheelbase, in.	108.0
Track, f/r, in.	59 /60
Overall length, in.	188.8
width	72.6
height	51.5
Front seat hip room, in.	20.2 x 2
shoulder room	56.7
head room	37.0
pedal-seatback, max.	39.6
Rear seat hip room, in.	48.6
shoulder room	53.6
leg room	29.5
head room	36.7
Door opening width, in.	38.5
Ground clearance, in.	7.1
Trunk liftover height, in.	29.1

PRICES

List, FOB factory	$2777
Equipped as tested	3829

Options included: Power steering, brakes, disc brakes, 4-speed transmission, 400-cu. in. engine, radio, lamp group, HD limited slip, hood mounted tachometer, Rally II wheels, Custom Trim Group.

CAPACITIES

No. of passengers	4
Luggage space, cu. ft.	9.9
Fuel tank, gal.	18.5
Crankcase, qt.	6
Transmission/dif., pt.	2.5/3
Radiator coolant, qt.	17.8

CHASSIS/SUSPENSION

Frame type: Unitized, front sub-frame.

Front suspension type: Independent with s.l.a., ball joints, coil springs and telescopic shock absorbers.

ride rate at wheel, lb./in.	92
antiroll bar dia., in.	n.s.

Rear suspension type: Hotchkiss type, single leaf springs, two trailing arms with windup bumpers.

ride rate at wheel, lb./in.	135

Steering system: Coaxial assist recirculating ball gear, parallelogram linkage behind front wheels.

overall ratio	17.5:1
turns, lock to lock	3.4
turning circle, ft. curb-curb	38.5
Curb weight, lb.	3580
Test weight	3980
distribution (driver), % f/r	56.0/44.0

BRAKES

Type: Two-line hydraulic, disc front, cast iron drum rear.

Front rotor, dia. x width, in.	11.1 x 1.75
Rear drum, dia. x width, in.	9.5 x 2.5
total swept area, sq. in.	323.6

Power assist: Integral vacuum.

line psi at 100 lb. pedal	800

WHEELS/TIRES

Wheel rim size	14 x 6
optional size	none
bolt no./circle dia. in.	5/4.75

Tires: Firestone Wide Oval.

size	E70-14
normal inflation, psi f/r	24/24
Capacity @ psi	n.a

ENGINE

Type, no. of cyl.	ohv 90° V-8
Bore x stroke, in.	4.12 x 3.75
Displacement, cu. in.	400.002
Compression ratio	10.75
Fuel required	premium
Rated bhp @ rpm	325 @ 4800
equivalent mph	108
Rated torque @ rpm	410 @ 3400
equivalent mph	76

Carburetion: 1x4 Rochester.

throttle dia., pri./sec.	1.38/2.25

Valve train: Hydraulic lifters, pushrods, overhead rocker arms.

cam timing deg., int./exh.	23-70/78-31
duration, int./exh.	273/289

Exhaust system: Dual, crossflow muffler with dual inlets & outlets, dual resonators ahead of muffler, 4 outlet pipes.

pipe dia., exh./tail	2.00/2.25
Normal oil press. @ rpm	55 @ 2600
Electrical supply, V./amp.	12/37
Battery, plates/amp. hr.	66 /61

DRIVE TRAIN

Clutch type: Single dry disc, disc spring pressure plate.

dia., in.	10.4

Transmission type: Manual, 4 synchronized forward speeds.

Gear ratio 4th (1.00:1) overall	3.36:1
3rd (1.46:1)	4.90:1
2nd (1.88:1)	6.31:1
1st (2.52:1)	8.47:1
1st x t.c. stall ( )	

Shift lever location: Floor.

Differential type: Hypoid, limited slip.

axle ratio	3.36:1

roads both during cornering and on acceleration at low speeds.

Axle hop on takeoff was supposedly eliminated by the twin trailing arms fitted to all "sporting" Firebirds. The test Sprint, however, exhibited poor axle control. Takeoff was accompanied by a period of violent hop, unless a very gentle "roll-out" was employed. Brake hop also was noticeable, but not as frequently encountered.

It was during ride-quality evaluation of the Firebird Sprint that the term vintage first came to mind. The Sprint delivered the same sort of rock-solid, back-slapping ride familiar to early post WW II sports cars. To those who associate ride firmness with superior handling, the Firebird meets their requirements. Most obvious among ride deficiencies in both Firebirds was a lack of free spring travel. The springs were forced to absorb all road irregularities in about 3 in. of travel, and if the bump was too severe to allow the stiff springs to accommodate it, the jounce bumpers entered the picture with a resounding bang. Other manufacturers, principally in Europe, have caused live axle layouts to produce a very comfortable ride while providing superb handling. Pontiac has not.

The Firebird Sprint, then, was an exciting car to drive hard on smooth roads. It was not particularly fast or economical, delivering less than 14 mpg during testing. It was not particularly comfortable, though turnpike or smooth highway ride was acceptable. An enjoyable car? Yes! An attractive car? Yes! A reliable car? Undoubtedly! A European-style GT car? No!

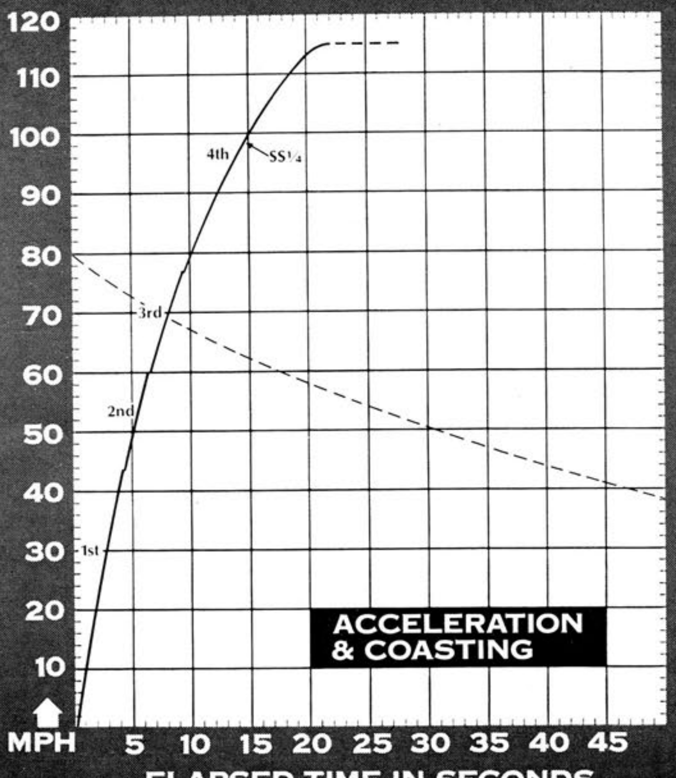
The Firebird 400 came closer to fulfilling its advertised goals than did the Sprint. The 400 is the most powerful, fastest of the Firebird family, and one of the fastest of Ponycars. Preceding comments on ride and handling apply to the 400 as much as they do to the test Sprint. The Firebird 400 exhibited slightly more understeer at low speeds, but could easily be placed into power oversteer attitude with a nudge on the accelerator pedal. Ride quality of the 400 was slightly superior to the Sprint, but still quite vintage.

PERFORMANCE, SPELLED acceleration, was the 400's forte. The 400-cu. in./325-bhp engine is a beautifully flexible, quiet, tremendously responsive powerplant. Around town, the only difficult task was avoiding flagrant speed limit violation. The engine seemed quite happy motoring along just above idle, but a few periods of this sort of operation did foul spark plugs. Once on the open road, a few bursts of speed cleared the plugs, and the 400 flexed its muscles. Acceleration was impressive in any gear, at almost any speed. The Firebird 400 would pull strongly to just over 5000 rpm, where hydraulic lifter pump-up was encountered. In high gear, the 400 would run out to valve float in an amazingly short period of time.

A quarter-mile elapsed time of 14.7 sec. is exceptional for an automobile in full street trim, with two passengers and test gear aboard. Only the 427 Corvette, and Hemi-powered Plymouths and Dodges are capable of times quicker than this, and that places the Firebird 400 in the very uppermost echelon of domestic Supercars.

The 400 is likely to be the enthusiast's choice among Firebird's lineup. It was definitely *CL*'s choice of the two test cars. The 400 simply made more sense. Neither car was a sports car, although both compare favorably in handling ability with others in the Ponycar brigade. Neither car was particularly economical, though the 400's near 12 mpg during hard driving was considered quite acceptable. The 400 delivered outstanding performance, unhampered by power-robbing emission reduction apparatus. To the average American purchaser, particularly one inclined toward Firebird-type vehicles, acceleration makes up for numerous faults. The Firebird 400 has acceleration, in spades. ■

CAR LIFE ROAD TEST



CALCULATED DATA

Lb/bhp (test weight)	12.2
Cu. ft./ton mile	156.0
Mph/1000 rpm (high gear)	22.4
Engine revs/mile (60 mph)	2680
Piston travel, ft./mile.	1675
CAR LIFE wear index	44.9
Frontal area, sq. ft.	20.8
NHRA-AHRA Class	B/S-C/S

SPEEDOMETER ERROR

30 mph, actual	30.7
40 mph	40.8
50 mph	50.8
60 mph	60.5
70 mph	71.3
80 mph	81.0
90 mph	91.8

MAINTENANCE

Engine oil, miles/days	6000/n.s.
oil filter, miles/days	6000/n.s.
Chassis lubrication, miles	24,000
Anti-smog servicing, type/miles	none fitted
Air cleaner	clean, 6 mo.
Spark plugs: AC, 44S. gap, (in.)	0.035
Basic timing, deg. /rpm	6/700
max. cent. adv., deg./rpm.	28/6000
max. vac. adv., deg./in. Hg.	20/16
Ignition point gap, in.	0.016
cam dwell angle, deg.	28-32
arm tension, oz.	19-23
Tappet clearance, int./exh.	0/0
Fuel pressure at idle, psi	5.0
Radiator cap relief press., psi	14-17

PERFORMANCE

Top speed (5100), mph	115
Test shift points (rpm) @ mph	
3rd to 4th (5000)	77
2nd to 3rd (5000)	60
1st to 2nd (5000)	44

ACCELERATION

0-30 mph, sec.	2.9
0-40 mph	4.0
0-50 mph	5.2
0-60 mph	6.5
0-70 mph	8.0
0-80 mph	9.9
0-90 mph	12.2
0-100 mph	15.5
Standing ¼-mile, sec.	14.7
speed at end, mph	98
Passing, 30-70 mph, sec.	5.1

BRAKING

Max. deceleration rate from 80 mph ft./sec.^{2}	24
No. of stops from 80 mph (60-sec. intervals) before 20% loss in deceleration rate	
Control loss?	severe
Overall brake performance	poor

FUEL CONSUMPTION

Test conditions, mpg	11.9
Normal cond., mpg	10-14
Cruising range, miles	180-250

GRADABILITY

4th % grade @ mph	25 @ 65
3rd	33 @ 60
2nd	39 @ 50
1st	off scale

DRAG FACTOR

Total drag @ 60 mph, lb.	130

CAR LIFE
ROAD TEST

FURY III convertible

Plymouth's Car Incarnadine Bewitchingly Invites Abandon

RED, IT WAS—a deep, rich red that suffused the Fury III's interior, contents and surroundings—a red that seemed to incarnadine the very sky above. Seats, door panels, sun visors—all red–even the steering wheel itself was fashioned of a translucent red plastic. And, even more confounding than its all-pervading redness, it was convertible! Surely this exquisite combination of delights would be enough to bewitch testers' senses, to lure them into arcane realms of automotive excess and abandon. And, just as surely, there was the admittedly delicious prospect of having to greet—strictly in the line of duty, of course—and gently spurn those gorgeous, fulsome blondes who would pitifully, inevitably be drawn against their wills to the great, mobile red flame.

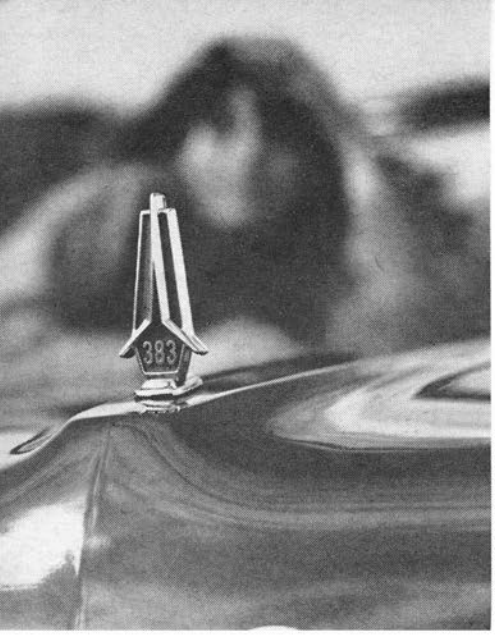
It wasn't quite like that, of course–anticipation always outruns reality—but the actual delights of a return to topless motoring were real enough. There is something about the sheer, downright pleasure of driving an open car—a feeling of free-wheeling escape from the super-silent, controlled-atmosphere, padded-cocoon world of tightly closed and insulated vehicles—a bold acceptance of the clouds above and the road below, and an exhilaration in the rushing wind and the sounds of speed.

Though the convertible's presence on the streets caused no rioting or nubile assaults upon its drivers, the styling of the Fury III was eminently satisfying in the modern mode—a welcome trend toward design simplicity and away from the peculiar fantasy of excrescence merely for the sake of make and model identification. The gratuitous protuberances of yesteryear have been lopped off and slimmed down into strong, straightforward lines that should wear well in the eye of both the first owner and the second buyer. This understatement extends even to the bumper guards, made of a gray synthetic rubber compound whose color blends so well into the chromium plating that they are all but invisible at a distance of 15 ft. or so.

The name "Fury" implies performance, and the test Fury III did indeed go like *furioso*. A 16.6 sec. standing-start quarter-mile bespeaks virile authority in the engine room, especially when the time is established by a car weighing nearly two and a quarter tons. The source of its thrust was Chrysler Corporation's optional 383-cu. in. V-8 with 4-barrel carburetion, which produces a potent, usable 425 lb.-ft. of torque down in the 2800-rpm range. This strong, no-nonsense engine is a fit mate for the Fury III's suave but exciting character, and owners will be doubly rewarded by its ability either to idle smoothly and coolly about town or hurl the car forward in a great, storming rush of acceleration.

Other engine variations available for the Fury III are the 318-cu. in./230-bhp V-8, standard with this model; and a 383-cu. in./270-bhp V-8 with 2-barrel carburetor, both of which are satisfied with regular gasoline. At the opposite end of the power scale are two mighty 440s—rated, respectively, at 350 and 375 bhp, and spinning out an irresistible 480 lb.-ft. of torque.

THE TEST FURY came equipped with the optional automatic Torque-Flite transmission, another component which blends well into the car's personality with its completely controllable brute strength. *CL* has expressed ▶



SCOTT MALCOLM PHOTOS

CLEAR SKIES, sunshine, a bit of breeze, the open road—all are part of the convertible syndrome that invites, demands top-down driving.

FURY III

high regard for this unit in previous tests of Chrysler products, and will merely reaffirm here its continuing excellence as a durable, positive means of power transmission. The Fury III is also available with either 3- or 4-speed manual gearboxes.

Test drivers' initial pleasure over the anticipated high performance of the Fury's disc brakes changed abruptly to disbelief, then extreme disappointment on the test strip. The very first 80-to-zero emergency stop was a memorable, vividly traumatic experience for the testers. These two jaded stalwarts were reduced to blobs of adrenalin-laced protoplasm by the car's actions under maximum deceleration, and later stoutly claimed that at one point they had been able to see both ends of the car at once.

The tragedy of a potentially superb braking system reduced to impotence by extreme forward weight transfer is a familiar story, and the results of this effect were almost classically pronounced in the Fury III. At the outset of the simulated panic stop, the brakes were applied heavily, just short of wheel lockup. As weight transferred forward onto the front wheels, the increasingly unloaded rear wheels locked, lost traction and slid sideways in an attempt to go around the still hard-braking front wheels. Luckily, the test road was long and wide, and allowed bringing the car to a more gradual halt.

In spite of this experience, however, testers still believe this could be the finest braking system Plymouth ever has offered. The power and endurance of the discs is abetted by a dual hydraulic brake system which keeps at least one front and one rear brake in operation, even in the event of a complete failure of the other two. Additionally, the "brakes on" panel light also will warn of trouble in either set of brake lines.

A SIMPLE, and much needed, solution to the rear-wheel lockup problem would involve the installation of a proportioning system to control braking effort applied to the rear wheels. These systems are now available, and can do much to keep rear wheels turning, gripping and providing di-

SHAZAM!

It's Convertible

CUT THE TOP off any 2-door hardtop and—Shazam!—a convertible. Well, sort of a convertible. Actually, it will be more a bowl of Jello. That steel top did more than shield occupants from the sun. The top provides great structural rigidity, particularly against torsion, in the modern body shell. Twenty years ago, convertible frames were simply boxed, with X-members added, and the body shell was perched on top. Today's unitized construction techniques require a different approach, because no frame, as such, is utilized.

The Plymouth Fury III is a typical example. As is normal for any unitized automobile structure, pseudo-frame members, called longitudinals, are an integral part of the floor pan-body sill structure. For convertible applications, sheet metal ribs are welded into the central cavity of the body sill box section. These ribs normally run the full length of the body, and contribute greatly to torsional rigidity of the body shell. Additional reinforcement is often incorporated into the cowl structure, with the result that the test Fury III convertible discussed herein demonstrates a degree of body rigidity which was considered exceptional by *CL* testers. ■

TOP UP for inclement weather, the Plymouth Fury III displays clean, uncluttered appearance. Raising that top is a matter of pressing a toggle, securing latches and zipping in the rear window, the latter a trying process.

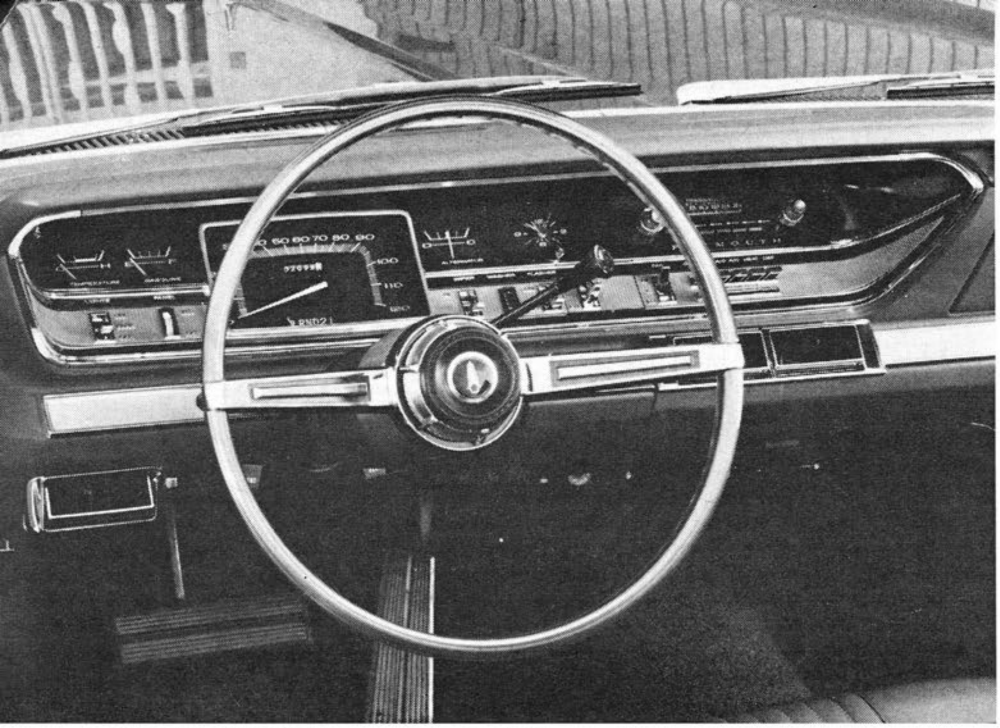
rectional stability, even under extreme weight transfer, while the front wheels do their work.

More happily, Plymouth design engineers have given the Fury III an unusually strong, stiff unit-frame which prevents nearly all of the objectional flexing and twisting characteristic of the majority of convertibles. This extra rigidity will bring dividends throughout the life of the car, and should even delay development of the body creaks, rattles and groans to which aging convertibles are wont to give querulous voice.

Manipulation of the power-driven top is child's play—in fact, *CL* suggests moving the actuating toggle switch away from the center of the console on future models, away from delighted but irresponsible young fingers. To one who has sweat, cursed and despaired over the erection of a manual top, this operation is a thing of blessed ease and grace.

The flexible-glass rear window zips open easily enough, but re-zipping it demands strict dedication and, if available, a muscular third hand. Even with top tension released and with the window-supporting straps snapped in place, simultaneously pressing the window into position, holding the bottom end of the zipper and meanwhile working it closed behind top bows and straps across the wide, wide back is a test of dexterity and vocabulary.

AMONG the many accessories available to the Fury III, several are worth the buyer's special consideration: The in-out/up-down steering wheel, the forward-and-back/up-down-plus-tilt power seat and the remote-control outside mirror are all decidedly worthwhile both from the comfort and safety standpoint. Nearly every driver has played the manual-action seat-positioning comedy to a packed car: Grope about under the seat for the lever; push, pull, twist, pry and jerk until the seat is free; finally hunch and bob it into position. Then at the next stoplight the unlatched seat suddenly lurches forward a couple of inches, slamming the driver's foot down on the brake and at the very least scaring the wits out of every passenger in the car. Humbling? Yes, and very dangerous. A power seat is not inexpensive, but it will correct a poor driving position quickly and with complete accuracy. ▶



COMPLETE, READABLE instrumentation. logically arranged controls near at hand were marks of human engineering shown in the Plymouth Fury III.

And the ability to adjust the outside mirror by simply moving a toggle handle inside the car obviates the evil arm-out-the-window, chin-on-the-steering-wheel contortion as well as the equally dangerous decision to fix it some other time. Use of these remote controls and power assists has very little exercise or dramatic value, but they serve the interests of safety and comfort very well indeed.

Top up, out of town and on the open road, the Fury III convertible comes into its own as a long-distance traveling machine. Though the inside noise level is slightly higher than in a hardtop, the padded, tight-fitting cloth top refuses to flap, and effectively seals out wind, rain and nearly all road racket. Controls already are, or can be, correctly positioned for long-haul relaxation, and nearly all auxiliary switches and buttons are close at hand. The 25-gal. fuel tank allows over 200 miles between refills at the Fury's going rate of about 10 mpg—not an overwhelmingly long cruising range, but time for a rest stop anyway.

High-speed handling of the Fury III is good for a car of its weight and size. The long-established Plymouth suspension system of torsion bars for the independent front wheels and longitudinal leaf springs at the rear seems entirely adequate for modern highway needs. Body lean and roll are moderate under all but fierce cornering, and the car gives a general impression of good balance and control.

THE TRUNK area is adequate for most touring necessities, though the tire occupies much of the choicest trunk space. Due to a long styling turn-down at the rear of the trunk lid, liftover height is surprisingly low, a boon to travelers with heavy luggage. These pounds added at the rear, incidentally,

1967 PLYMOUTH
FURY III CONVERTIBLE

DIMENSIONS

Wheelbase, in.	119.0
Track, f/r, in.	62.0/60.7
Overall length, in.	213.1
width	77.7
height	55.5
Front seat hip room, in.	57.7
shoulder room	60.0
head room	41.8
pedal-seatback, max.	44.5
Rear seat hip room, in.	51.6
shoulder room	49.4
leg room	33.5
head room	38.2
Door opening width, in.	42.5
Ground clearance, in.	6.25
Trunk liftover height, in.	22.2

PRICES

List, FOB factory	$3118
Equipped as tested	4485
Options included: 383-cu. in. 4-barrel engine; power steering, windows, seat, disc brakes, air conditioning; Cleaner Air Package; tilt/telescoping steering column, wsw tires, bumper guards.	

CAPACITIES

No. of passengers	6
Luggage space, cu. ft.	n.a.
Fuel tank, gal.	25.0
Crankcase, qt.	4
Transmission/dif., pt.	18.5/4
Radiator coolant, qt.	18

CHASSIS/SUSPENSION

Frame type: Unitized.	
Front suspension type: Independent, coil springs, upper control arm, single lower arm with drag strut.	
ride rate at wheel, lb./in.	118
antiroll bar dia., in.	0.88
Rear suspension type: Hotchkiss type, multileaf springs, tube shock absorbers.	
ride rate at wheel, lb./in.	124
Steering system: Integral assist recirculating ball gear, parallelogram linkage behind wheels.	
overall ratio	19.1:1
turns, lock to lock	3.5
turning circle, ft. curb-curb	42.8
Curb weight, lb.	4280
Test weight	4660
distribution (driver), % f/r	56.6/43.4

BRAKES

Type: Disc front, cast iron drum rear, 2-line hydraulic system.	
Front rotor, dia. x width, in.	11.76 x 2.20
Rear drum, dia. x width	11.00 x 2.00
total swept area, sq. in.	437.1
Power assist: Integral vacuum.	
line psi at 100 lb. pedal	1155

WHEELS/TIRES

Wheel rim size	15 x 6K
optional size	15 x 5.5JK
bolt no./circle dia. in.	5/4.5
Tires: Firestone Deluxe Champion	
size	8.15-15
normal inflation, psi f/r	24/24
Capacity @ psi	5480 @ 24

ENGINE

Type, no. of cyl.	ohv 90° V-8
Bore x stroke, in.	4.25 x 3.38
Displacement, cu. in.	383.646
Compression ratio	10.0:1
Fuel required	premium
Rated bhp @ rpm	325 @ 4800
equivalent mph	116
Rated torque @ rpm	425 @ 2800
equivalent mph	68
Carburetion: 1x4 AFB	
throttle dia., pri./sec.	1.44/1.56
Valve train: Hydraulic lifters, pushrods and overhead rocker arms.	
cam timing deg., int./exh.	16-60/64-16
duration, int./exh.	256/260
Exhaust system: Dual exhausts, reverse flow mufflers.	
pipe dia., exh./tail	2.25/2.00
Normal oil press. @ rpm	55 @ 2000
Electrical supply, V./amp	12/46
Battery, plates/amp. hr.	66/59

DRIVE TRAIN

Clutch type:	
dia., in.	
Transmission type: Three-speed automatic with torque converter.	
Gear ratio 4th ( ) overall	
3rd (1.00:1)	3.23:1
2nd (1.45:1)	4.69:1
1st (2.45:1)	7.92:1
1st x t.c. stall (2.00:1)	15.84:1
Shift lever location: Column.	
Differential type: Hypoid.	
axle ratio	3.23:1

will improve the Fury III's weight ratio and help the rear wheels avoid lockup under hard braking. The standard car already has a strong front weight bias, and the great bulk of optional equipment weight is added to the front. For example, the test car's air conditioner, 383-cu. in. V-8 engine, TorqueFlite transmission, power brakes and power steering put an extra 323 lb. on the front wheels, as compared with only 21 lb. added to the rear.

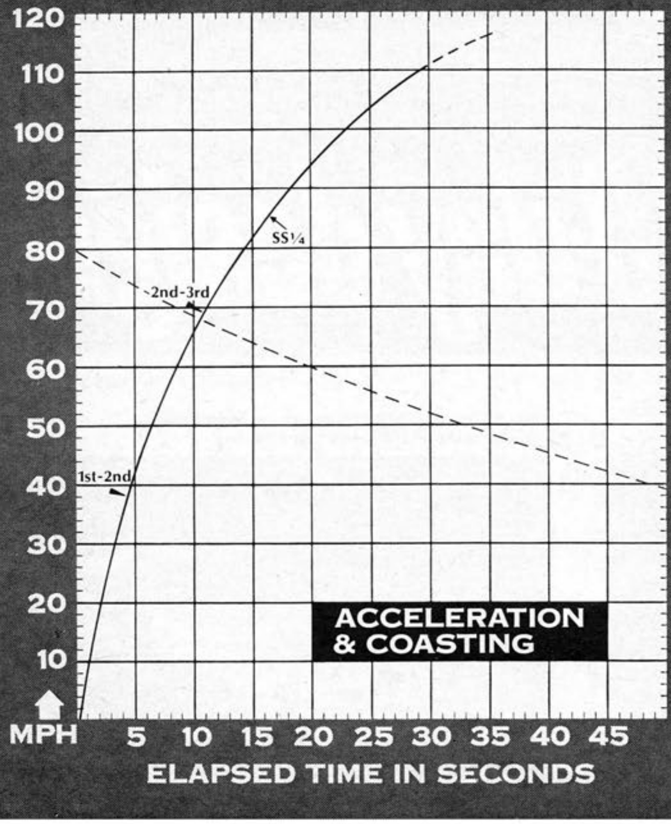
Instrument console design is excellent, with neat, easily read dials and gauges aligned above an agreeable minimum of toggle switches and buttons. The panel is deeply recessed under an impact-absorbing hood, which also prevents light reflections from the instrument faces. Though we would have voted for the inclusion of an oil-pressure gauge, this must be rated an especially useful and attractive control center, and might well be studied by go-for-baroque designers who still feel they must include everything short of a pinball game just to make the layout impressive.

In brief, while it would be enjoyable to sum up *CAR LIFE*'s test car as little more than a big, red playboy's toy, this would be unjust both to prospective owners who might be put off by our misdirection, and to the Plymouth engineers who labored well and brought forth a car that is undeniably excellent in a great many respects.

On the other hand, it is important to recognize that Plymouth's Fury III successfully sustains the promise of gallantry and adventure common even to luxurious convertibles, and the rare ability to seem new again every time the garage door is opened. It is a car that is fun to see and to be seen in and even, when the occasion demands, a car to be used for serious motoring.■


A COULD-BE cavernous cargo compartment was rendered much less spacious by wasteful positioning of spare tire, wheel and tire-change tools.

CAR LIFE ROAD TEST



CALCULATED DATA

Lb/bhp (test weight)	14.33
Cu. ft./ton mile	119.5
Mph/1000 rpm (high gear)	24.2
Engine revs/mile (60 mph)	2510
Piston travel, ft./mile	1413
CAR LIFE wear index	35.5
Frontal area, sq. ft.	24.0
NHRA-AHRA class	D/SA-E/SA

SPEEDOMETER ERROR

30 mph, actual	28.1
40 mph	38.1
50 mph	48.4
60 mph	58.4
70 mph	68.2
80 mph	78.2
90 mph	88.3

MAINTENANCE

Engine oil, miles/days	4000/90
oil filter, miles/days	8000/180
Chassis lubrication, miles	36,000
Antismog servicing, type/miles	
tuneup check	12,000
replace PCV valve	12,000
Air cleaner, miles	24,000
Spark plugs: MoPar P-3-5P	
gap (in.)	0.035
Basic timing, deg./rpm	5/550
max. cent. adv., deg./rpm.	14/1580
max. vac. adv., deg./in. Hg	26/16.5
Ignition point gap, in.	0.014-0.019
cam dwell angle, deg.	28-32
arm tension, oz.	17-20
Tappet clearance, int./exh.	0/0
Fuel pressure at idle, psi	3.5
Radiator cap relief press., psi	16

PERFORMANCE

Top speed (4700), mph	115
Test shift points (rpm) @ mph	
3rd to 4th ( )	
2nd to 3rd (4250)	71
1st to 2nd (3850)	38

ACCELERATION

0-30 mph, sec.	3.1
0-40 mph	4.6
0-50 mph	6.5
0-60 mph	8.7
0-70 mph	11.4
0-80 mph	14.5
0-90 mph	18.1
0-100 mph	23.0
Standing ¼-mile, sec.	16.6
speed at end, mph	86.2
Passing, 30-70 mph, sec.	8.3

BRAKING

Max. deceleration rate from 80 mph ft./sec.^{2}	23
No. of stops from 80 mph (60-sec. intervals) before 20% loss in deceleration rate	not taken
Control loss?	severe
Overall brake performance	poor

FUEL CONSUMPTION

Test conditions, mpg	10.8
Normal cond., mph	10-14
Cruising range, miles	250-340

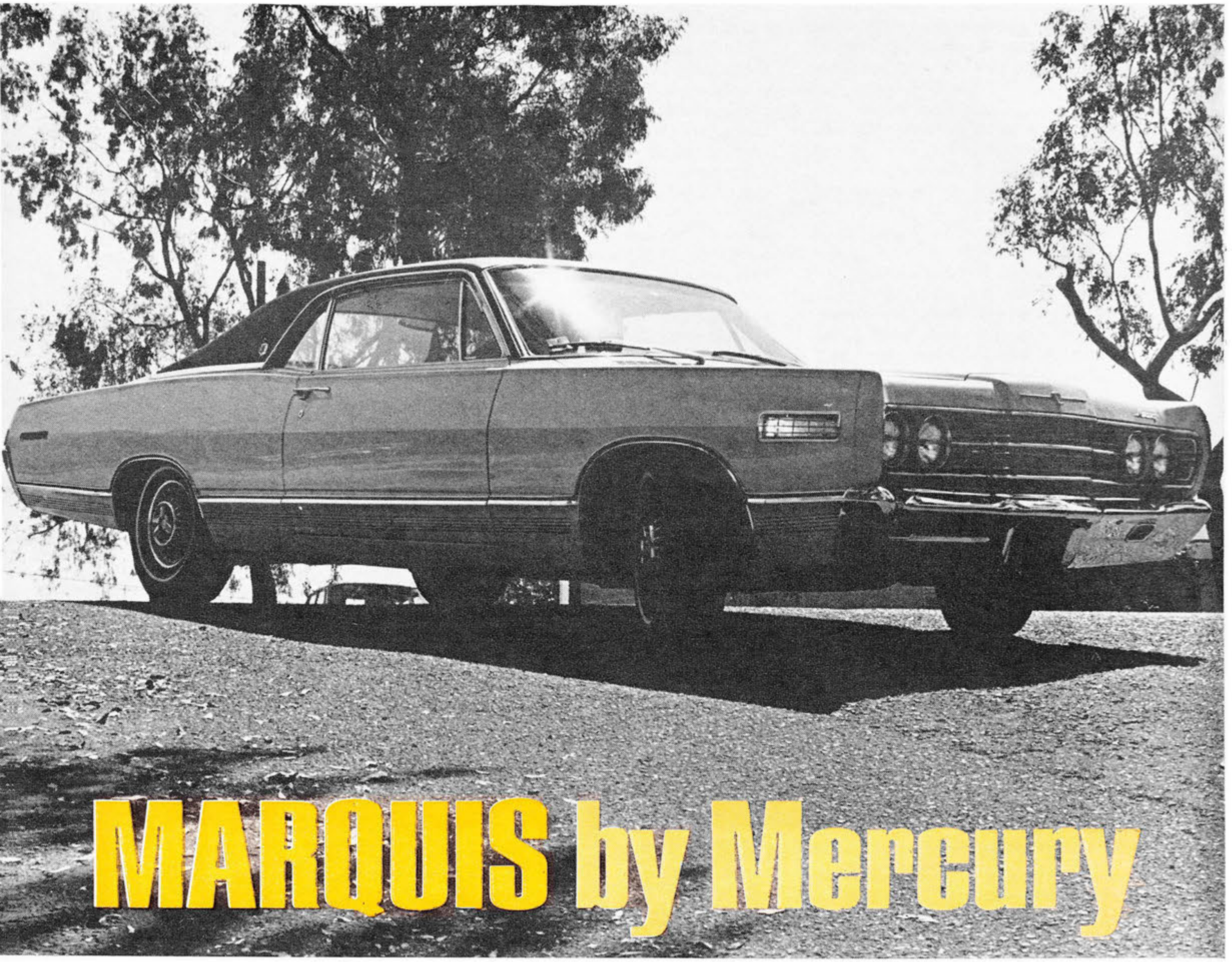
GRADABILITY

4th % grade @ mph	
3rd	14 @ 56
2nd	20 @ 49
1st	31 @ 37

DRAG FACTOR

Total drag @ 60 mph, lb.	202

CAR LIFE ROAD TEST



MARQUIS by Mercury

Is the American Public Going Soft—or Vice Versa?

IS THE AMERICAN Public going soft, or is the American Soft going public? Are consumers demanding ever-softer cars, or are manufacturers creating ever-softer cars for the public to demand? Do consumers demand cars as billowy as Lincoln-Mercury's Marquis, or did L-M create the Marquis' cushiony automotive environment with the idea that people would buy once treated to this level of comfort? Snug cocoon, warm garment, inner space capsule, insulator against all that does not cater kindly to creatures within—such is the luxurious Mercury Marquis.

Longest of all Mercury products at 218.5 in. overall, most plushly appointed of all cars in that Ford Motor Co. division, fitted with an engine exclusive to the line, inviting sustained travel, these facets were most readily apparent in the Mercury Marquis 2-door hardtop coupe delivered to *CAR LIFE* for road test. The aspect of softness surfaced later, during the course of more than 1500 miles.

Breadth of almost 79 in. and height of more than 56 in., when added to that overall length, gave the Marquis a commanding appearance that was in no way diminished by a combination of robin's egg "Tiffany" blue paint on the lower body, contrasted with deep "Oxford" blue pebbled vinyl roof topping. None would argue that outwardly the Marquis was a truly large, visually striking automobile.

Largeness inside was translated into terms of spaciousness for passengers and luggage. Though only a 2-door model, the Marquis easily accommodated six passengers, with only moderate complaints on lack of rear seat knee room and rear head room voiced by the longest legged of *CL*'s testers.

THE MARQUIS' split bench front seat—upholstered in a nylon subdued blue floral pattern and harmonizing vinyl—accommodated three persons easily when individual center armrests were raised, and armrests down gave driver and one passenger in front vast spaces for uncramped travel comfort.

Adding to the driver's ease was a 6-way power-adjustable seat. Height, front-rear travel and rake were variable to provide first comfort, then variety of position for necessary changes during trips of long duration. When driving, *CL*'s long-legged tester expressed satisfaction with leg room and pedal-to-seatback dimensions; he was at ease at the wheel throughout an extended tour.

Luggage space, deep and wide, was uncluttered, as the spare was mounted above and to the rear of the cargo compartment. Bag and baggage for an away-from-home weekend for six descended into this cavern, leaving space for more if need be.

CONTRIBUTING to convenience for passengers and driver were power windows and vents, a remote-control deck lid release, power antenna and a radio.

The latter was an AM-only unit, with left, right and rear speakers somewhat wasted on its reception quality. The AM radio sells for $60.05, whereas the AM-FM receiver sells at $133.65. AM-stereotape equipment may be installed for $188.50. The quietude of the Marquis' interior demands the extra expenditure for FM or stereotape if one desires the best in accompaniment to travel.

Another creature comfort, air conditioning, made extended driving a thing of dehumidified, even temperature, selected to meet the personal demands of the car's occupants. Tinted glass all around reduced glare and aided the chiller in its work. Heating or cooling of the Marquis brought into use the car's pressure-relief system. With all windows closed and with blower or cowl air inlet in operation, positive pressure inside the passenger compartment—and negative pressure outside the car—actuated pressure relief valves in the rear face of the doors to exhaust internal air through outlets in the lower edge of the door panels.

The test Marquis was fitted with a visual check panel, a $31.42 optional item. Warning lights reminded occupants to fasten seat belts, and provided information on doors ajar, low fuel and parking brake engagement. Also in the panel was the release handle for the vacuum-rolling door lock system. Because the panel was mounted below the dash panel at the centerline of the car, a long, inconvenient reach was required to unlock doors—which locked automatically when the Marquis attained approximately 5 mph. Testers speculated that location of the release might prove a hazard in an emergency. Drivers and passengers are accustomed to reaching for door-mounted latch release mechanisms and in all probability would, in panic, reach for the door handle, rather than a below-dash lever. Ford Motor Co., after the test Marquis was built, halted installation of the vacuum-rolling system on top line cars.

Another convenience item on the Marquis was an interval selector windshield wiper control. The wipers could be operated at fast or slow rate, or in a now-and-again mode with swipes timed at a rate selected by the driver—very convenient in a light spatter of rain.

Providing motive power and energy to operate all the optional comfort and convenience equipment was the Mercury-only 410-cu. in./330-bhp engine. The 410 is something of a cross between the Ford family 390- and 428-cu. in. powerplants. The 410 has the bore of the 390, which is 4.054 in., and the stroke of the 428, which is 3.984 in. The engine, with 10.5:1 compression ratio and premium fuel, develops its peak bhp at 4600 rpm and its full torque delivery of 444 lb.-ft. at 2800 rpm.

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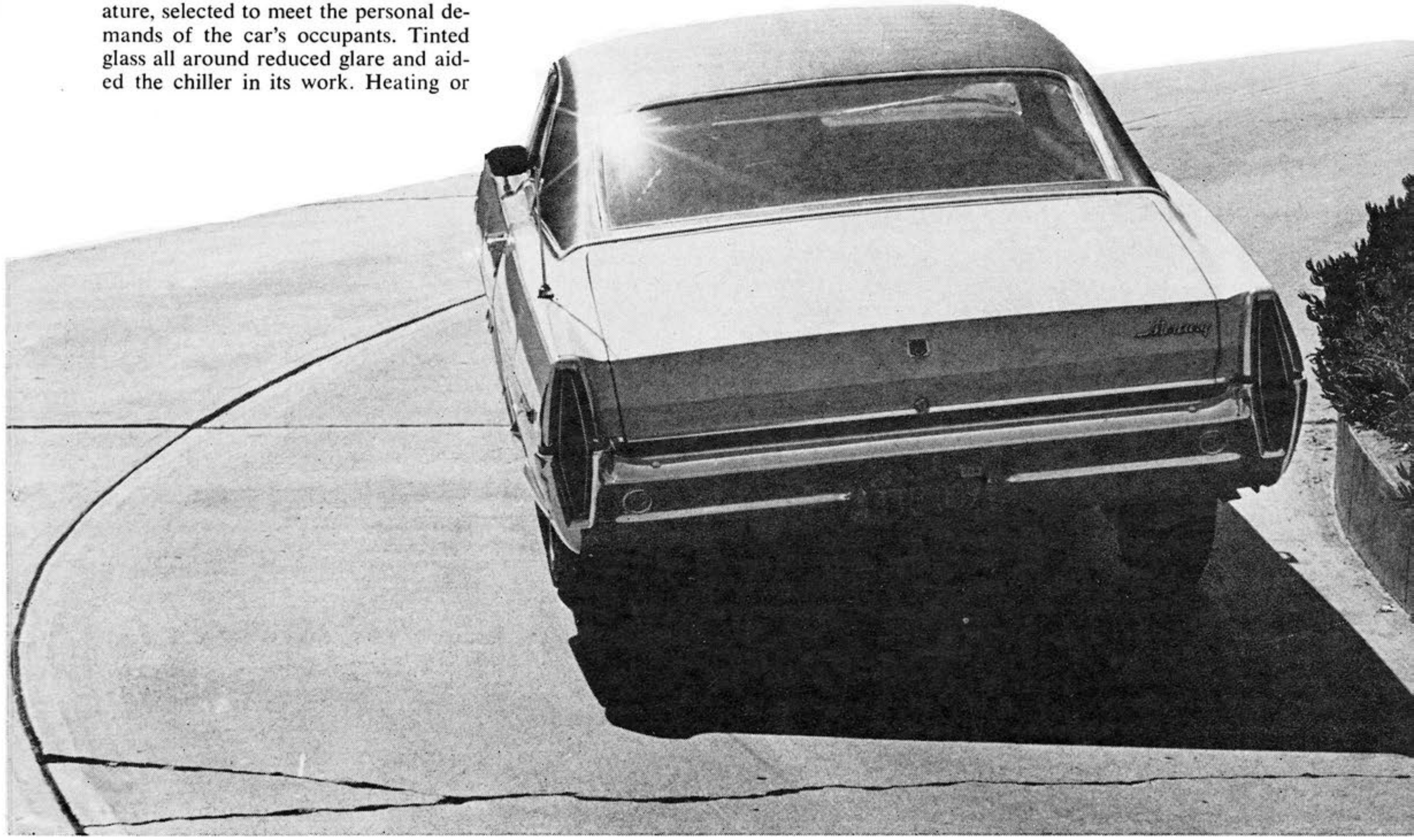
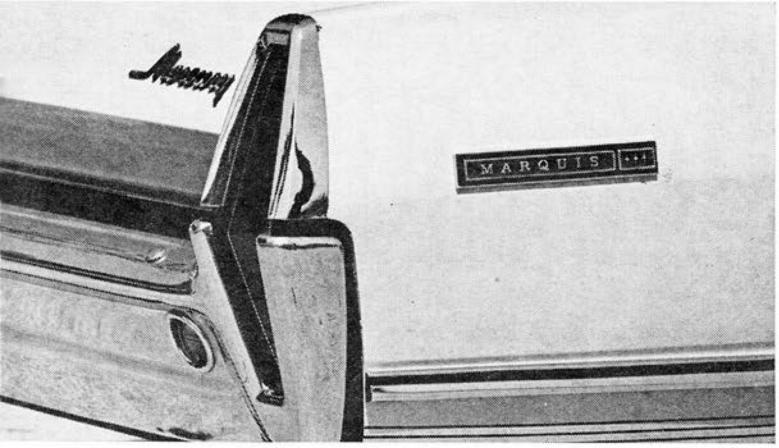
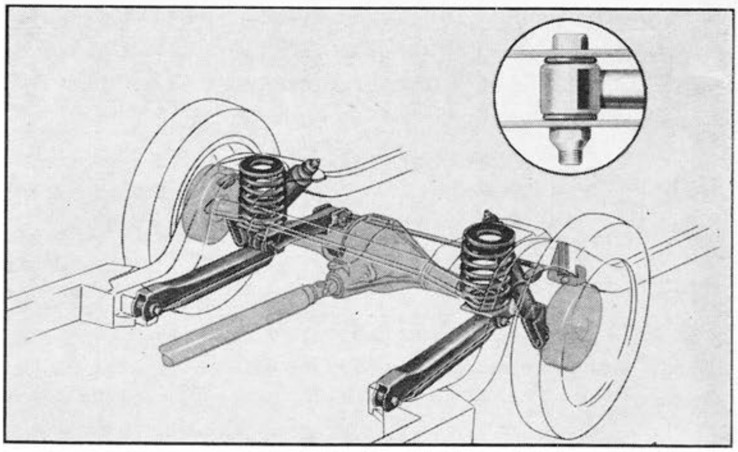




STYLING IN broad strokes, wide bumpers, heavy chromium exposure emphasize Marquis massiveness.



TRAILING LINKS, two below, one above, low rate coil springs and soft shock absorbers form rear suspension.

A new-for-1967 carburetor, a 4-barrel Autolite unit, is fitted to the 410 engine. The carburetor is similar to Holley 4-barrel units, with velocity-controlled secondary throttles.

Backing up the 410 V-8 in the test Marquis was a Merc-O-Matic 3-speed automatic transmission and 2.80:1 rear axle ratio in the standard limited-slip differential. Despite the rather long-legged gearing, the 4880-lb. Marquis was capable of some rather quick quarter-miles. Test drivers tallied 17.1 and 17.0 sec., then turned off the air conditioning, determined optimum manual gear change points, and turned a 16.8-sec. quarter.

Acceleration and dragstrip activity weren't, however, the Marquis 410 engine's forte. The car was happiest cruising with its engine at torque peak, 2800 rpm, which unfortunately translated in terms of speed to 79 mph, or 14 mph faster than the law allowed anywhere the Marquis was driven during its test period. Typically, a test driver would, for a time, consciously maintain the 65-mph freeway limit; then his mind would wander and the 410 engine would silently seek its torque peak, increasing speed imperceptibly to well beyond the posted speed.

Anything as massive, anything that can move as swiftly as the Mercury Marquis requires some reliable means of being brought to a rapid, safe, controllable halt. Thus it is to the everlasting credit of Lincoln-Mercury product planners, engineers and merchandisers that Ford Motor Company's sterling front-disc/rear drum, vacuum assisted

1967 MERCURY
MARQUIS 2-DOOR HARDTOP

DIMENSIONS

Wheelbase, in.	123.0
Track, f/r, in.	62.0/62.0
Overall length, in.	218.5
width	78.2
height	56.1
Front seat hip room, in.	55.9
shoulder room	60.0
head room	37.9
pedal-seatback, max.	47.2
Rear seat hip room, in.	55.6
shoulder room	58.7
leg room	33.3
head room	37.4
Door opening width, in.	43.8
Ground clearance, in.	6.7
Trunk liftover height, in.	24.1

PRICES

List, FOB factory	$3989
Equipped as tested	5215

Options included: Air conditioning, power windows, seat, steering, exhaust emission control, dual exhausts, radio, power antenna, tinted glass, wsw tires, remote deck lid release, HD battery, cornering lights.

CAPACITIES

No. of passengers	6
Luggage space, cu. ft.	19.1
Fuel tank, gal.	25.0
Crankcase, qt.	4.0
Transmission/dif., pt.	20/5
Radiator coolant, qt.	22.7

CHASSIS/SUSPENSION

Frame type: Perimeter.

Front suspension type: Independent, s.l.a., coil springs, telescopic shock absorbers, cushioned drag struts.

ride rate at wheel, lb./in.	112
antiroll bar dia., in.	0.69

Rear suspension type: Link-coil, two lower and one upper trailing arms, telescopic shock absorbers.

ride rate at wheel, lb./in.	110

Steering system: Integral assist, recirculating ball-nut gear, parallelogram linkage behind wheels.

overall ratio	22.1:1
turns, lock to lock	3.6
turning circle, ft. curb-curb	43.6
Curb weight, lb	4475
Test weight	4880
distribution (driver), % f/r	57.0/43.0

BRAKES

Type: Disc front, cast iron drum rear.

Front rotor, dia. x width, in.	11.87x1.90
Rear drum, dia. x width	11.03 x 2.25
total swept area, sq. in.	392.4

Power assist: Integral vacuum.

line psi at 100 lb. pedal	920

WHEELS/TIRES

Wheel rim size	15 x 5J
optional size	none
bolt no./circle dia., in.	5/4.5

Tires: Goodyear Power Cushion.

size	8.45-15
normal inflation, psi f/r	26/26
Capacity @ psi	6200 @ 26

ENGINE

Type, no. of cyl.	ohv 90° V-8
Bore x stroke, in.	4.054 x 3.984
Displacement, cu. in.	411.40
Compression ratio	10.5:1
Fuel required	premium
Rated bhp @ rpm	330 @ 4600
equivalent mph	130
Rated torque @ rpm	444 @ 2800
equivalent mph	79

Carburetion: 1x4 Autolite.

throttle dia., pri./sec.	1.44/1.44

Valve train: Hydraulic lifters, pushrods and overhead rocker arms.

cam timing deg., int./exh.	16-60/55-21
duration, int./exh.	256/256

Exhaust system: Dual exhaust system, 2 reverse-flow mufflers and resonators.

pipe dia., exh./tail	2.25/2.25
Normal oil press. @ rpm	52 @ 2000
Electrical supply, V./amp.	12/55
Battery, plates/amp. hr.	66/70

DRIVE TRAIN

Clutch type:

dia., in.	

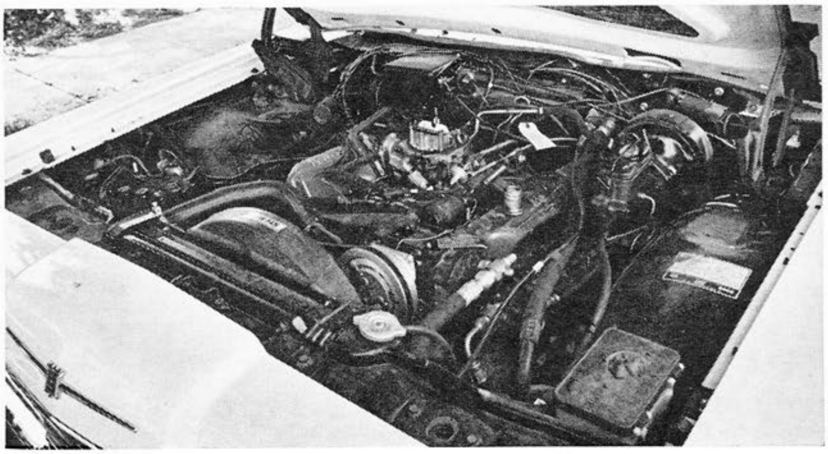
Transmission type: 3-speed automatic with torque converter.

Gear ratio 4th ( ) overall	
3rd (1.00:1)	2.80:1
2nd (1.46:1)	4.09:1
1st (2.46:1)	6.89:1
1st x t.c. stall (2.10:1)	14.45:1

Shift lever location: Column.

Differential type: Hypoid, limited-slip.

axle ratio	2.80:1



MERCURY'S EXCLUSIVE 410-cu. in. engine, rated at 330 bhp has the bore of Ford Motor Co. 390, stroke of 428.

PAUL E. HANSEN PHOTOS

PLACEMENT OF spare, fuel tank location, unusual depth contribute to optimum cargo space utility.

braking system was made standard on the Marquis (and Park Lane, Brougham, Colony Park and S-55 Mercurys as well). Ventilated rotors and 1.9-in. wide pads at the front, and 11.03-in. diameter drums and 2.25-in. wide shoes at the rear provide 392.4 sq. in. of brake swept area. Pads and brake shoes are driven at 920 lb.-sq. in. of line pressure for 100 lb. of pedal pressure. As with L-M's Continental, a proportioning valve limits brake line pressure to the rear drums. Excellent front-to-rear proportioning minimized rear wheel lockup as all-on braking caused forward weight transfer in the already noseheavy Marquis. Resulting extreme front-end loadings were easily accommodated by the front discs.

The first of the Marquis' series of panic stops from 80 mph was achieved at a deceleration rate of 26 ft./sec.^{2} Two succeeding stops were recorded at 23 ft./sec.^{2} A fourth stop produced a deceleration rate of 17 ft./sec.^{2} The right rear wheel tended to lock toward the end of all four stops, but not to such a degree that control of the car was lost. All four stops were manageable within an average width traffic lane. Test figures show the Marquis was equipped with a braking system of better than average stopping capability, stopping power which was sustained during exceptionally hard, continued usage. This top-of-the-line car had top-of-the-line brakes.

The Marquis' suspension system is of the large Ford series variety with independent ball-jointed s.l.a. configuration with 0.69-in. antiroll bar for-

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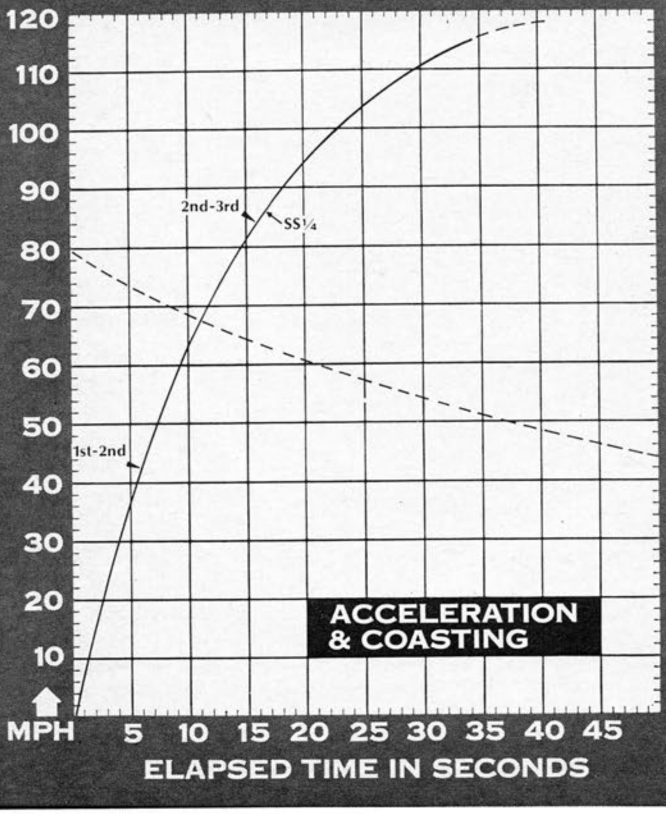
CAR LIFE ROAD TEST



CALCULATED DATA

Lb/bhp (test weight)	14.77
Cu. ft./ton mile	1753
Mph/1000 rpm (high gear)	28.3
Engine revs/mile (60 mph)	2120
Piston travel, ft./mile	1407
CAR LIFE wear index	29.8
Frontal area, sq. ft.	24.4
NHRA-AHRA Class	E/SA-E/SA

SPEEDOMETER ERROR

30 mph, actual	26.8
40 mph	37.2
50 mph	47.2
60 mph	57.1
70 mph	67.2
80 mph	79.0
90 mph	90.0

MAINTENANCE

Engine oil, miles/days	6000/180
oil filter, miles/days	6000/180
Chassis lubrication, miles	36,000

Anti-smog servicing, type/miles: Clean entire air pump system/ 12,000. Replace air pump filter & PCV valve/12,000.

Air cleaner, miles clean, 6000; replace, 36,000.

Spark plugs: Autolite BF-42

gap, (in.)	0.035
Basic timing, deg./rpm	6/610
max. cent. adv., deg./rpm.	23/4000
max. vac. adv., deg./in. Hg.	25/19
Ignition point gap, in.	0.016-0.018
cam dwell angle, deg.	26-31
arm tension, oz.	17-21
Tappet clearance, int./exh.	0/0
Fuel pressure at idle, psi	5
Radiator cap relief press., psi	12-15

PERFORMANCE

Top speed (4250), mph	120
Test shift points (rpm) @ mph	
3rd to 4th ( )	
2nd to 3rd (4300)	84
1st to 2nd (3600)	42

ACCELERATION

0-30 mph, sec.	4.1
0-40 mph	5.7
0-50 mph	7.4
0-60 mph	9.4
0-70 mph	11.6
0-80 mph	14.8
0-90 mph	18.8
0-100 mph	23.5
Standing ¼-mile, sec.	16.8
speed at end, mph	85.6
Passing, 30-70 mph, sec.	7.5

BRAKING

Max. deceleration rate from 80 mph ft./sec.^{2}	26
No. of stops from 80 mph (60-sec. intervals) before 20% loss in deceleration rate	3

Control loss? Slight.

Overall brake performance	good

FUEL CONSUMPTION

Test conditions, mpg	14.5
Normal cond., mpg	12-16
Cruising range, miles	300-400

GRADABILITY

4th % grade @ mph	
3rd	15 @ 56
2nd	22 @ 44
1st	36 @ 28

DRAG FACTOR

Total drag @ 60 mph, lb.	120

MARQUIS

ward, and a live axle with coil springs, 3-link location and a track bar at the rear. In reworking this supension system for 1967, Mercury engineers made changes in both front and rear suspension components aimed expressly at a softer ride. Front rebound bumper shape was altered to provide softer entry when wheels drop in rebound travel. Front drag struts were rubber anchored to provide fore-and-aft compliance. At the rear, larger upper arm and new track bar bushings of a lower dynamic rate were fitted in an effort to reduce shake and harshness sensitivity. The rear axle jounce bumper was located 0.5 in. higher than in 1966 to permit longer jounce travel. Spring rates and shock absorber calibration were changed in order to achieve better balance between front and rear suspension. Resulting ride rates at wheel were 112 lb./in. at the front and 110 lb./in. at the rear. Soft.

What hath softness wrought? Given smooth, ribbon-laid asphalt or concrete of modern expressways, the Marquis met its design parameters—a soft, shake-free, vibrationless, luxurious ride. Mile after quiet freeway mile flowed past with the only sound from the radio or the living room level conversation of driver and passenger.

On the quiet urban boulevards where 35 mph is excessive speed, the Marquis slipped about its business, silence belying size.

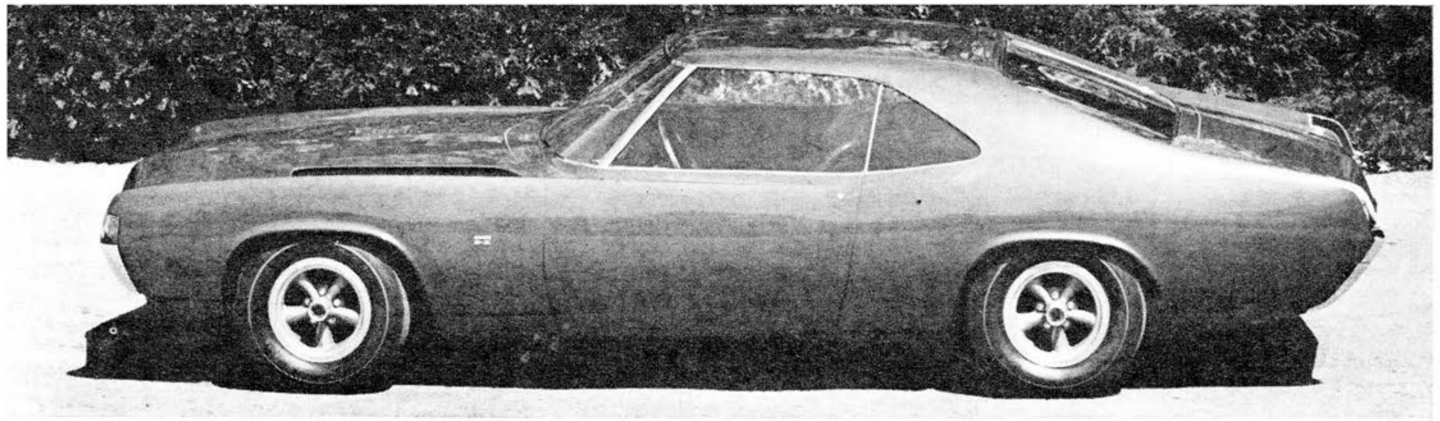
But, take the Marquis out of its expressway-urban environment and place it on an enthusiast's road, a hidden bit of mountainous terrain, that undulating straight through secluded farmland, the winding secondary that skirts the lake shore. It is in these situations that the soft, kind Marquis loses its cool. The heavy forward weight distribution (57% forward static weight bias), abetted in no small way by the 410 engine, induced an exceptionally high degree of understeer. Each curve, taken at speed, urged the driver to withdraw his accelerator foot. Each roadway irregularity, met by the soft suspension, resulted in a long, slow jounce and an equally long, slow rebound—which was followed by three, sometimes four, oscillations. Taken together, speed, curve and bump, the combination of understeer and oscillation became almost unmanageable.

THUS IN ROAD test assessment two axioms of automobilia became increasingly clear. One: Balanced weight distribution, front and rear, and well controlled suspension damping are mandatory for good handling characteristics. Two: The individual should first ascertain what tasks he will ask of his automobile before he makes his purchase, then choose, then buy the car most adequate for these tasks.

A consideration apart from ride and handling, of course, is cost—not economy in the case of the Marquis, just cost. Equipped as tested, the Marquis was priced at more than $5200—which puts the car, give or take $100 or so one way or the other, in a class with Chrysler 300, Cadillac Calais, Oldsmobile 98 and Buick Electra 225.

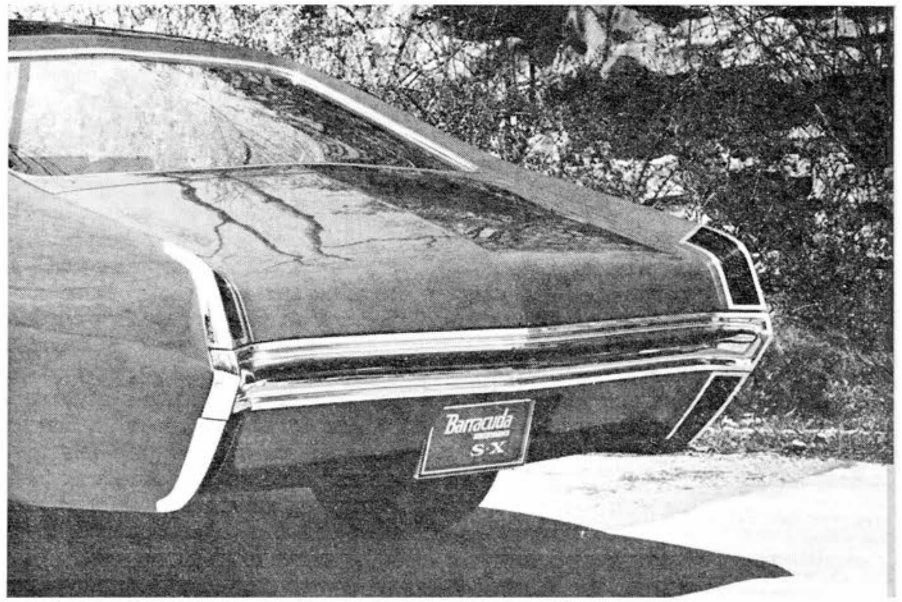
There is no doubt among *CL* testers that the Marquis is able to compete on an equal basis in regard to comfort, appearance, appointments, spaciousness, acceleration, braking and long distance cruising capability.

That goodly numbers of the aforementioned cars are sold is indication that a large segment of the American automobile buying public has gone soft. Whether the American public buys the American Soft Marquis in great numbers is a question that is directly up to advertising people and salesmen who must whet the public appetite for softness, demonstrate its comfortable benefits, then induce cash payment for it. ■



FORMULA SX

A Beauteous Barracuda By Plymouth's Studio of Style



Custom show cars are a favorite gimmick of auto manufacturers the world over to attract more attention than is warranted to an exhibit which offers nothing new or exciting. This isn't always true, but more often than not the most interesting exhibits at auto shows—aside from the ever-increasing female epidermal exposure as an adjunct to the cars—are the one-off custom vehicles, done as design exercises by otherwise restricted stylists.

Some of these showpieces bear little resemblance to the current line of whatevercaritis, while others, such as the Plymouth's Barracuda Formula SX, *CL*'s cover car, are logical evolutions of current models or series. Quite often these cars are non-functioning models, as compared with operational models or prototypes. The Plymouth Barracuda SX is of the non-working variety, with bodywork of fiberglass reinforced plastic—though there seems to be no reason why it couldn't be incorporated on a stock Barracuda chassis. Both have 108-in. wheelbase and the show car is based on production components throughout—though non-functioning components in this case.

Aside from the drawing power of a show car, it can also provide sought-after audience reaction to new design ideas. Inasmuch as these show cars are almost invariably better looking than the cars from which they were derived, one can be excused for wondering why the production model, too, doesn't look that smart. Why ask the public? Doesn't the design staff have enough confidence in its ability to *know* when a design is right or wrong?

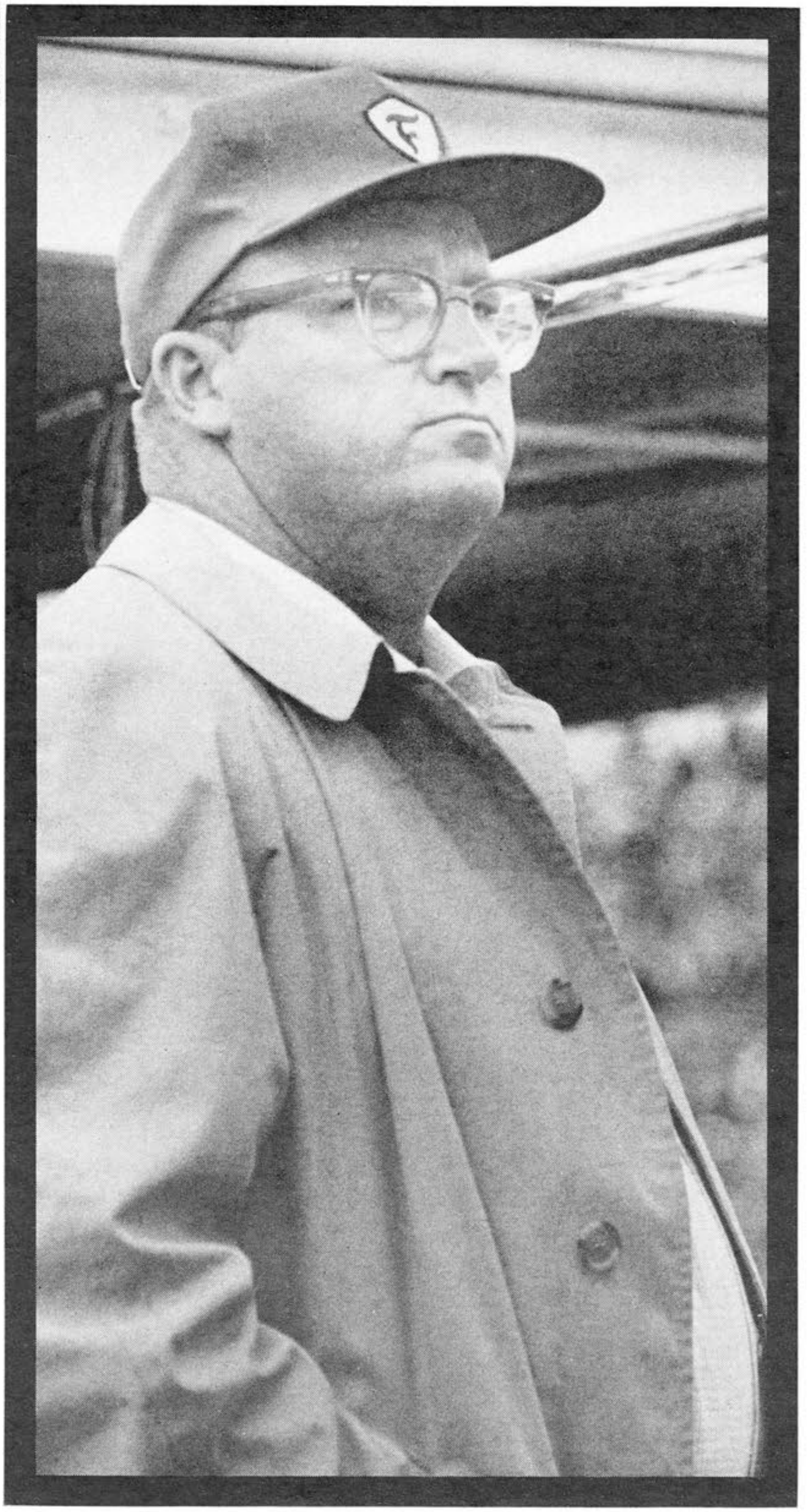
The Barracuda SX is distinguished by its clean lines and absence of superficial trim. The bumper/grille unit is an excellent combination (and simplification) of the 1967 Barracuda grille and bumper. Production Barracuda are relatively free of clutter, but Chrysler Corp. stylists have shown that even simpler styling presents a more pleasing appearance. The body shape of the SX is a cross between production fastback and notchback shapes; a semi-fastback with side window treatment more akin to the notchback.

Absence of door handles, windshield wipers, hood and trunk ornamentation contributes to the clean look, but the major improvement is in the rear-end treatment (like a cleaned-up Riviera—which is no bad thing). The Barracuda Formula SX was created completely at Chrysler Corp. Styling, unlike other Chrysler dream cars which are company designed, then farmed out to independent coachbuilding contractors (Alexander Bros. or Creative Designs).

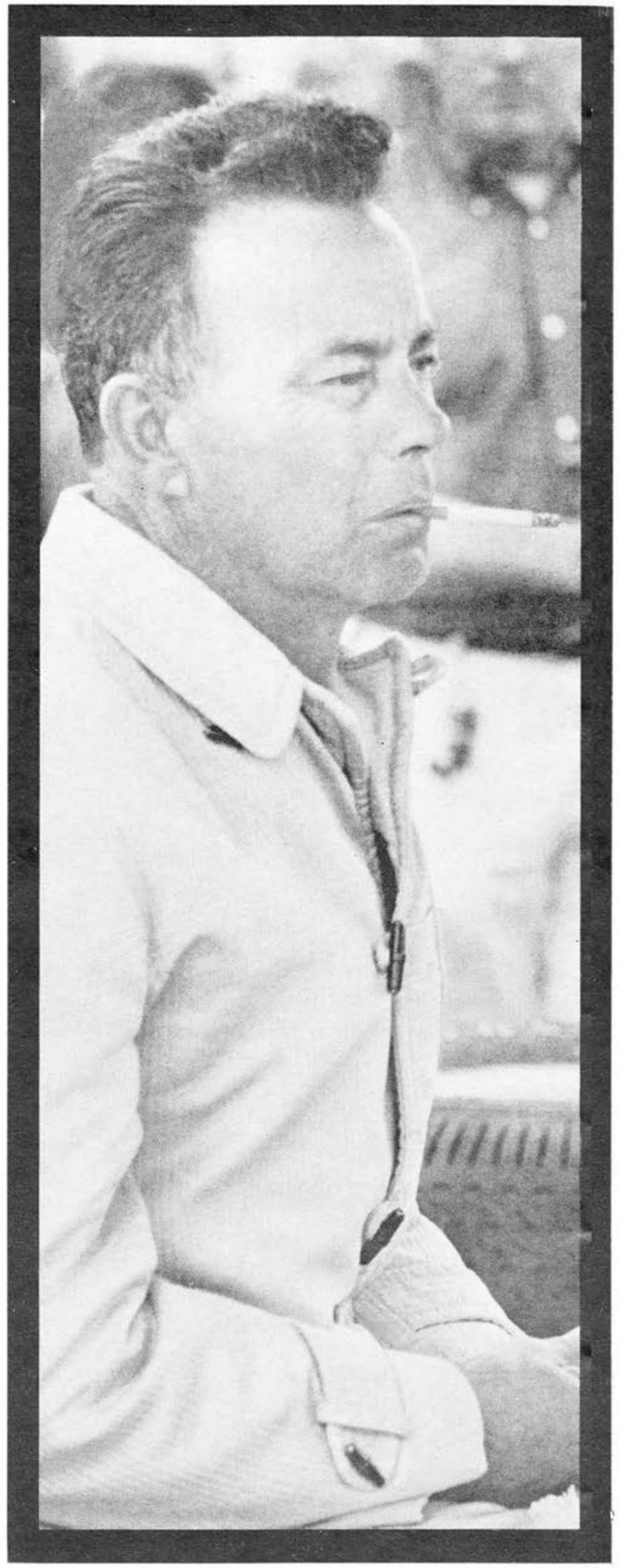
No production plans are mentioned for the SX. Some features of the car could present problems at the current state of the art. The ultra-thin windshield pillars, for example, undoubtedly would cause some loss of structural rigidity. The low roof line would limit head room—particularly in the rear. Bumper arrangements, again, particularly at the rear, could be disastrous for American-style parking.

The clean look that contributes to the handsome appearance, however, is something automobile enthusiasts long to see once again. There was hope, for a time. Cars started to become better looking early in the 1960s, and possibly reached a peak in 1966, but it now appears the industry may be headed for another 1957-58 low. Cars such as the SX demonstrate there is still hope. —*Dean Batchelor*

ALICE BIXLER



JOHN HOLMAN sells the parts.



RALPH MOODY puts 'em together.

holman & moody

These Unlikely Allies Are FoMoCo South

BY BILL LIBBY

John Holman and Ralph Moody hitched their wagon to a star, namely Ford Motor Co. They rode it to the heights. Now that some clouds are obscuring that star, they are setting forth to conquer new worlds on their own. "We are a big company, getting bigger," John Holman has said. "We started something on our own and we have the determination to finish it on our own. You call ours a success story."

Holman & Moody, the firm, made its name in stock car racing, as the partnership that developed Fords and Ford drivers into the most potent force on the fabulously rich and prestigious NASCAR circuit. Holman and Moody, the men, have become powerful, influential men in the sport. Along the way, the firm branched out into marine engines and have made Holman & Moody a great name in water sports.

Since Ford was shunted to the NASCAR sidelines by rulings that prevented the company from putting its strongest equipment on the tracks, Holman & Moody is a name which has been heard less frequently this year. Behind the scenes, however, the firm has been flexing its muscles and seems about to put on a show of strength far beyond anything previously demonstrated. Holman and Moody, the men, are a fascinating pair, contrasting individuals, whose particular talents blend admirably.

John Holman is a large, balding, bespectacled man, born in Tennessee and reared in Southern California. He drifted into the business end of automobile racing after World War II, initiated to the sport with the legendary Lincoln racing team that swept *Carrera Panamericana Mexico*—the Mexican Road Race—in the early 1950s. Under the direction of Clay Smith and Bill Stroppe, Holman was put in charge of procurement and distribution of all parts and equipment for the 4-car team and its affiliates, and of transporting them during the week-long grind. Later, he joined the DePaolo Engineering Co., which was in charge of the Ford stock car racing program in the middle 1950s, and became manager of its headquarters at Charlotte, N.C.

Ralph Moody is a tall, husky fellow, a native of Taunton, Mass., who raced many kinds of cars in many circuits for 25 years, then retired from driving. Ralph was the number one driver for the DePaolo team. When Ford left racing and the DePaolo operation disbanded in 1957, John and Ralph took what money they had, borrowed some more from a bank and formed Holman & Moody Inc., to take over the North Carolina facility as independents, specializing in stock car racing. When Ford returned to racing in 1963, it contracted its former employees to oversee the activity.

Holman is president and chairman of the board of the stock car company, as well as of the marine engine company. In the racing operation, Holman is the direct contact with Ford and others with whom H&M does business. Moody is in charge of development of cars and parts and race activities at the tracks.

The Holman & Moody operation has more than 100 employees working on new Fords and engines delivered directly from Dearborn to be reshaped for racing purposes. Many basic high-performance parts are fabricated from raw materials. Some of the cars, with a 4-man crew, are sent out on the NASCAR circuit to be raced directly under the H&M banner. Fred Lorenzen, Dick Hutcherson and A.J. Foyt are the most prominent of the H&M Ford team drivers. Other cars are sold to individual sponsors, but H&M provides the equipment for them and takes an interest in them.

Parts H&M manufactures, such as wheels, hubs, suspensions, camshafts, engine cooling systems, differential pumps, instrument panels and so forth, are purchased for and used on many rival cars. The majority of NASCAR Grand National cars use H&M wheels, for example.

In the early years of NASCAR, launched in 1949, Oldsmobiles and Hudsons were the dominant cars. In the mid-1950s, first Chryslers, then Chevrolets and Fords moved into the forefront. Ford has continued strong into the 1960s with Pontiacs, then Chevrolets and then Plymouths, in that order, as chief rivals. Through the end of last season, Fords had won the most races, 197, in NASCAR's 17-year history, followed by Chevrolet with 107 victories, Olds 87, Hudson 79, Plymouth 76, Pontiac 69, Chrysler 59, Dodge 36 and Mercury 16.

To fully understand the impact Holman & Moody and the Ford operation has made on NASCAR, a moment in early 1965 must be reviewed. Chrysler had withdrawn its Plymouths and Dodges from competition and Ford was entering its period of greatest power in stock car racing. This was the Atlanta International Raceway, 40 miles south of the Georgia capital, and one of the four "Super/Speedways" of NASCAR, tracks of 1 mile or longer, on which the eight big races of 300-600 miles are contested each season.

The cars begin to come through the gates early Monday morning. They appear to be American passenger cars—big, heavy and gaudy—but they aren't the cars one sees in show windows. They have been slimmed in some places, toughened in others, dressed expensively, given flashy paint and powered with huge, highly tuned engines.

The "poor boys" among the drivers haul in their own cars and pick up mechanics and pit crews from among casuals who drift into every track the week of the race. Full-time mechanics and pitmen bring in the cars for the "rich boys," the sponsored and factory drivers, who start to arrive on Tuesday in their own cars, by commercial plane or often in their own private aircraft. The serious business is just beginning. The Atlanta 500 is on Sunday.

Fifty cars are in the pits; 34 are Fords. In NASCAR history, the major automotive firms have come in the front doors and under the tables and out the windows and back doors like uncertain lovers. They can't decide whether racing is good for their business or bad for it. Some manufacturers find it easier to publicly damn the sport, while privately supplying money to support it.

Near the end of 1963, Chrysler, tired of running behind Ford, came in with a 525-bhp 426-cu. in. hemispherical combustion chambered V-8 "King Kong" engine. Ford had won 11 straight major races, but at Daytona in January, 1964, Richard Petty stood beside his Chrysler-manufactured Plymouth, patted the hood that protected King Kong from the outside world and said, "I never felt as certain of winning any race as I do now." And with his Hemi carrying him 500 miles at an average speed of 154 miles an hour, he won. Chrysler executive Ron Householder rubbed his hands together and grinned, "It's been a long time coming. We've been taking our lumps."

NASCAR, through its powerful president, Bill France, promptly sent the Chrysler team reeling once again, ruling the Hemi was much too big, powerful and costly, and unavailable to the gen-

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BEFORE HIS retirement, Freddie Lorenzen (28) was top driver for Holman & Moody. He earned more than $300,000 driving Fords against such a competitor as Richard Petty (43) and Plymouth.

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eral public, thereby outlawing the engine. Chrysler pulled out of racing angrily, withdrawing its Plymouths, Dodges and top drivers.

That year more than 500 Fords, twice as many as any other car, were entered in NASCAR Grand National races and 30 won. Dodge won 14, Plymouth 12, Mercury five and Chevy one.

At Daytona last year, Fred Lorenzen wheeled a 1965 Ford with a 600-bhp, 427-cu. in. engine at 141 mph to win a rain-reduced, accident-slowed 500 renewal. Lorenzen's hand was shaken by John Holman and his back slapped by Ralph Moody and congratulations from the Ford Motor Co. were wired to the Holman & Moody shop in Charlotte, not the Lorenzen bachelor apartment in Elmhurst, Ill.

Searching out the partners at Atlanta that spring, this writer was told, "You had best see Moody first. He's an agreeable enough guy and will be easy to find. Holman will be hard to nail down and will give you less when you do. You'll know Holman when you see him because he's as big as a house and will have a scowl that's even bigger."

As it turned out, Moody was easier to find, but both were agreeable and informative. Holman presented the impression of being more explosive, but never did explode. Asked about a story that one of the poor boys, Sam McQuagg, had broken a tie rod and had been unable to purchase a replacement from H&M until other teams and officials had sympathetically brought pressure to bear, Holman snapped, "We sold him one, didn't we? No one has to put pressure on us to get a part. All they have to do is pay our price.

"The bigger you are, the less popular you are," snorted John Holman. "It doesn't bother us that we're not popular. We're not in business to win popularity contests. We're in business to win races, help sell cars and make money, which we have been doing. Our prices aren't high. We're still selling wheels at what we have sold them for years, $30 each. But we don't sell cut-rate, either, because we don't make cut-rate. Ours is a very expensive operation. An engine costs $2000. A car costs $6000. It costs another $6000 to put it in shape to race and another $35,000 to race it for a full season. Do you know how much tires cost? They cost $56 each. They wear out in 50 miles. It takes a lot of tires to practice and qualify and run a race with each car. We're not a charity."

He shook his head as though with great sadness and said, "People talk about us and write about us like we were ogres. We're not. We're not domineering and we have no monopoly. It's just that we got here first and we've grown strong. There's nothing to stop someone else from coming in, setting up shop and trying to beat us at our own business. All they'd have to have is what we had—guts and ability and the willingness to work."

Ralph Moody stood by a guard rail and watched one of his flashy Fords circle the track in practice. "We recognized a need, we gambled that we could fill it and, while it's been more of a struggle than most people realize, we've made good," he said.

"As NASCAR got bigger, it was inevitable that the factories would come into it. Racing scares 'em out from time to time, but I think it's good for them. I think it helps them put out better cars and sell more of them, and I wish they would stay in it.

"It is only with factory help that we could develop the great, fast, safe cars we now have, and could build the tracks and put the sort of races on them that would draw the sort of crowds and pay the sort of purses we now have. The factories have helped us incorporate a lot of new safety features in these cars. The basic construction of the car is better.

"I'm sorry if factory interest makes it rough for the independent, the poor boy, to survive, but, if all the factories were in, we wouldn't need the independent and there'd be plenty of cars for all the good mechanics and drivers. There really isn't room for a poor boy in any major circuit in the world, and NASCAR is a major circuit."

WHEN CHRYSLER came out with King Kong at Daytona, John Holman stormed up to the local supply house demanding to be sold one. To his surprise, one was available and was sold to him.

"You might have been able to buy one of those things in the right spot at the right time," he comments coldly, "but they were not the sort of things that were put in the average car, or that the average guy ever could afford to buy or ever would want to drive.

"Most of NASCAR's rules in this regard have been to keep costs down and to hold equipment to things at least roughly comparable to what's used on the highways. Chrysler had plenty of warning and should not have acted so surprised when Bill France outlawed the engine. Ford had an engine that was pulled out a few years ago. It's pretty obvious Chrysler isn't being picked on."

Pat Purcell is dead now, but he was alive then and vice president of NASCAR, and he stood in his undershirt in a room full of old pals and assorted visitors, splashed a glass of whisky and said, "We've come a long way since 1950. We've got something the people want. They eat it up. No race circuit in the world has anything better going for it. We've got to get all the factories in it. Then there'd be good rides for all the boys. A poor boy may spend $15,000 to run a car a whole season. A factory can spend that on one race. With Ford the only one in, Holman & Moody has everyone over a barrel. That operation has earned what it's got. But I don't like to see one outfit in a position where it's almighty strong. Right now we're hurtin' some."

In the morning, the track opened for practice and qualifying runs. The car that wasn't running at 140 mph or so was in trouble. The mechanics kept tearing the cars apart and putting them back together again. Marvin Panch drove a blood-red Ford four laps at an average speed of 145.581 to qualify to start Sunday's race from the pole. Next fastest were Darel Dieringer and Earl Balmer in 1964 Mercurys. Then came Ned Jarrett, Dick Hutcherson, A.J. Foyt, Bobby Johns, Larry Frank, Junior Johnson and Sam McQuagg in Fords. Eight of the first ten were in Fords. Hutcherson and Foyt were in H&M Fords. Four of the others were in H&M "interest" Fords. Only Frank and McQuagg were soloing.

The star of the H&M team and pre-race favorite, Fred Lorenzen, blew an engine in practice and coasted back to the pits smoking. His mechanics pulled the dead engine out of the car, while a new one was hauled off the H&M truck. However, it was not installed and ready before the deadline for first-day qualifications had passed. This encouraged the anti-H&M bunch. And, the performances of Dieringer and Balmer in their year-old Mercs further raised rebel hopes. But, Dieringer, himself, was conservative. "We ran well today, but I don't know how much longer we'll be able to put our 'used cars' on the track without some help," he said.

The great Buck Baker, at 46, NASCAR's eldest driver, and his son, Buddy, were bucking the Fords with an Oldsmobile and a Dodge, respectively. Buck said, "This year, you're not much of a hero when you take Ford out and win a race. But you've done something if you win in another car. I may be able to win in my Olds in the short races on short tracks, but the engine isn't designed for long, fast races. It's getting too costly for us even to qualify for these big races. I'd risk blowing an engine if I went for the pole."

BOB DERRINGTON stood by his 1964 Ford and admitted, "I don't expect to do much here. I can't risk running so hard I might damage my equipment. The way I feel is if enough factories aren't in to give us all good rides, there ought to be no factories in, so we'd all be even."

In the star circle, H&M ace Lorenzen insisted he wasn't discouraged by his engine blowing troubles of the day. "I'll just have to make it tomorrow," he shrugged. He talked of his career. "When I started driving NASCAR, I owned and raced my own car," he said. "I slept in the back of the car and got by on peanut butter sandwiches. I couldn't beat anyone. I went deep in debt. I sold my car, quit racing, went home and went to work as a carpenter to bail myself out and to support myself. Holman & Moody called me up to offer me a place on the team. They took a helluva' chance with me, they taught me a lot, and with the kind of help and equipment they could give me, I started to win. I've made $300,000 in the few years since."

Larry Frank said he used to sleep in the back seat of his car, too. In 1961, he won the Southern 500 at Darlington and figured he was on his way, but he has been struggling to make a buck ever since. This year he bought one of the previous year's Fords from Holman & Moody for $4000 and went to a Ford dealer looking for some sponsorship help. The dealer told him, "We're selling '65s now, not '64s. Get yourself a new car and we'll see what we can do. Right now we can't do anything for you." Frank said, "I can't afford a new car, so I'll have to make do with my old car, but I've been getting discouraged."

THE NEXT DAY, a Friday, Buck and Buddy Baker qualified, but Derrington didn't make it. Lorenzen blew another engine. While his crew was extracting the second dead engine from the car and pulling another new one off the H&M truck, one of the independents said, "It just goes to show you no matter how much money and good help you have behind you, things can still go wrong, but my heart doesn't bleed for Lorenzen. If I blow an engine, I'm through."

After some hours of feverish work, Lorenzen got on the track 10 minutes before it was to close for the day, sped four laps at 143.2 mph and qualified to start in 17th place.

Among the most relieved members of the Lorenzen H&M team was Jack Sullivan, the chief mechanic. An old friend of Lorenzen's, Jack once operated a speed shop in Chicago. "I tried to drive race cars, but I didn't have it, so I started turning wrenches," he smiled. "I came south a few years ago to work for Smokey Yunick, and then went with Holman & Moody in 1962.

"The way they work it, there are a few chief mechanics like myself. We're assigned three to six new cars each year. We supervise the rebuilding of them at the shop. Then we're assigned a driver and a pit crew and we go out with a long track car, a short track car and a dirt track car, and we race."

Despite all Sullivan's troubles getting Lorenzen into the race, neither Holman nor Moody had interfered. "That's right," Sullivan said. "It's my car and my crew, right from the start. They give a guy a lot of responsibility. Of course, if I don't do my job right, the driver could always ask to have me changed or I could always be fired."

The race was rained out on Sunday. The cars were locked up for the week and most of the owners and mechanics and drivers drove out, but some of the poor boys decided it would be cheaper to hang around town and went looking for inexpensive rooms.

The next Sunday turned out dry and hot. A crowd of 50,700 crawled in cars through feeder road traffic jams to the track.

In the race, Lorenzen worked his way up through the pack to lead for a time, but he took a lot out of his car doing it, and at the halfway point Marvin Panch was in command. At 315 miles. J.T. Putney in a Chevy drifted into Panch's path and Marvin clipped his bumper and sent him hurtling down a 15-ft. embankment. Putney got out of it with only a broken nose and cuts, and Panch continued on in the lead. Foyt went out with a stuck throttle and Balmer departed

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with a blown engine. Dieringer slid the length of a straightaway and out of the running.

Panch began to suffer from neck cramps and heat fatigue. When he was waved into the pits at 330 miles, he found Foyt ready to drive in relief. Lorenzen was a serious threat to Foyt until his right front tire blew at 375 miles and he rammed into a guard rail. Lorenzen walked away unhurt, but his H&M automobile was badly damaged.

FOYT HELD the lead to the checkered flag, and drove Panch's Ford into victory lane, where an $18,300 check awaited them. Holman and Moody stood in the background figuring out their piece of the action. Fords had taken four of the first ten places.

During the remainder of the year, Fords swept the Super/Speedway classics. Panch returned to Atlanta to win the Dixie 400; Foyt won the Firecracker 400 at Daytona; Lorenzen swept the World 600 and National 400 at Charlotte; Junior Johnson won the Rebel 300; and Ned Jarrett won the Southern 500 at Darlington. In all, Fords won 48 of 55 NASCAR events, Plymouths won four, Dodges two and a Mercury one. Fords took 360 places around the top 10, more than five times as many as any other make of car. And Jarrett became the first driver to win the driving title in a Ford. With Ford on top, Holman & Moody was king of the hill.

Near the end of the season, NASCAR officials backtracked, ruling that Chrysler could run its Hemi engine with certain weight and size limitations on the cars. However, Chrysler officials were reluctant to return to action and it was not until the start of 1966 season that Chrysler cars were back in full swing on the circuit.

In the first big race of the year, Richard Petty piloted a new Plymouth with a 405-cu. in./550-bhp Hemi engine to victory in the Daytona 500 at an average speed of 160.627 mph, outdistancing Cale Yarborough in a new Ford. A Petty Plymouth also won the Rebel 400 at Darlington and the Dixie 400 at Atlanta. Jim Hurtubise drove a new Plymouth to victory in a 500-mile event at Atlanta. Chrysler was on top once again, though in the Darlington 500, Darel Dieringer pushed a new Mercury Comet to the first victory won in five years by an independently financed NASCAR racing automobile.

FORD? EARLY in the season, when a severe weight penalty was slapped on its sohc engine, Ford withdrew its cars and such standouts as Jarrett, Lorenzen and Dick Hutcherson. Now the shoe was on the other foot. "Don't ask me to feel sorry for the poor Fords," a Chrysler official chortled.

A Ford spokesman said, "It does seem as though every year when a manufacturer comes up with something a little better, NASCAR feels as though it must put that firm in its place." A NASCAR spokesman said, "Last year it was Fords vs. Fords vs. Fords. This year it's one kind of Chrysler vs. another and another. Until we get Fords vs. Chrysler vs. Chevrolets and so forth, we are removing a lot of competition and interest from our races. If we don't have the majority or all of the major factories in, perhaps we should have none."

Fords began to creep back in toward the end of the season, but on an independent basis, without open factory help. Fords won only six of the first 44 races on the circuit, while Chrysler cars, Plymouths and Dodges, won nearly all the remaining events. The Holman & Moody factory in Charlotte continued to operate, though on a limited basis.

"We're just playing it by ear," John Holman admitted. "We don't know what's going to happen and we'll have to wait and see, but we're still very much in the stock car racing business."

AS THE SEASON drew near a close, there was considerable question as to the participation of the factories, including Ford, in 1967.

Disinclined to cringe in the face of reversals, Holman & Moody was far from out in the cold. A Holman & Moody spokesman admitted privately, "We've always prepared for the day Ford might go out of the stock car racing business. We're still in that business, with or without Ford and while we would like to continue our association with Ford on a full-scale basis, we do not require it to survive."

Holman & Moody now owns 60% and Ogden "Denny" Phipps owns 40% of H&M Marine, which operates out of the home plant in Charlotte as well as plants in Long Beach, Calif., opened in 1963, and Miami, Fla., opened in 1964. The 26-year-old Phipps, an independently wealthy New York sportsman, took a short fling at boat racing before buying into H&M Marine. Holman is president and Phipps is vice president of the firm. Charles "Chuck" Daigh is general manager of the firm.

The most popular powerplant turned out by H&M Marine so far is a 427-cu. in. unit. In all, some 1500 engines are being sold annually. Prices range from $750 to $4000, but the average price tag is $2000. Thus, engine sales alone approach $3 million per year and the sales of separate parts boost that figure considerably. A pet H&M project is a new fresh-water/cooling system. Most boat engines cool with salt water, but when engine temperature gets high, the salt falls out, cakes on the part and does considerable damage.

Proving marine products as it has proven its road and raceway products, H&M has been represented and successful in winning at least once every major endurance event in the U.S. since 1963. Additionally, the firm has had considerable luck in the water skiing and off-shore racing fields, as well as in water drag racing. Men such as Chuck Stearns, Rick Fowler, Butch Peterson, Rudy Ramos, Lloyd Marshall, Howard Brown, Dave Kalawain, Bob Nordskog, Mike Wallace, Lou Brummet, Don Aranow and Jim Wynne are among the water performance "names" who have achieved success in recent years under the powering of H&M engines.

"The future is unlimited," John Holman says. The past has made Holman and Moody wealthy, men of stature. "The only problem," Ralph Moody says, "is for John and me to find enough time to enjoy life. The demands of our business are such that we are on the go all the time. Neither of us has the time to spend with our families we would like to have. There are things you must do to be successful. There are penalties."

HOLMAN AND his wife, Zona, have two sons, Randy, 23, and Lee, 20, and a daughter, Jolanna, 18. Randy spent four years in the Air Force and Lee has been attending North Carolina State. Both are engineering specialists who are moving into places of prominence with their father's firm. The Holmans have a house in Charlotte proper and another on the river. Moody and his wife, Marjorie, have a son, Ralph III, 10, and a daughter, Ann, 5, and live in a large home in Charlotte. "Our house is so large, we have two dens," Moody grins. "The den downstairs has a bar so we can booze it up good." He talks a good boozing, anyway. Cut from rough cloth, Holman and Moody don't drink so much as they drive their detractors to drink.

Big, burly, hard-talking John Holman and tall, slim, soft-spoken Ralph Moody, unlikely allies, are men who have made enemies as well as friends, powerful men, whose power makes them feared, powerful men whose power is increasing by the year, who may lose a battle, but seem able to win a war. ■

THE TURBINE TERROR

Will USAC Ban the Bomb?

Parnelli Jones' impressive domination of the Indianapolis 500, or 493 to be more precise, in the STP turbine-engined racing car has led to more vitriolic debates among the racing fraternity than any single occurrence at that tradition-steeped raceway in the past 30 years. With consummate ease, Parnelli swept past competitors while motoring swiftly around the 4-cornered Speedway in virtual silence. The STP Turbocar demonstrated a combination of reliable power and superb handling.

As expected, cries of "Unfair competition!" were heard throughout Gasoline Alley when practice speeds of 166-plus mph were observed. Drivers suddenly noticed a tremendous amount of heat being rejected by the gas turbine engine. The car also became a navigational hazard because of its alleged bulk, although, in fact, it was not grossly oversized and was quite low. Visibility problems were attributed to the "heat waves" formed above the turbine car due to the exhaust gases. Perhaps the most ridiculous gripe of all concerned the intoxicating nature of the turbine's exhaust, which was wonderfully breathable compared to the noxious nitro fumes exuded by Ford and Drake engines in conventional cars.

The STP Turbocar is not the first turbine-engined race car to be entered at the Indianapolis 500. It does happen to be the first carefully engineered and adequately powered vehicle of this type. Strangely enough, none of the aforementioned complaints were levied against previous turbine-engined racers. Apparently, one must become a genuine threat for 500 victory before being deemed worthy of disparaging remarks.

One factor generally ignored by critics of the STP Turbocar is that the car can lap Indianapolis Speedway at extremely high speeds not only because of its powerful turbine engine, but perhaps more important, because the cornering ability of its 4-wheel drive chassis is superior to any other racer in the field. When Jones passed cars during the 500, he did so generally by driving around them in the turns. It appeared the Turbocar was completely maneuverable, running up and down the banked turns of the Speedway to pass cars either inside or outside with complete safety. This certainly indicates a high degree of adhesion, because such tactics obviously would be impossible if the turbine car were being cornered near its limit. It is to Jones' credit that he was able to make use of the superb handling of the STP vehicle's chassis to corner faster than his competitors. This higher cornering speed capability probably also accounted for some of the apparent acceleration of the automobile.

If the STP Turbocar had any one significant advantage over the field, in addition to the superbly designed chassis, it was engine reliability. The turbine engine used in this Indianapolis racer is capable of running at full speed for the equivalent of at least a dozen 500-mile races. Acceleration imposes the greatest limitation on the turbine engine's life in this application and, if acceleration temperatures are kept to a reasonable level, the engine should be completely reliable. Speed, as such, is not critical to the life of a turbine engine, as long as maximum speed is limited to rated peak value. Conversely, running a piston engine at peak speed results in high component loadings on moving parts and causes serious reliability problems.

Ken Wallis, chief engineer on the turbine car project, made extensive use of a computer in designing the sheet metal double-Y chassis. The 4-wheel-drive system is an adaptation of the Ferguson layout familiar to followers of European Formula racing. While the Ferguson system never achieved widespread acceptance in Formula I competition, probably because of excessive weight and complexity for the small engines used in this type of racing, for Indianapolis, it appears that the Ferguson system is perfectly suited. Utilizing four of the huge Firestone 12.10-16 tires to apply the tremendous torque of the Pratt & Whitney Type ST6B-62 gas turbine engine to the pavement results in greatly increased acceleration.

Suspension geometry also was determined by computer analysis and, judging from the handling of the car at Indianapolis, the computer gave the correct answers. Indianapolis is notorious for being a difficult track to drive, because of small but significant differences between the four turns. Jones managed to make the vaunted Speedway seem a freeway while Sunday driving his way into an impressive lead.

It may be that the handicapping system used by the USAC rules committee in determining the size of gas turbine to be permitted at Indianapolis was not quite fair. Perhaps a reduction in turbine size or increase in piston engine displacement is necessary to match performance potential. It is fervently hoped, however, that USAC will not handicap turbine engines excessively on the basis of one outstanding performance by one superbly designed vehicle. Also, it must be kept in mind that commercially available gas turbine engines currently are produced in only a few sizes, and no manufacturer is likely to invest the capital necessary to tool up for production of a gas turbine expressly for Indianapolis racing. It would be far easier to alter bore and stroke of currently available piston engines than to manufacture a completely new turbine.

In short, this writer was impressed by the performance of the STP turbine-engined racing car at Indianapolis. It was a sad sight, indeed, to see this outstanding piece of automotive engineering fail so near its goal. This is the very type of automobile needed if Indianapolis is to prove its proclaimed worth as an advanced automotive proving ground. It would be extremely shortsighted and stupidly unfair for USAC to eliminate gas turbine engines from a competitive position in Championship car racing. The STP Turbocar is neither airplane nor intruder from outer space, as many of the newspapers of the country would have one believe. It is an automobile, and a fine one. True, it employs a powerplant which sounds different from the screaming piston engines that have dominated racing for many years, but this does not alter the fact that this vehicle embodies many principles of automotive engineering which would prove of significant value in any type of automobile. It would certainly be of interest to construct an identical chassis and power it with a conventional piston engine. It is likely that this would also be an outstanding performer. If gas turbines are unfairly handicapped because one nearly won the greatest race in the U.S., then this country will be guilty of one of the worst examples of head-in-the-sand thinking in racing history. The type of advanced thinking and courageous innovation evident in the STP Turbocar is exactly what auto racing needs to grow and prosper. Pioneers always have encountered obstacles to surmount. It is to be hoped that the racing officials of USAC have the wisdom to keep these obstacles within reason. —*Jon McKibben*

AVANTI: the 40-day design

Raymond Loewy's tour de force In Automotive Functionality

BY DAVID H. ROSS

DEVELOPMENT OF styling for Studebaker's Avanti, because of unusual circumstances, was one of the most demanding and challenging assignments ever given a designer. The majority of design programs require a year or more, cost thousands of dollars and involve literally scores of designers. One recent design program was three years in reaching fruition, involved over 100 designers and cost $4 million.

The Avanti had to be designed in 40 days.

Automobile styling is subject to personal preference and taste. This truism may be observed whether the car in question is in the luxury class, or is an economy compact, whether it is an import or a domestic. Studebaker's Avanti was no exception. It lays no claim to being the most beautiful car on the road—though some consider it to be. It is an outstanding example of functional design, a veritable *tour de force*.

This is an age of specialization. In most design studios, one group is responsible for the basic styling concept—the shape. Another group styles nothing but grilles and front ends. A third designs only hardware and accessories. Still another styles only interiors. Design supervision then integrates the various elements into a balanced, coherent package.

Time didn't permit development of the Avanti styling to follow these methods. One man created the basic concept, supervised every stage and detail of its development, and brought the design to a successful completion. That man was Raymond Loewy.

For 15 years, from 1941 to 1956, Raymond Loewy was responsible for styling at Studebaker, where he maintained a design staff and studio in the Studebaker plant at South Bend. Twice during those years, Loewy's designs achieved new breakthroughs in styling concepts. One, styling of the 1947 Studebakers, established a trend that was followed by the entire industry. The other, the styling of the 1953 Studebaker sport coupes—later known as the Hawks—won worldwide acclamation.

The validity of Loewy's concept is proved not only by the fact that until 1966—13 years later—the same basic bodyshell was in production, but also by the introduction of comparable models by the competition. The impact on the styling concepts of the rest of the industry would have been even greater had Studebaker's management accepted Loewy's proposals for the styling of the remainder of 1953 models. What was needed at Studebaker for the '53 line was a total redesign, a completely new image.

Studebaker's management didn't see it that way. Instead, management instructed Loewy to develop designs for the 1953 models based on the styling of the Big Three. Perforce, Loewy had to carry out those instructions, but he believed this decision was wrong. Behind locked doors, unknown to management, Loewy developed an entirely new styling concept in a parallel program.

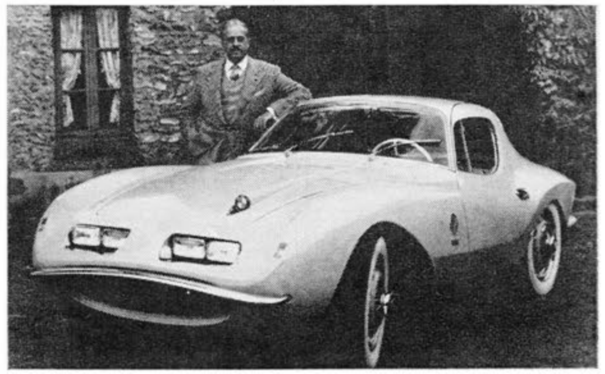
After showing management the models developed in accordance with instructions, Loewy made a presentation of the models developed in secrecy. The presentation consisted of full-scale, clay mock-ups of a low-silhouette sedan, a companion low-silhouette sports coupe and a sports personal car.

The presentation of these strikingly new and different designs was received by management with mixed emotions ▶

SCOTT MALCOLM

FORERUNNER OF Avanti was Loewy's 1955 Jaguar, contoured for smooth air flow. Angularity presages Avanti style.

BMW 507 was modified for Loewy. It included integral rollover bars, interior padding.



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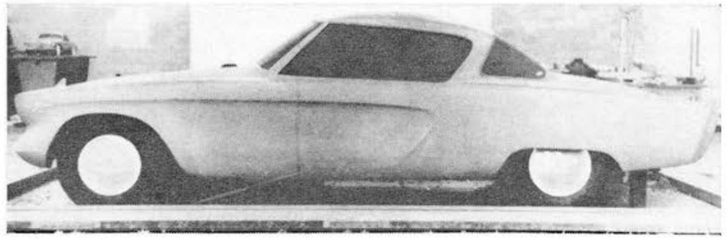
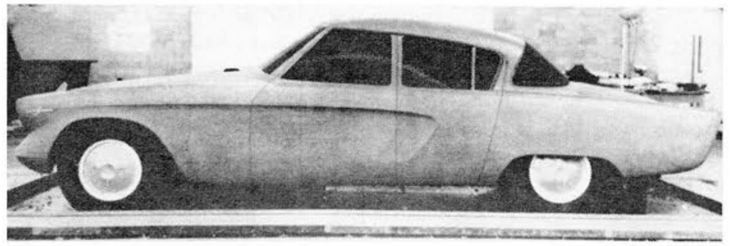
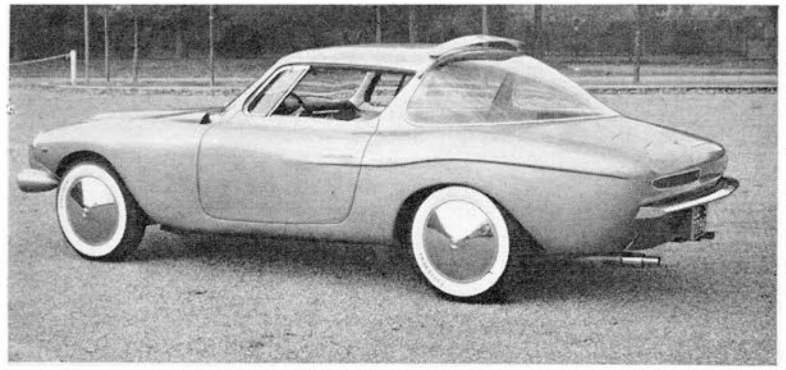


FULL-SIZED clay mockups were presented to Studebaker management for 1953. The sports coupe, above, was accepted. A convertible, below, was rejected, though it was well in advance of Thunderbird, Corvette.

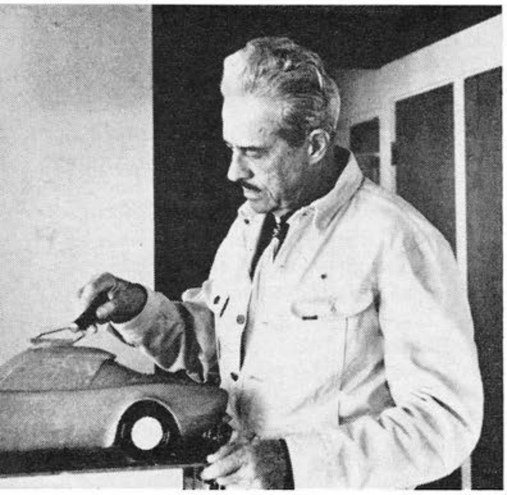
EXECUTIVES AT Studebaker also rejected the full-sized clay mockup of the low silhouette 4-door sedan, below, which Loewy proposed for the 1953 model year. Some of its lines were carried through to the Avanti.



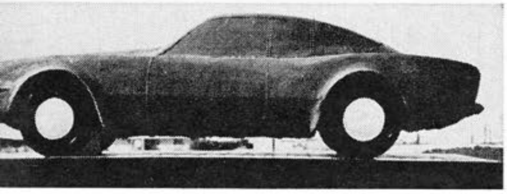
REFINEMENT OF form and design, which later was to appear in the Avanti, was displayed in Loewy's 1960 Lancia.



RAYMOND LOEWY headed the team whose intensive creative work resulted in introduction of the Avanti April 25, 1962.



LOEWY is shown working on a ⅛ scale model of the Avanti in temporary styling quarters in Palm Springs, Calif.



CLOSER to the final product is this ⅛ scale preliminary model of the Loewy-designed 1963 Studebaker Avanti.

LOEWY and Studebaker's then president, Sherwood Egbert, in 1962 were well pleased with the sensational new product.

AVANTI

of enthusiasm and fear. The discussions in the many conferences that followed the presentation were long and heated. Finally management compromised. The sports coupe was ordered into production. The low-silhouette sedan and sports car were killed. The latter could have hit the market a full year in advance of both the Corvette and the Thunderbird.

What followed is well known. The 1953 coupes were enthusiastically received and would have been as enthusiastically bought by the public if production had started smoothly. Other cars of the line were not. Studebaker headed into trying times and into several changes in top management. In 1956, Loewy's long association with the company came to an end.

With the lapse of the Studebaker contract, the Loewy organization was no longer active in the field of automotive styling. For the first time in years, Raymond Loewy was free to indulge his interest in sports cars without having to consider the position of his client. Loewy long had had such an interest. He attended Grand Prix and sports car races both in Europe and the U.S., haunting the pit areas, studying the shapes of the cars, talking with the drivers and builders. He wished to absorb the more successful design features of racing equipment and incorporate them in the designs of *Gran Turismo* machines. He previously had refrained from doing so lest it give rise to rumors Studebaker was contemplating such a venture. But the need to protect Studebaker no longer existed.

IN 1955, WORK was started on the construction of a *Gran Turismo* coupe that Loewy designed for his personal use. The chassis selected was a Jaguar, with the coachwork done by Boano of Italy. The styling reflected Loewy's concern with aerodynamic principles as applied to automotive design. The contours of the rear deck leading out and up to the rear fenders provided channels of departure for air flowing over and around the greenhouse.

In 1957, Pichon & Parat of Sens, France, built another *Gran Turismo* coupe to Loewy's design on a BMW 507 chassis. This design was more successful that that of the Jaguar. The styling demonstrates a greater simplification of form, and a beautiful integration and balance of masses. Not one continuous straight line is to be seen in the entire body sculpture. The car is low and graceful, yet fast and brutal looking. Its lines imbue it with a feeling of motion and speed even at rest. Its performance lived up to its styling. With an engine of only 183.6-cu. in. capacity, it would accelerate 0-60 mph in 7.2 sec. Its top speed was 135 mph.

The styling features of the BMW, and of a Lancia which followed it, are significant because both designs contributed directly to the styling of Studebaker's Avanti. The relationship of the three cars is unmistakable. Features of both earlier designs were incorporated in the Avanti. Only the greenhouse and front end of the latter were original in detail. Yet even the contouring of the Avanti's front end was derived from the BMW.

In 1960, Loewy commissioned Carrozzeria Motto, of Turin, to build to his design a *Gran Turismo* coupe on a Lancia chassis. The engine was reworked by Nardi for higher sustained output. The car, only 48 in. high, was displayed at the Paris Salon where it inspired more inquiry and comment than any other car on the floor.

In plan view, the sculpturing of the body narrowed slightly at the waist, swelled imperceptibly over the rear wheels and tapered again to complete the smoothly contoured rear end. This Coke-bottle shape, and that of the rear end, were incorporated in the styling of the Avanti. The styling of the Lancia represented the refining of a design concept that started with the Jaguar, was furthered in the BMW and found its ultimate expression in the Avanti.

That Studebaker produced the Avanti, a car of this type, with such advanced styling, is a tribute to the vision, courage and acumen of Sherwood Egbert, then Studebaker's President. Egbert had met Raymond Loewy while both were vacationing in Palm Springs. He was aware of Loewy's position as the most successful designer in the wider field of industrial design. Perhaps that is why Egbert believed Loewy was the only designer who would not be fazed by the time element involved, who could successfully meet the challenge of his requirements. He requested Loewy to meet with him in South Bend on March 9, 1961.

Egbert announced his desire for a sensational new car. During the ensuing discussion, he produced automotive magazines and pointed to pictures of the types of cars he liked best.

It would be difficult to find two men whose outlook on design was more compatible. Both were convinced the level of the American public's taste in automotive styling had been grossly and consistently underrated. Both believed there was a large segment of automobile buyers who would respond favorably to clean, functional design, free of superfluous ornamentation. Before the discussion ended, Loewy had Egbert's agreement on three essentials for any new high-performance car. These were disc brakes, integral rollover bar and 0-60 mph acceleration in 7 sec. or less to assure performance in keeping with the styling. From that moment on, Raymond Loewy took over.

ON ONE POINT, Egbert had been adamant. He required the project to be shrouded in absolute secrecy. Normal security measures would not suffice. Only those with a proven "need to know" were to be made cognizant of the styling concept or design details. And each of those was warned that even an inadvertent disclosure would be grounds for instant dismissal. Before leaving Egbert that afternoon, Loewy phoned his New York office and ordered a design team to leave immediately for the West Coast. Then he returned to Palm Springs, Calif.

John Ebstein, a vice president in the Raymond Loewy/William Snaith organization, was made project director for the Avanti. He arrived in Palm Springs with two design assistants on March 19.

Loewy had prepared 12 sketches that clearly delineated design directions for the team. For work space, he had rented an ordinary, air-conditioned, ranch-style house on the edge of Palm Springs, and had brought drafting tables and instruments. When the team arrived, he already had decided on a design philosophy and had established design parameters for the development stage.

THE LOGIC OF Loewy's design philosophy proceeded from three premises. First, the "Q" car (it had not yet been named the Avanti) would embody no phony lines or styling gimmicks; form would evolve from functional features. Second, there were enough customers in the American market to assure the success of a functional, high performance, special automobile type. Third, Studebaker had established styling precedents that the whole industry had adopted on two previous occasions, and could do as much again.

Loewy had chosen the design team from among his most disciplined designers. They hewed to the Loewy line in both form and detail without hesitation or deviation. What the unorthodox facilities lacked in studio efficiency was more than compensated for in the isolation and dedication of the team. There was nothing on the outside to indicate the nature of the activities in the house. There were no visitors, telephones or clocks. Twelve- and 15-hour days became commonplace. Weekends were no exception.

Design parameters and criteria which Loewy posted on the walls of the house were specific.

1) A "Coke-bottle" shaped body form (Loewy had used this, as previously noted, in the styling of the Lancia).

2) An off-center "gun-sight" air scoop on the hood. (Again he had used this feature on both the BMW and the Lancia, centering the device in relation to the steering column as an aid to the driver.)

3) A wedge-shaped profile—which is compatible with high speed performance.

4) No single straight line in the entire body sculpture—all contours relate to aerodynamic flow lines.

5) Some overhead "cockpit" controls. (In aircraft design, this placement proves to be accessible both manually and visually.)

6) Form-fitting bucket seats.

7) Adequate trunk space to suit American preference.

8) No front end grille. (In racing cars, the elite of automotive engineering and design, it has been found the best location for air intake on a front-engined car is a scoop as close to the road as practical.)

9) All projections, except bumpers, to be flush or recessed.

10) "Re-entry" curve fender openings for both front and rear wheels.

11) A strong, heavily padded roll-over bar to be located amidship.

12) All interior body pillars to be padded.

13) Suspension to be calculated for high speed operation—important in styling because of the clearances required for vertical wheel travel.

14) Thorough streamlining of the body in both elevation and plan—a basic clay model, in 0.125 scale, was completed in eight days.

To conserve time and energy, only one half of the model was prepared, a mirror serving to create the image of the other half. In addition, more than 30 sketches (renderings) showing variations in detail of the basic automobile form were readied for presentation to Egbert.

With the drawings and the clay model literally on his lap, Raymond Loewy jetted once again to South Bend. Gene Hardig, Studebaker's Chief Engineer, endorsed the designs as being feasible for production, and offered constructive suggestions. Egbert approved the styling concept.

MEANWHILE AT Studebaker, thorough engineering development of chassis, suspension and power train had been proceeding in a parallel program. On the basis of Loewy's presentation, the Engineering Division started the preparation of full-size body bucks for building clay mock-ups when Loewy delivered the designs in final form to South Bend.

Once again in Palm Springs, Loewy and his team cleared a wall for mounting a full-size blueprint of the new car in order to study shelter characteristics—human factors affecting dimensions, placement of controls, seating and storage accessibility. In just five days a final 0.125 scale clay model was completed. Also completed was a full-size elevation of the car showing seats, clearances and some details too fine to depict in the scale model.

Loewy telephoned Egbert who flew out from South Bend in a company plane. Egbert allowed himself only one hour at the design site in Palm Springs. Contrasted against the normal design-er/management sessions in the automobile industry, with their interminable discussions, hesitations and compromises, this was an unprecedented meeting of two decisive men.

Egbert studied model and drawings intently. Scarcely a word was spoken. Then Egbert turned to Loewy. "That's it!" he said, then returned to his plane.

Later that same day, designers broke camp, taking the model and drawings to South Bend. Immediately upon arrival at the plant, work began on the previously prepared mock-up bucks. The activity was feverish, if not frantic. Compressing the difficult final stages of design into a full-scale presentation was accomplished in just 15 working days. On April 27, 1961, a clay automobile complete with chromium detail, but without paint, was presented by Egbert to his board.

FOR ALL THE drama of the time element involved in this major design effort, Loewy believes there is no such thing as plucking a correct design out of thin air. Instead, he describes the styling concept of the Avanti as a case of educated intuition. Added to this, and to the years of Raymond Loewy's design experience, was the courage and good taste of Sherwood Egbert to create an environment in which the Avanti could be designed and put into production. Considering the magnitude of the stakes, his was a unique conviction. Considering the magnitude of the task of designing the Avanti in just 40 days, Raymond Loewy's was indeed a unique accomplishment.

And, the accomplishment remains, six years after fruition, one year beyond the demise of Studebaker Corp. as a manufacturer of automobiles. In December, 1963, Studebaker withdrew from manufacture in the U.S., shifting operations to Canada. In mid-summer, 1965, Nathan D. Altman of South Bend, Ind., obtained manufacturing rights and formed the Avanti Motor Corp. to continue production of the Loewy-designed *Gran Turismo* car. Production continues today, simply for the reason that some Americans are sufficiently in love with the sleek Loewy design to pay up to $8000 per copy. Avanti IIs, manufactured in limited numbers, powered by Chevrolet engines, 40-day design modified slightly, are singular cars which bear the mark of the master stylist. ■

STILL in production, the Avanti II keeps alive the striking lines of the Loewy design.

SCOTT MALCOLM

THE IMAGINEER
WILLIAM B. STOUT

Automobile and Airplane, His Goal Was to See Them Wedded

BY MICHAEL LAMM

BILL STOUT's career as an inventor and engineer spanned nearly a half century, from 1910 to 1956. His life coincided with the birth and maturation of both the automobile and the airplane. Stout hoped eventually to see the two wedded. He did manage to mate them, but during his life and theirs, a good measure of these machines' individual progress came directly from his unusual, almost occult, creative powers.

"Occult" is used because William B. Stout was more than simply a mechanical genius ahead of his time. He was a seer, a predictor of hard, pure, practical automobile and aircraft design.

He took great pleasure in teasing his colleagues in the auto industry. He very much enjoyed reciting the future to them, telling them what they ought to be doing. Despite this, they elected him president of the SAE in 1935. Unlike the more gentle auto engineers, he reveled in predicting what cars would someday be like. Very few auto men, then or now, have cared to go on record with long-range predictions about the automobile. Stout cared to, because throughout his life he saw the motorcar as tradition-bound and badly in need of re-evaluation—a machine whose redeeming grace lay in its potential to be made much better. Instead of saying this, he showed it.

Some of Stout's predictions came true after his death. He foresaw fiberglass bodies 15 years before the Kaiser Darrin and Chevrolet Corvette. He believed firmly in air-cooled, rear-engined designs 30 years before the Corvair. He preached automatic transmissions, power steering, no-draft ventilation, air conditioning, and high horsepower from lightweight engines long before they became realities. Many more of Stout's predictions lie ahead. Among them are stressed-skin unit body construction, genuinely aerodynamic styling, practical pneumatic suspension systems, curved and polarized windshields integrated with the development of polarized headlamps, maximum utilization of interior space in lightweight packages and automobiles that convert into airplanes.

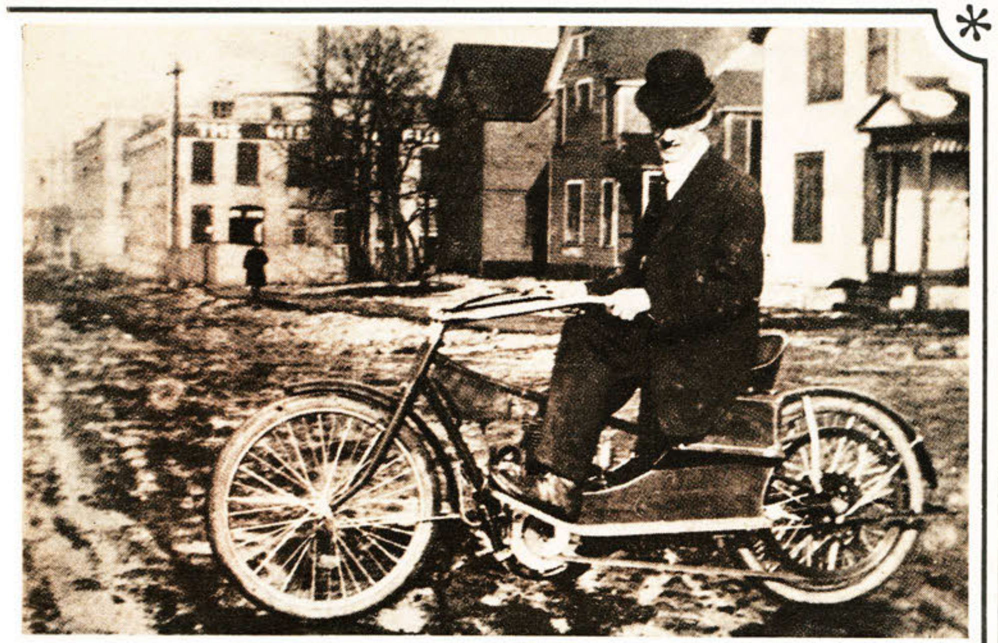
Everything that moved under its own power interested Bill Stout. He was as gifted in designing motorcycles, airplanes, railroad vehicles, trailers, and mobile homes as in automobiles. He approached all mechanized conveyances in unorthodox but deeply practical ways. No one could ever accuse him of following the common herd. He was far-out, yet wasn't the Lorenzo-Jones sort of inventor. His ideas worked. His theories were sound.

William Bushnell Stout was born in 1880 in Quincy, Ill., son of an itinerant Methodist minister and the survivor of twins. His twin sister died shortly after birth. Perhaps because he was a twin (perhaps not) he remained small during childhood—a fact that influenced his later life profoundly.

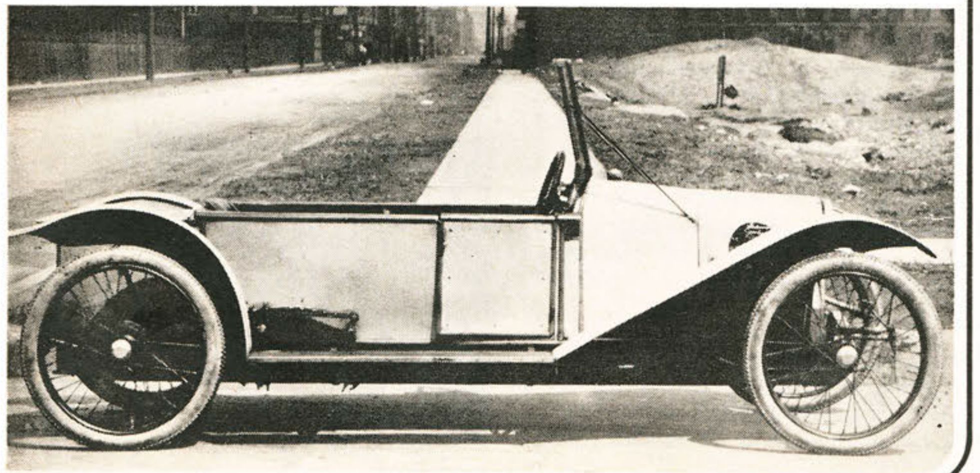
BESIDE BEING physically small, Stout suffered weak eyes. While his schoolmates at Mechanical Arts High School in St. Paul, Minn., played football, Bill spent his adolescence with a pocket knife, carving mechanical toys out of wood. He completed his first model airplane in 1898, five years before the Wright Brothers were to fly the real thing.

After high school, Bill attended the University of Minnesota, where he worked his way through by waiting on tables and teaching manual training. At the same time, he began a newspaper column about mechanized "Things for Boys," under the pen name of Jack Kneiff. He kept up this column for several years. It later helped his early aeronautical experiments, gave him entry into the editorships of various mechanical magazines, and paid for his honeymoon in 1906 to Europe and an extended stay on the Continent.

Stout and his bride, the former Alma Raymond of Kingston, Ont., spent that rather prolonged and very enjoyable honeymoon riding around Europe together on a motorcycle. It was the first motorized vehicle Stout had owned, and even while he was driving it, he thought he could improve it. In 1910, when he returned to the U.S., he immediately built a motorcycle of his own design—a "Bi-Car," as he called it. This put rider ▶



FROM HIS first automotive production, the Bi-Car of 1910, above, through his 1913 Imp cyclecar, with air-cooled V-2 engine, below, into his retirement years, in which he experimented with ornithopter aircraft, designed on principles of insect flight, left, Stout remained a curious creator, eager to apply his ideas on land and in the air.



comfort uppermost. The machine featured an independently sprung bucket seat, an automatic 2-speed transmission, and was powered by a 2-cyl. air-cooled engine. Women could ride it side-saddle. That same year, he landed a job as chief engineer of the Schurmeier Motor Car Co. in St. Paul and designed two motorcycles for the firm.

By 1912, his technical writing had grown to such an extent that he was made technical editor of the *Chicago Tribune*, a part-time position. He showed himself to be an excellent and persuasive writer whose articles about aviation and automobile engines earned him deep respect in and outside the industries. In 1913, he joined the staff of *Motor Age* and *Automobile*, but still had enough time away from the typewriter to design and style a cross between a motorcycle and a car—a cyclecar, which was then very much in vogue in France and was just becoming popular in America.

A YEAR LATER, he became a member of the Society of Automotive Engineers and at the same time received an offer from the McIntyre Motor Co. to become its manager of advertising and general sales. Here, beside writing ad copy, he designed the Imp cyclecar—the fruit of his earlier doodlings. This was Stout's first concrete attempt at 4-wheeled transportation, and when the first Imp rolled off the assembly line, his immediate problem was to learn to drive it. He'd never driven a car before. The Imp was powered by a V-2 air-cooled motorcycle engine, had friction drive, and its automatic transmission had four speeds forward. The cyclecar fad ended soon after the Imp reached production, though in Europe the idea and production of cyclecars persisted until after WW II.

In 1915, Scripps-Booth asked Stout to take a position as chief engineer. His original assignment there was to design a superior motorcycle, but given free rein, he developed the company's first automobile. It was *his* project, from engine specifications to body style—a handsome full-sized car that boasted, among other things, electric door locks with one central button to lock all doors, electric starter, built-in trunk at the rear, and several other engineering innovations. Power came from a conventional 4-cyl. water-cooled engine. The roadster sold for $775—a bargain, all considered.

During this period, he was still writing technical articles for various automotive and scientific publications, building a reputation not only as an innovator and popularizer of mechanical developments, but spreading his name as a clear, concise writer as well. Here was a rare person. He could simultaneously engineer, design, advertise, explain and sell his products. This multiplicity of talents later gave him confidence to start several businesses of his own—all of them far-sighted and pioneering.

The Packard Motor Car Co. lured Stout away from Scripps-Booth in 1916 by offering him a consulting engineer's position with its aircraft division. Aeronautical work came as an especially strong inducement, because Stout was itching to design aircraft. He soon did much research and developmental work on the Liberty engine and, in 1917, was made Packard's chief engineer in charge of aircraft projects. By this time, the U.S. had entered WW I, and thousands of Liberty airplane engines left Packard under Stout's supervision.

Now Stout entered a period of his life given over almost entirely to aircraft engineering. This phase alone would fill a thick book, but the mainstream of this article lies with Stout's automotive achievements.

Briefly, he pioneered the all-metal airplane. In 1919, he developed the first internally braced, cantilever-winged aircraft in America. That year, too, his "Bat-Wing," America's first commercial monoplane—a radically modern and streamlined design—flew at Daytona Beach, creating a national sensation. His reputation caused him to be installed as technical adviser to the Aircraft Board in Washington, D.C., and a little later he became an adviser to the United Aircraft Engineering Corp.

Succeeding designs included his "Veneer Airplane" in 1921—a delta-winged affair; a seaplane and a Navy torpedo plane in 1922; and an all-metal transport plane in 1923-24. With this latter, he founded the Stout Metal Plane Co., which he sold to Henry Ford in 1924, staying on as a vice president and turning his original design into the Ford Tri-Motor (the famous "Tin Goose").

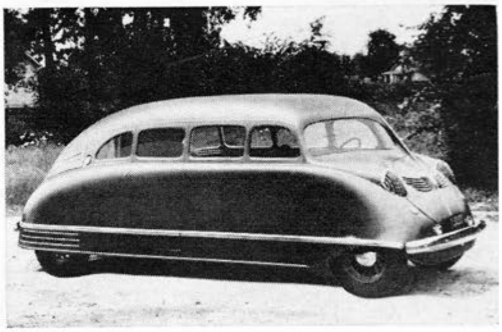
In 1926, he started the Stout Air Services, which was the first U.S. airline to offer its passengers regularly scheduled flights. Stout's own planes at first carried people only from Detroit to Grand Rapids and back. The airline later was expanded to take in a wider route, but before it really got off the ground, Stout sold out to United in 1929. By 1932, Stout and Ford had had their differences about the Tri-Motor, so Stout bowed out.

At this point, Stout again took up the automobile. In 1932, under the umbrella of Stout Engineering Laboratories, he engineered and built his first Scarab automobile, a revolutionary design from any standpoint. First of all, it took aerodynamics dramatically into account, which certainly wasn't the norm in 1932. Unlike the Scripps-Booth, the original Scarab and the two subsequent versions of 1935 and 1946 were hideously ugly from the stylist's conventional view. Yet they embodied a measure of practicality previously and even now unrealized in automotive design.

Stout originally capitalized his Engineering Labs by personally raising $128,000 with the slogan, "Invest with me and lose your shirt," by which he meant that anyone out for a quick buck wouldn't be a likely candidate to back such unorthodox ideas.

He was fortunate from the beginning because he had no factory affiliation, no old stock or inventory to use up in a new model, no body dies or engine castings from which to wring more life. He started the Scarab project with a clean drawing board and no preconceived notions. What developed came from constant thought, research and experimentation.

HE DID HIS initial work in Dearborn, alongside Ford's empire. Many of his components came from Ford—the V-8 engine mounted astern in combination with a conventional 3-speed transmission modified into a Stout-designed differential/transaxle unit. The steering gear and several other components also were Ford. But the



SCARAB No. 2 of 1935 carried steel body over tube frame.

INTERIOR of No. 2 had movable divan, folding card table.

swing axle system, the unitized duraluminum body with its slab-sided design and wraparound bumper, the lounge interior, the lack of overhang—these were strictly Stout's ideas.

Keynotes of the early Scarab were simplicity, practicality, and comfort. Stout gave reasons publicly for all his styling and engineering innovations, again in the crisp prose he became so adept at in his years as writer and editor. These are some of his comments in connection with the car.

On safety: "Many people have the illusion that the engine in front is a protection in case of accident. In reality it is little, if any, protection. When you come to a sudden stop from 40 or 50 mph, nothing but a seat belt can protect the driver from being driven forward into the steering wheel or through the windshield. If the crash is bad enough, the engine comes back in your lap. Furthermore, with no engine in front, [the car] can be so designed as to give the driver much better visibility to front and sides than he now possesses."

About comfort: "It is in the interior design that the rear engine provides the greatest advantage. There is no longer need for a long drive shaft running from engine to rear wheels, and therefore the floor can be lowered, thus increasing head room in the car without increasing overall height. Inside, there is more length and width than is found in a present-day high-priced car. The rear seat is a divan, a full 6 ft. long. While the driver's seat is fixed to the floor and adjustable, the other one or two seats in the car are movable. The effect is that of a spacious, well windowed room."

Stout said many times that he designed this car from the inside out, not the other way around as is usually done. He went on to spell out the rear-engined car's now-recognized advantages of easier steering, better traction, reduced nose-dive in braking, lessened interior heat and noise.

Stout maintained that his first Scarab was an experiment, not a prototype. The second Scarab, though, aired in late 1935, was a prototype, and he hoped to put it into limited production—perhaps 100 units a year. His advertised price was $5000.

THIS CAR essentially repeated all features of the 1932 version, but with two great differences. First, it used a steel body instead of duraluminum (again on a steel-hoop chassis), and second, it utilized a most unusual suspension system. Unfortunately, Stout's second Scarab had even uglier styling than before—his attempt at decoration failed magnificently. He put vented louvers over the headlights and a chrome moustache over the front luggage compartment. Without these, the car could at least be excused for functional styling. Again, the interior embodied such features as indirect lighting, a fold-down table for dining or card playing, movable chairs and davenport, no-draft ventilation, electric door locks, sound and temperature insulation and no-glare tinted windows.

From an engineering standpoint, the car's suspension held the most interest. It was very softly sprung, with the points of suspension well above the car's longitudinal center of gravity. This gave the body a sort of hammock effect in turns; it had a tendency to swing out slightly when cornering, so it created its own "bank." This way, passengers weren't tossed sideways so much as in more conventionally suspended cars.

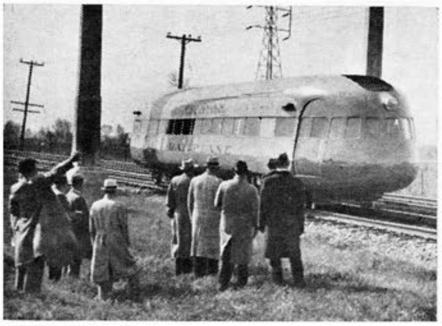
Scarab No. 2 used coil springs at all four wheels, each axle being independent. These springs were bolstered by large oil cylinders—"oleos" in airplane parlance—which absorbed road roughness. The oleos were mounted very high on the body, in fact their upper point of attachment stood just below the window line, and this gave the car its pendulum effect in turns.

To show off the car's stability, Stout had a favorite trick of placing a glass of water on the folding card table inside the car. He once drove this way from Detroit to San Francisco without spilling a drop. In all, Stout made six trips from coast to coast in this car, put 89,000 miles on it, and kept it for eight years. It's now part of Harrah's Automobile Collection in Reno.

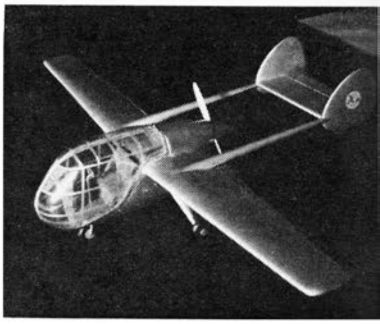
This car had the same overall length as a 1935 Ford. Yet by eliminating the running boards, by widening the body to the fender edges, by cutting down front and rear overhang through a stretched wheelbase, and by eliminating a long hood in front, he managed to produce a usable interior floor area of 56 sq. ft.—as compared with an average of 28 sq. ft. in the conventional car of that time.

The radical Scarab managed to dredge up too few customers to affirm ▶

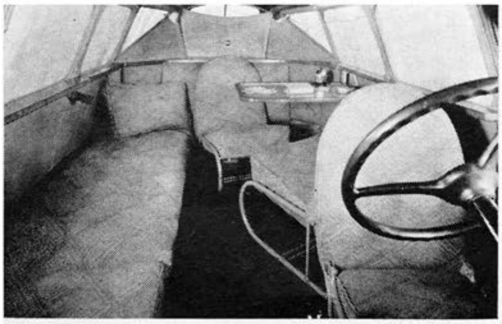
AERODYNAMIC design went into aluminum skinned Scarab No. 1.



RAILPLANE of 1933 featured aero construction, twin 320-bhp Sixes.

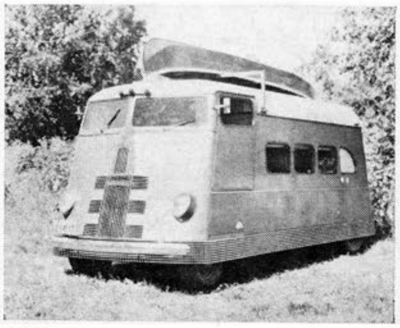


STOUT Skycar III blended plane, auto.



LIVING room comfort was Stout's aim for No. 1 Scarab's interior.

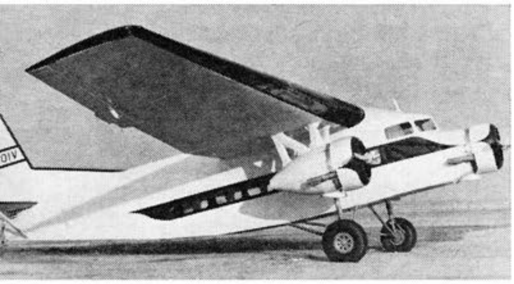
FIBERGLASS body, pushbutton doors marked Scarab No. 3.



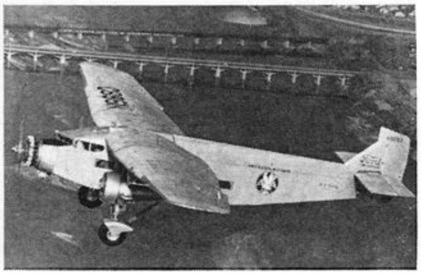
STOUT designed this camper for the 1937 outdoorsman.

its financial success. This is hardly surprising if one considers that the Chrysler Airflow, with a much larger advertising budget and more conventional engineering, fared little better.

Yet Stout was a hard man to discourage, and in 1946, he unveiled his ultimate Scarab. This third and final attempt again was an experiment, with no plans for commercial production. This version used an Owens-Corning fiberglass body—one of the country's first. Again, it wasn't much to look at. It had slab sides, a front hood with a false grille, and its styling was much more conventional. This time it had windows in the standard arrangement, a curved windshield, doors without handles and wraparound molded bumpers.



BUSHMASTER, above, is modern revival of Tri-Motor, below.



AMERICAN AIRLINES

In this No. 3 version, the entire body was molded in one gigantic piece—floor, sides, ends and roof. Only the doors were metal. The car had no chassis. The body provided its total rigidity. Four-wheel independent suspension was by hydro-pneumatic cells at each wheel. Engine, again at the rear, was an opposed, air-cooled Six. The interior was large even by today's standards, with 66 sq. ft. of floor area and, again, movable sofa and chairs. Stout eventually hoped to bring out a smaller version of this car to compete with the Low-Priced Three. Unfortunately it never materialized.

All during this time—from 1932 to 1946— the Stout Engineering Laboratories and the Stout Research Division of Consolidated Vultee Aircraft Corp., later to become Convair Division of General Dynamics, also were busy with other projects. Stout developed, among other things, a self-contained railcar, streamlined and capable of 100 mph, which used two automobile engines, automatic transmission and delivered a respectable 5 mpg at normal speeds. By incorporating aircraft principles, this 1933 Pullman Railplane weighed about 20% as much as a standard rail car.

Stout also designed and built a sportsman camper—very modern in every respect—in 1937. He pioneered collapsible travel trailers with a unit that expanded from a width about equal to a car's to three times that.

The high point of Stout's career was in his experiments with roadable aircraft or flying cars—whichever they might be called. His research along these lines started in 1931, when he developed his first Skycar. This was strictly an airplane, not meant to convert to an automobile, but it laid the fundamentals for his later mating of car and plane.

The first Skycar (1931) was designed as an inexpensive, easy-to-pilot, almost foolproof small plane that used a pusher propeller, an inverted 75-bhp in-line Four, and had a 4-wheel landing gear. Stout designed it on the theory that anyone who could drive a car could easily learn to fly the plane. The 4-wheel pattern (one nose wheel, two at the sides of the cockpit, and one behind it) gave rise to and helped popularize the tricycle landing gear now almost universal in light planes.

Stout built a second Skycar in 1939-40, again mainly airplane. This version, though, had a 4-wheel landing gear with the wheels arranged like a car's. The two front wheels were steerable. The second Skycar gained distinction by being the world's first airplane to be built of stainless steel.

Then, in 1943, Stout, together with Waldo Waterman, designed and built the third Skycar—the first roadable version. This was still primarily an airplane which, when the fuselage and wings were removed, could be driven on the street. In the air, it had a cruising speed of about 120 mph, with a speed on the ground of 35 mph. Again, this Skycar used a pusher propeller. It carried three passengers.

Stout realized, even while designing this third Skycar, that it was too much airplane and too little car. The wings and tail section were difficult to remove and harder to store. The car portion offered only minimal performance on the street to make it practical.

So, in 1945, working with Vultee in Detroit, Stout designed his fourth and final Skycar. It was much more practical than earlier models, because the fuselage and cockpit were built into one compact unit. Only the wing required removal for street use. Again, it had the pusher propeller, this time built into the very rear of the body. The stubby tail section was no wider or taller than a conventional automobile. Stout did away with the need for rudder, stabilizers and ailerons altogether. All flight controls were built into the wing design, which had been developed by Stout's colleague, George Spratt.

Spratt's wing held the secret of the ultimate Skycar's practicality. It was mounted on removable struts above the cockpit. The wing could bank independently of the fuselage, like a tightrope walker's balancing pole. The single, slightly veed wing attached by two universal joints at the ends of a pair of side-by-side pivot bars extending upward from the cabin. A forward push of the single control stick inside the cockpit tilted the leading edge of the wing downward, reducing the angle of attack and causing the Skycar to glide or descend. Pulling back produced climb. When the stick was turned to one side, the Skycar likewise turned. It was one of the simplest flight mechanisms devised, and it certainly worked. Stout tested this fourth Skycar for at least 100 hours in the air.

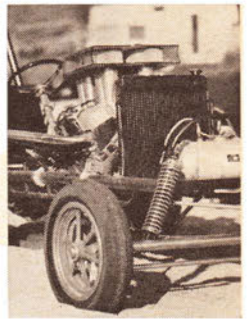
On the ground, the Skycar had a top speed of around 70 mph—more reasonable than any former design. And although other inventors tackled the same problem of marrying car and airplane (notably Robert E. Fulton Jr., whose 1945 design was more like Stout & Waterman's earlier Aerocar), the idea never caught on.

FOR PERSONAL reasons, Stout "retired" to Phoenix, where he turned his attention to the flight of insects. It was Bill Stout's theory that insects fly much more efficiently than birds in glide. In studying insects' flap-wing flight, he believed that if these principles could be adapted to machines, they would prove more suitable than propeller-driven craft. But in this study, he held no hope of being the genius to crack the flap-wing barrier. He was merely acting as the idea man, hoping to leave enough experimental material behind to goad some imaginative youngster to carry on.

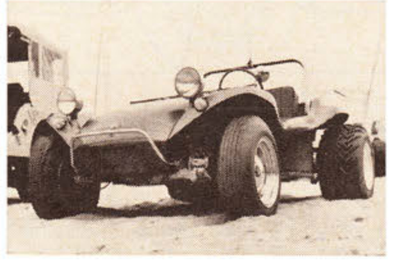
The now oft-heard term "imagineering" was one Stout coined, and it delighted him. His concept of the word fused the sort of imagination and engineering that started with a blank sheet of paper and, following sound principles, arrived at a logical and unconventional conclusion. This type of thinking and this approach to engineering problems was the legacy he hoped to leave.

Bill Stout died suddenly on March 20, 1956, of a heart attack. ■

TEXT AND PHOTOS BY GENE BOOTH



SAND SCENE



Dune Buggies, Symbols of Independent Arrogance, Elemental Free Expression

DUNE BUGGIES DATE back to the earliest days of motoring, but the real spurt in popularity is only recent, coinciding with the world of free expression, psychedelia, rock music and hippies. What really props it all up, however, are growing junkyards full of wrecked Volkswagens. Cheap and plentiful VW engines and suspension assemblies are what provide the motive force for the buggy crowd. And the elves of the Black Forest have made possible a second-generation revolution among American auto enthusiasts.

In Southern California, where aberrations of this sort always seem to start, the sleeky functional dune buggy has replaced the sports car as the symbol of independent arrogance. Movie stars drive them, sportsmen race them and outdoorsmen regard them as the modern equivalent of the pack mule. As with sports cars of an earlier eon, some owners think them so attractively sporting that they emphasize the image to the exclusion of the activity. Even so, the real element of the buggy is sand.

Trackless wastes of sand are found in relative proximity to the boundless suburbs of Los Angeles. One hundred freeway miles northwest of the megalopolis lies the mile-long strand of surf-lapped sand called Pismo Beach. Or, 250 miles to the southwest, near the Arizona border, creeps an even larger expanse of wind blown dunes called—predictably enough for the nearby Chamber of Commerce—"America's Sahara." Any weekend finds hundreds of buggies scooting in either direction, under their own power or towed on trailers behind pickup truck campers and laden station wagons.

A drive to the sand is nothing more than freeway boredom, offering no other diversion than windburn and overchill in the open buggy. The tiny car, humming along the concrete ribbon on fat black "street" tires, overflows with the weekend's necessities—most obvious of which is another pair of tires of even more grotesque, Disneyesque dimensions. Oddments of camp gear jam whatever crannies remain around these space-consuming sand boots which will be substituted for the road tires once the sand is reached.

Every sport has its own peculiar badge, and the totem of the *buggiesta* is his super-porcine tire. Ultra-wide wheel rims measuring 6 or 8 or 12 in. across have been grafted to the VW centers to take gargantuan rubber. Flotation and flab are the mark of the sand tires, owners attending to the latter requirement with a hand gouger during the intervals between trips. They start with "sand service" tires invented for 2-ton Jeeps, or skinny-dipped gumballs from racing stock cars, and pare away superfluous rubber. The heated iron peels down to the cords along the sidewalls and makes slashing strips across the treads. The violated carcasses are held to the rims with barely enough air pressure to register on the tire gauge. Properly bulging flab along the bottom, like water wings, then floats the buggy across the shifting sands.

THE SAND at Pismo provides an exceptional introduction to dune buggying. There, spreading inland from the pounding surf of the Pacific, are larger and more timeless waves of sand, formed and imperceptibly moved by the prevailing winds. And that's what it's all about. Dunes drivers are nothing more than surfers, riding motorized buggy-boards over the crests and into the troughs. "Supersonic surfing over prehistoric waves," as one sandsage characterizes it. And that fits another piece into the puzzle: Among the earliest buggies were some used by surfers to cart their then-monstrous redwood and balsa planks to where the waves were biggest. That was long before the modern plastic age, to be sure, but so too were their buggies.

To the novice, the sand world is unreal. Brown drifts of the shifting stuff stretch to the horizon all around. After a weekend of camping amid the wastes, a necessary ingredient because the dunes are some distance from civilized habitation, one becomes convinced that the entire world is made of granulated waves. Beach dunes, such as those at Pismo, enfold the temporary resident in a damp discomfort that is vaguely tolerable; but desert dunes, such as those near Arizona, have a special life of their own.

There the nights are bone chilling and clear, with the glow of distant city lights brushing the western horizon. The heat of the day, hoarded by the sands until sundown, rapidly surrenders itself to the cloudless skies. And this lifeless tract of hostile land begins creeping and crawling in the sudden darkness. Beetles, scorpions, spiders, bugs of strange appearance and other denizens of the dunes begin their nocturnal activity in quest of only they know what. Strangely in-

▶

SAND

MERCILESS ADVERSARY to man and machines, the sand also is a playground for water pumpers, 4-wheel-drive vehicles and buggies built from VW bits.

visible during the daylight hours—perhaps dozing under the sand's surface—these multi-legged creatures prowl endlessly about their sand domain dancing in the flickering shadows cast by campsite firelight.

It is a world without landmarks. Even at Pismo, at night when the buggy drivers like to accept additional unknown odds from this undulating world, nothing is distinctive. No dune seems different from the last; merely a succession of endless sand waves over which the buggy rolls like a noisy sand flea inching onward with nothing more than instinct to guide it.

The buggy drivers, like many peculiar species found in Nature, draw some comfort from a closeness to others of their kind. So they travel in packs of four or six cars, dumping their gear in one sandy cove and calling the cache a campsite. Yet they are decidedly disorganized; the "club" concept is a hangup of the 4-wheel-Jeep and Bronco crowd with their trailmasters and radio controlled in-line-astern caravans across the sand by grim-faced and determined drivers. Among the buggies, a swashbuckling freebooter attitude prevails. These are essentially loners, individual operators, free spirits on the sand, so their protective companionship is loosely knit and easily ignored.

WHEN THEY chase off over the dunes, their game is called Rat Race. It is a rag-tag sort of follow-the-leader at full tilt through the sand. Often it becomes a rough and ready parody of the carnival's Dodgem car ride. And, like the dune creatures, it very often happens in the dead of night, with only a satin sheen from the headlights to pave the way across the eerie wastes.

They seek the sand bowl, a special universe of spectacularly towering dunes that surround immense pits of frightening dimension. This is the buggy's exclusive domain, denied to other styles of sand trawler. The buggy is expressly shaped to shoot the bowl: Extreme light weight, short wheelbase, huge flotation tires with a precisely balanced weight distribution over the rear driving axles, the rear-mounted VW or Corvair engine and, most important of all, that fully independent front suspension of exceptional stamina. Nothing else can fully exploit the deep and forbidding sand bowls.

Other sand vehicles, those exquisite "waterpumpers" as gracefully formed as Grand Prix cars, dare not attempt to shoot the bowls. These are the dune domain originals, latest manifestation of the earliest junkyard art to move through the wastes. But they are far removed from their ancestry; rather, they seem most closely akin to the modern world's rail dragsters. And they earn their name from the variety of potent water-cooled engines placed dragster-like in the middle of their long, spindly, tube steel frames. Corvette and Chrysler powerplants, often the recipients of as much fiddling as the Summernationals entry, drive these specialized beasts.

And they have special games of their own, their owners displaying more of the herd instinct by organizing competition events to give the machines some small measure of purpose in life. Their particular world consists of the hillclimb and the drag race, divided into classes which are often thought up at the moment to accommodate the variety of machines entered. The drag race is not unlike that on more civilized strips, though there is no need in the slippery sand for elaborate timing lights and other amenities. A pair of officials flanking the finish line of the course, marked off with conveniently placed stakes, decide the winner in contests where there might be some doubt. The waterpumpers, lunging off the line to spread an eighth-mile roostertail of sand, spew raucous exhaust noise and abrasive dust over spectators lounging in the sand or waiting their turns in other machines along the impromptu strip.

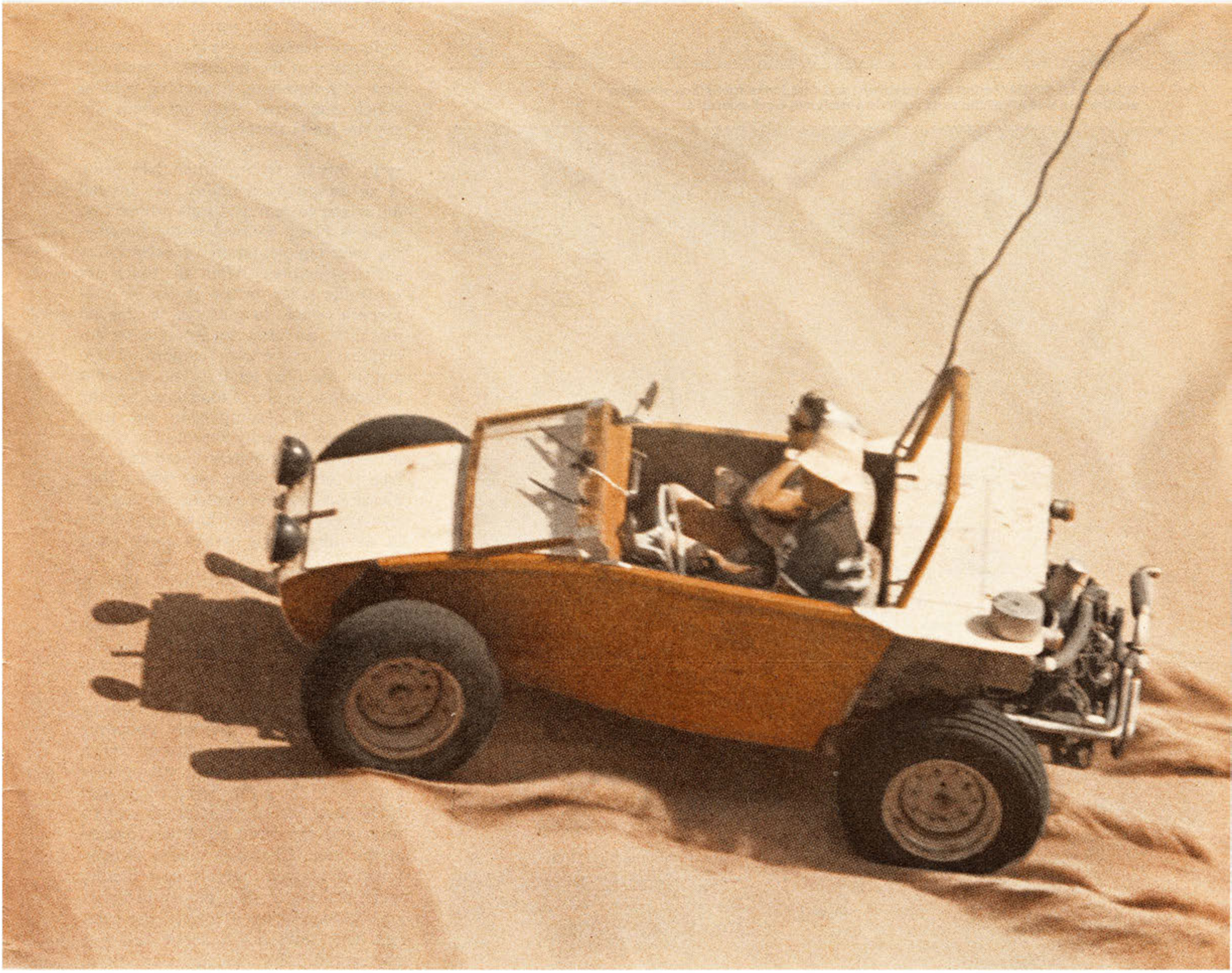
OR, MOVING to the over-towering dune in the vicinity, the waterpumpers bellow defiance to each other in climbing contests. The slope, always the picture of impossibility, actually is limited in steepness by sand's natural angle of repose; dry sand granules, no matter how carefully stacked, roll and shift down across themselves to seek a level of equilibrium that never exceeds about 60° in steepness. The name of this game is elimination, and to handicap those waterpumpers so powerful that even immense sand mountains are of no moment, starts are made progressively higher along the slope until finally, only one makes it up and over.

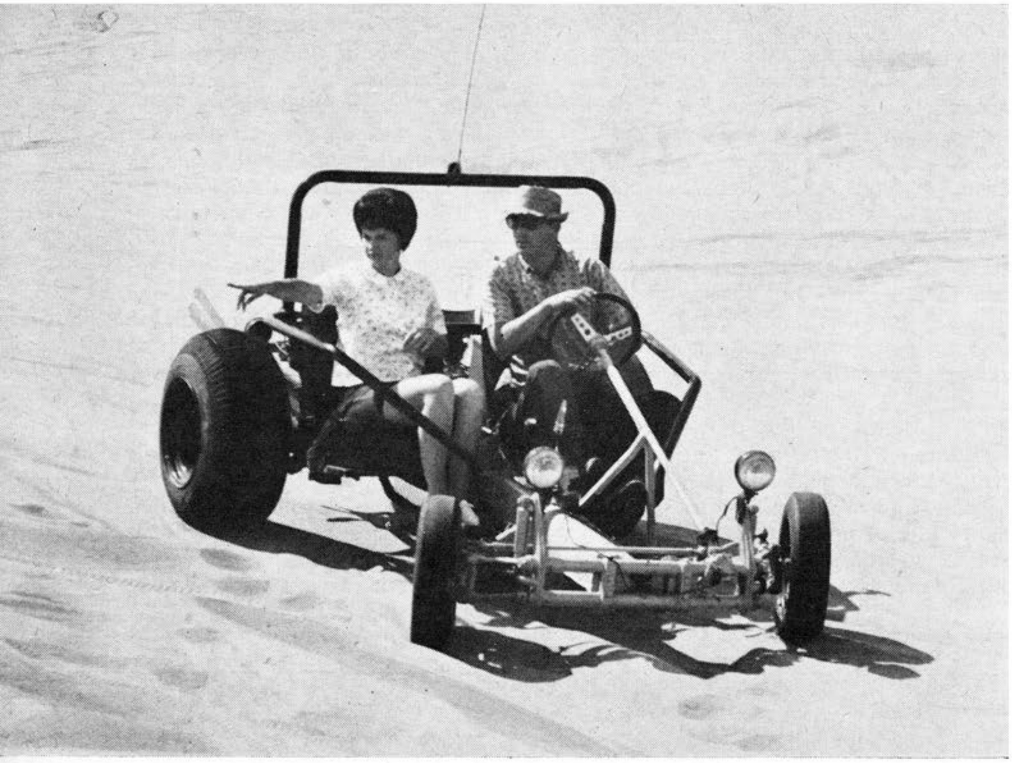
Throughout the day they go, upraised in wheelstands during the long lurch upwards. Balanced delicately on their huge rear tires, they skitter an eardrum shattering route up the dune, spidery front bicycle wheels tipping and waving gently like some huge insect's antennae above the sand. Their spindly front wheels and rudimentary steering and go-kart-like suspension keep them in straighter lines along already explored paths.

The omnipresent and ever-changing ▶

PLYWOOD, ALUMINUM, porcine tires, engine and chassis from the Black Forest, the vastness of California seashore or desert dunes and a freebooting attitude are things of the *buggiesta's* gritty, windy, Dodgem car world.

SCOTT MALCOLM





GUMBALLS GIVEN the hot iron treatment and that indestructible suspension are the fore and aft of the sand surfer's 4-wheeled, 4-cyl. board.

sand tests the mettle of the driver. It can be a merciless adversary to man and to the machines he fashions. And the man, pausing briefly at the base of a sand mountain and eyeing it to take its measure, tames the toughest of them. He wends his way upward in an uncompromising drive toward the summit, pulling the dune's enormity down beneath the fat black tires of his buggy, and he finds he measures himself against a timeless constant. If he is not totally pasteurized, homogenized, computerized, and sanitized from 20th Century living, he discovers that he is the equal to that heretofore unknown. And he can truly relish the discovery.

The sand dunes begin to assume a reality of their own, though one from an altered point of view. Whether he peers through a face mask at undersea coral, or chases a soaring hawk through the eddies of the air ocean, or storms through the staggering piles of stinging windblown sand, a man puts a different yardstick against himself and the world that surrounds him. His ordinary workaday world, far from being reality at the moment, rematerializes as a numbing, deadening void in which one exists with uncertain (to say the least) purpose.

THE DUNES, THEN, rather than being an escape *from* reality, are instead an escape *to* reality. In all probability, what is being escaped is regulation—the over-regimentation of present-day social structures. After all, there are no traffic lanes on the dunes, no motorcycle cops to enforce a special morality, no laws to strangle an individual's exuberant freedom. There are, in the final analysis, no innocent bystanders to be endangered in the dunes, so the compulsion for such orderliness is totally absent. The dunes drivers feel completely unfettered and free to charge when and where they please and to give vent to any aggressive urges they may have bottled up in the intervening weeks away from the sand.

And, in this neo-realism that is Pismo, four buggies roll easily if bumpily along the crests of prehistorically slow surf. Each rise is different, some gently rounded and others dipping sharply to the leeward troughs, undulating, waving, rippling inland from the ceaselessly pounding surf at the beach. Topping one rise, a tall escarpment of sand comes into view off to the right, being challenged by a dozen or so vehicles of various sorts and pondered by others paused at the base. Changing course directly for it, the buggies merely slow slightly when nearing it, then plunge in loose-knit formation up it toward the summit. One bogs down about half-way up, swings 180° and swoops down,

SAND

circling back at the base for a second, successful try.

Momentum is what does it for the light but low-powered buggies; momentum, maintained by precise and skilled use of gears and throttle foot and differential driving brake to avoid digging the car's own grave. The others, conquerors of this minor peak on initial momentum, peer back down over the lip, front wheels hanging over the edge, awaiting the laggard's arrival. Then down and onward into the deep sand bowls, careening along the ridges, down around the insides and back up and over into an adjoining, even more frightfully deep bowl.

Chasing, darting, dashing, sliding, spinning to a stop and starting down and over again, the buggies badger each other in an uncoordinated contest encompassing dune after dune. Wind and sand spray sting the faces of the unprotected drivers and they regularly cuff their plastic one-piece goggles to peer with any comprehension toward where this free-for-all leads them. For hours, days, weeks, an eternity, this breathless dash across the pits and bowls of a world of sand keeps up its reckless pace. And soon the buggies find themselves over the last rim and skidding down to the hard-packed beach.

At the beach, the dunes are long fingers stretching seaward and capped with weed-like growth and shrub brush. The game here is to charge into the valley between a pair, wind back and up atop the dune, reversing direction and down to return to the beach, then repeat the process around the next finger. This is more solid sand, and the underbrush and ground cover provide some interesting variation as the buggies go crashing over and through it all. Back and forth, zig-zagging between beach and steeper dunes inland, a slow progress along the length of the beachfront is made over an hour's play time.

The chase continues southward, mile after mile, past a long sand plain dotted with the pipeworks of a petroleum company's business, and onward. Now the cars skitter along under cliffs covered with greenery, grass and shrubs, and bold brown rocks, until there, in the distance, looms the greatest monster of all: Devil's Slide.

Huge, mammoth, towering for a full mile above the sea, it would seem Devil's Slide is the ultimate test of the Pismo weekenders. In steepness, this staggering slash of sand lying between rocky ridges varies its angle of repose. The buggies pause somewhat longer than usual at its foot, drivers eyeing its slopes and watching those already struggling upward. Then, along the beach comes a monster vehicle meant to conquer monster sand mountains. Rumbling along easily on tires taller than a man, this challenger is one of the most spectacular sand vehicles yet constructed. Perched atop heavy army truck frame rails, behind an almost idling Chevy truck engine, is the body of an ancient Austin sedan. The front end, from cowl forward, has disappeared and all the glass except for the windshield is gone.

Rolling effortlessly along on its elephantine tires, this monster swings toward the Slide and drives upward. It doesn't falter once, doesn't slow or pause for breath, but moves inexorably upward toward the distant top of Devil's Slide. Behind it, two boys ride in the overturned hood from some abandoned auto, towed along in this impromptu sand dinghy at the end of a 50-ft. hawser.

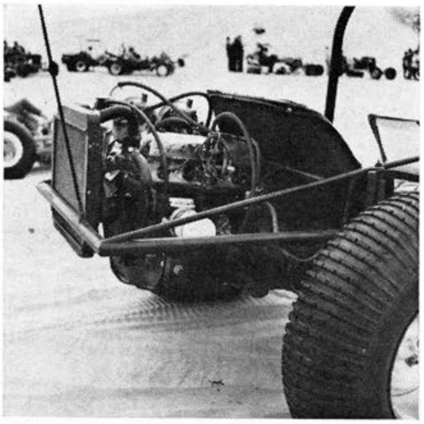
Buggy drivers pick their routes, after this haughty display of monstrous muscle, and begin the assault. Lower slopes are relatively steep before a decided change to a more gradual pitch occurs. That rest area, about a third of the way up, rapidly swoops upward in even more pitched slope for the final climb to the top. The buggies, struggling to make the first level, manage the feat after numerous attempts and altered routes. Beyond that, they are frustrated. All save one, its highly modified engine laboring mightily to turn the bulging Terra-Tires fitted at the rear, a solitary green bug in the hands of a determined, expert sand buster named Vic Wilson, finally, agonizingly, surmounts the uppermost lip of Devil's Slide and sits there in smug disdain.

DENIED THIS victory, but undaunted and with undampened spirit, the other buggies charge back up the beach to where lesser dunes await them. Up and over, then back around from the rear, through ever widening and deepening sand bowls, the 3-dimensional motorized rat race continues until the crews find themselves at the top of Devil's Slide. Wilson and the green buggy already have started down, moving easily and swinging to test the variety of rolling roadways which the winds have left in its upper reaches. The rest plunge over, zig-zagging their way downward, savoring every second of play upon the forbidding face of this grandfather of sand mountains. As inexorably as that elephantine rig went up, the buggies slide farther and farther down the Slide until, over that last lip (or first from the bottom) they roll down once again to the beach.

Refreshing themselves with what's left in their *bota* bags, the drivers point in the general direction of the campsite and move off through the dunes. The day is waning and the sea breeze has picked up, adding to the wind chill that slices through the jacket of each man. But there still are bowls to shoot, rolling high up the side of one until engine lugs and strains, and then plunging into the pit and up the opposite side to gather ever-needed momentum for conquering the original obstacle. It is an endless, hour-long drive that seems to be over in minutes when, over one final dune, the buggies come upon a strange sight.

Spread before them, inexplicably, is a blue lagoon bearing the unlikely name Oso Flaco Lake. Beyond it, surrounded by a smooth green lawn, is a rambling country home and nearby barn, all backed up by green, irrigated crop lands extending to the hazy horizon in the distance. The day has been long, the driving has been intense, the exertion has been unflagging, and the sand has been unending. And then, to come upon this just before reaching the campsite for an evening's fire and food and frivolity, is just too jarring. After 24 hours in a world of undulating sand surf, relieved only by sudden spots of sumac, it is a confrontation with a strange and hostile world. ■

TREAD for traction, low pressure for flotation are buggy needs.



RENAULT engine equipped with SU carburetors makes odd hybrid.

THREE LITERS OF FURIOUS FORD

Clark and Hill Will Put This New dohc V-8 Into Action

BY JOSEPH LOWREY

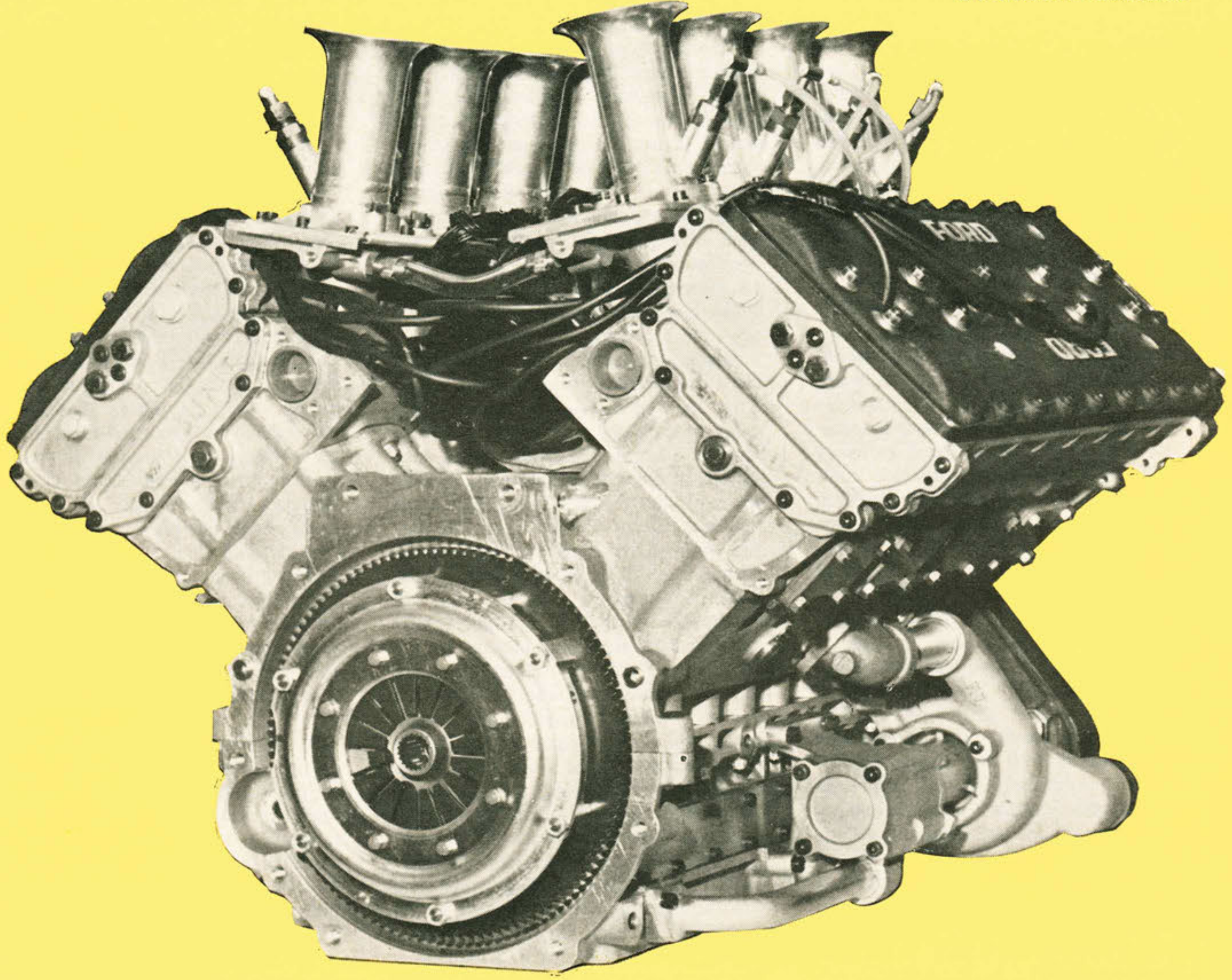
FORD NOW builds a special 3-liter, Formula I Grand Prix racing engine, in addition to all the competition engines based on "stock" blocks. The new powerplant is a 90° V-8 with four overhead camshafts, built of aluminum castings. It is ultra-compact, with a length of less than 21.5 in. from front cover to clutch face. Its weight, including clutch, is only 370 lb. And this 182.6-cu. in. engine is expected to produce well over 400 bhp from the very start of its development.

Designed by Keith Duckworth, and built in Northampton, England, by his Cosworth Engineering plant, the new Ford engine is to be raced by Jim Clark and Graham Hill in new Lotus single-seaters. From the first lines on drawing paper, the new Ford engine has been planned as the heart of a race-winning car, not just as a power source around which someone else must fit a chassis and body.

Horsepower aplenty is needed for success in road racing, but bhp alone cannot insure success. A good racing engine must fit into a car of light weight, low wind resistance and good road holding capability. On all these three counts, the new Ford racing engine is designed to give a car designer advantages over his rivals. If its power output only equals that achieved by such engines as the Anglo-American Racers' Eagle V-12, a Lotus powered by Ford should be markedly faster than its rivals.

Light weight has been achieved in the new engine partly by careful application of light alloys to the proven 90° V-8 layout. More than this, the engine has been designed to serve as a main structural part of a car, thereby reducing chassis weight. For any given lap speed, this Ford engine should burn rather less fuel that its rivals, reducing weight which must be carried through most of a Grand Prix race.

Low wind resistance has been achieved in part by keeping the engine compact. Overall width is moderate thanks to narrow cylinder heads, and there is only 5.25 in. of engine below the crankshaft centerline! Additional saving in frontal area comes from the fact that, acting as part of the car structure and having the rear suspension mounted directly to it, this engine does not require a chassis structure at each side of it. Still greater saving in frontal area comes from shortness of the engine, which leaves room for fuel tankage within the body, between the driving seat and rear-mounted engine of a standard-length race car, instead of tanks projecting at each side of the cockpit, as is common practice.



Good handling of the Lotus GP car also should result from the new Ford engine's extreme shortness. A fuel tank located between the driving seat and the engine is close to the car's center of gravity, hence there is no change of weight distribution between the start and finish of a race, such as occurs with cars that carry part of the fuel load in the nose.

All these three potential advantages have led Ford to believe a car with a light and compact V-8 engine should defeat 12- and 16-cyl. models on racing circuits, though the latter have smaller moving parts and so should be able to run at higher rpm. Experience of the 1.6-liter Ford Formula II racing engine, which first ran on the test bench early in 1966, has suggested that Keith Duckworth's very "flat" 4-valve cylinder heads can provide exceptionally good cylinder filling and combustion. Thanks to exceptionally high brake mean effective pressures, Ford's new Grand Prix engine may actually be a full match for its rivals on bhp alone!

Because it is simple, and draws on experience gained with the Ford Formula II engine, this Grand Prix unit is reaching the road racing circuits less than a year after initial planning. The 1.6-liter unit, which (to comply with Formula II rules) was based on a stock Ford Cortina's cast iron cylinder block, delivers 220 bhp at 9000 rpm, unsupercharged and on pump gasoline. With various improvements, resulting from lessons of the F II engine or permitted by less restrictive rules, the F I Ford should readily top 400 bhp without needing to run any faster—although its valve gear has been designed for a potential 11,500 rpm.

In its first few days the prototype engine reached its 400 bhp on the test bench at 8750 rpm, then did itself no good when a valve spring broke at 8000 rpm. The spring, rather than design, was at fault.

The new 3-liter Ford engine is scarcely bulkier than were 1.5-liter V-8 engines designed under the pre-1966 GP rules, yet no vital dimensions have been cramped. Keith Duckworth has "shrunk" his engine by taking extreme care to fit auxiliaries and their drives into a minimum of space. Between cylinders of 3.375-in. bore, there is a minimum center distance of 4.1 in., providing ample gas sealing between bores. Connecting rods are comfortably long, with a center-to-center length 4.1 times the crankthrow radius to minimize piston side thrust and secondary vibration forces. The designer laughs at any suggestion that his engine can be enlarged 12% in bore and stroke, to provide Indianapolis displacement for incredibly little weight or bulk, yet his denials aren't 100% convincing.

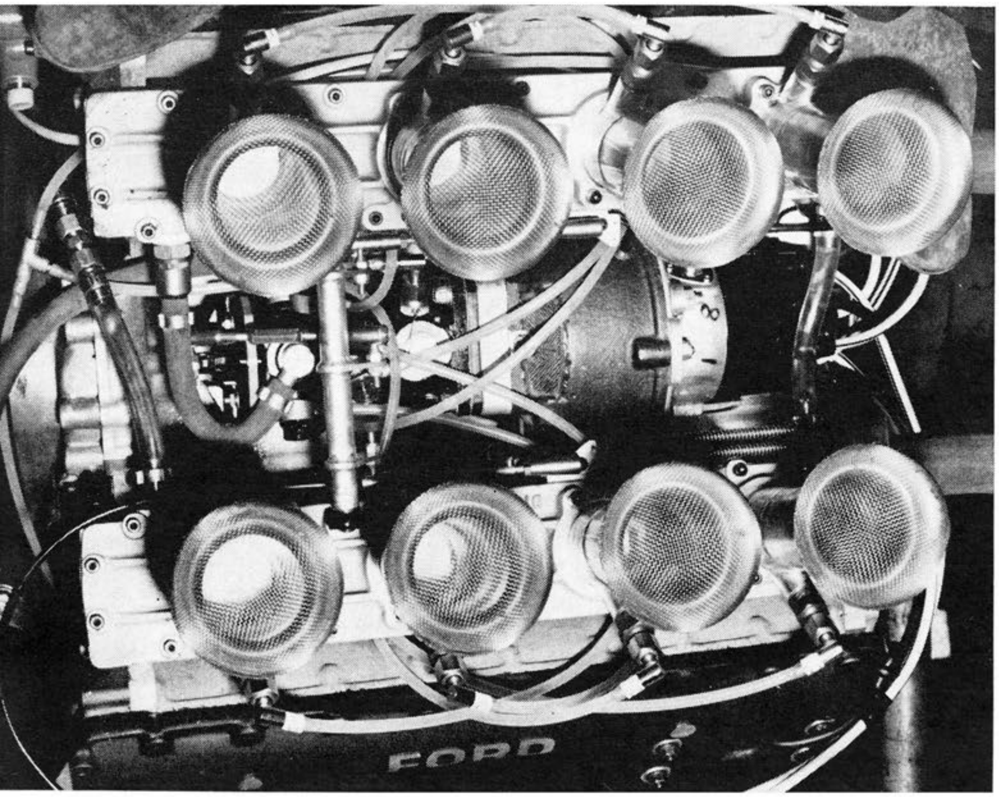
DESIGNER Keith Duckworth, left, discusses FI V-8 with Cosworth director Bill Brown, driver Graham Hill and Colin Chapman.

Horsepower actually is developed by burning a fuel/air mixture inside an engine's combustion chambers. This Ford engine is planned to do this very efficiently. Its double overhead camshaft cylinder heads of aluminum alloy carry four valves per cylinder, to permit entry and exit of plenty of gasoline. The two inlet valves are of 1.35-in. head diameter, the two exhaust valves are of 1.14-in. head diameter, inclined symmetrically at a very narrow 32° included angle, in shallow pent-roof combustion chambers. With four valves per cylinder, plenty of gas flow into large-bore cylinders is obtained, with only sufficient valve inclination to hold tappets clear of centrally placed 10-mm spark plugs. Whereas the usual "hemispherical" heads require filling with domed piston crowns if they are to have high compression ratios, this Ford produces 11:1 compression with flat-topped pistons, slightly recessed for valve clearance.

FROM THE displacement of 182.6 cu. in., good breathing and combustion, plus minimum friction loss should insure a torque of about 270 lb.-ft. at 7000 rpm, and a peak power output of approximately 410 bhp at 9000 rpm. These are the figures expected from the first engine. With development, the other five units under construction should exceed this performance.

Each aluminum cylinder head of the new engine is a casting of only 3.765-in. depth. Superimposed on this, a separate cam carrier casting incorporates the guides for 16 piston-type tappets, and five bearings each for inlet and exhaust camshafts that act directly on these tappets. Above the cam carriers, there is only a very shallow cover plate to enclose the pair of camshafts. No gaskets are used between the cylinder block and heads. Bores and cooling water passages are sealed by recessed O-rings.

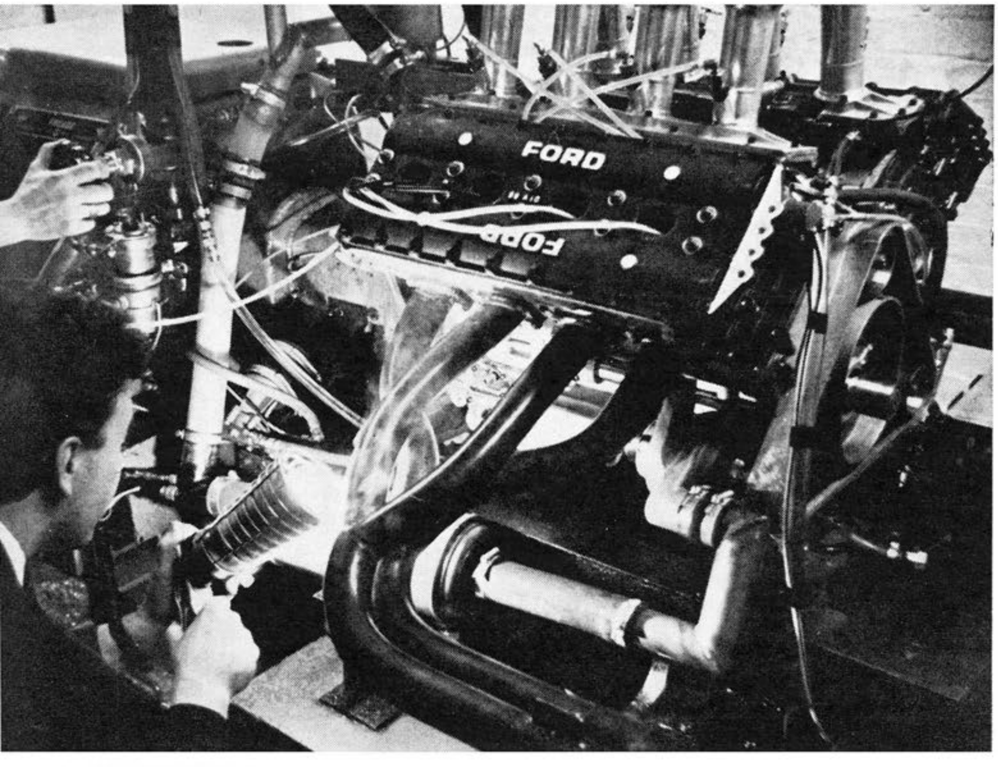
Much the most orthodox part of the Ford engine is its aluminum cylinder block casting, which extends downward only to the crankshaft centerline. Individual wet cylinder liners of 3.375-in. bore are pressed into place, located by top flanges and with O-ring coolant seals at the lower ends. A "flat" crankshaft with hollow crankpins has its four throws in a single plane, so that each bank of cylinders can have its own simple and effective 4-cyl. extractor exhaust system. Piston stroke is 2.55 in., giving a stroke/bore ratio of 0.756:1. ▶



INJECTION system feeds eight downstream pointing spray nozzles, metered by distributor-gear-driven shuttle unit.

FORD

PROTOTYPE engine swallowed a valve spring at 8000 rpm after reaching 400 bhp at 8750 rpm during dynamometer tests.



Design of the lower half of the crankcase, a mere 5.25 in. deep from the crankshaft centerline to the lowest point on the engine, is unconventional in that caps for five shell-type main bearings are integral with the aluminum casting. This makes engine assembly a skilled job, but is fully practical on a racing engine, the ten bearing cap bolts quite separate from flange bolts closing the crankcase periphery. Internally, the shallow crankcase has been very carefully streamlined, and provided with drains to permit two scavenger pumps to effectively clear the "dry sump" of oil.

As a structural part of a rear-engined, single-seat car, this Ford engine is designed so that its forward end bolts onto a bulkhead behind the driving seat and central fuel tank, and so that independent rear wheel suspension links and spring/damper struts bolt onto its rear end. Four front mountings are provided, two on the crankcase lower half and two on forward extensions of the valve gear covers. Rear suspension pickup points are on the cylinder block casting and on rear extensions of the camshaft carrier castings on top of the cylinder heads.

With forces applied high up and low down on both ends of the engine, interfaces between castings carry structural stresses, but clamping forces needed to carry engine internal loadings are ample to prevent movement at metal-to-metal joints. Some local stiffening of castings has, however, been provided, to spread the structural loads through the engine from their points of application. In the base of the crankcase lower half, two longitudinal tubes and a transverse tube have been formed. Each camshaft carrier casting has a longitudinal tube formed along its center, pierced by holes for access to the 10-mm spark

TECHNICAL SPECIFICATIONS

Type, no. cyl.	90° dohc V-8
Bore x stroke, in.	3.375 x 2.550
Bore spacing, in.	4.125
Displacement, cu. in.	182.6
Compression ratio	11:1
Rated bhp @ rpm	410 @ 9000
Rated torque @ rpm	270 @ 7000
Valve operation: By piston tappets from two gear-driven overhead camshafts per cylinder bank; four valves per cylinder.	
valve dia., int./exh.	1.32/1.14
valve included angle, deg.	32
Piston speed, fpm/9000 rpm	3825
Firing order	1-8-3-6-4-5-2-7
Flywheel dia., in.	9.7
Clutch, twin plate, dia., in.	7.25
Ignition: Coil, with magnetic distributor pickup and transistor amplification.	
basic timing, deg. BTDC	35
alternator capacity, amps	9
spark plug dia., mm	10
Fuel system: Timed pulse injection into intake ports by electric and mechanical pumps.	
fuel supply pressure, lb./sq. in.	100
Length, in.	21.45
Width, in.	27.00
Weight, with clutch, lb.	370

plugs. Making the engine serve as a structural member, involves extensive extra thinking at the design stage, but not much extra metal on the engine.

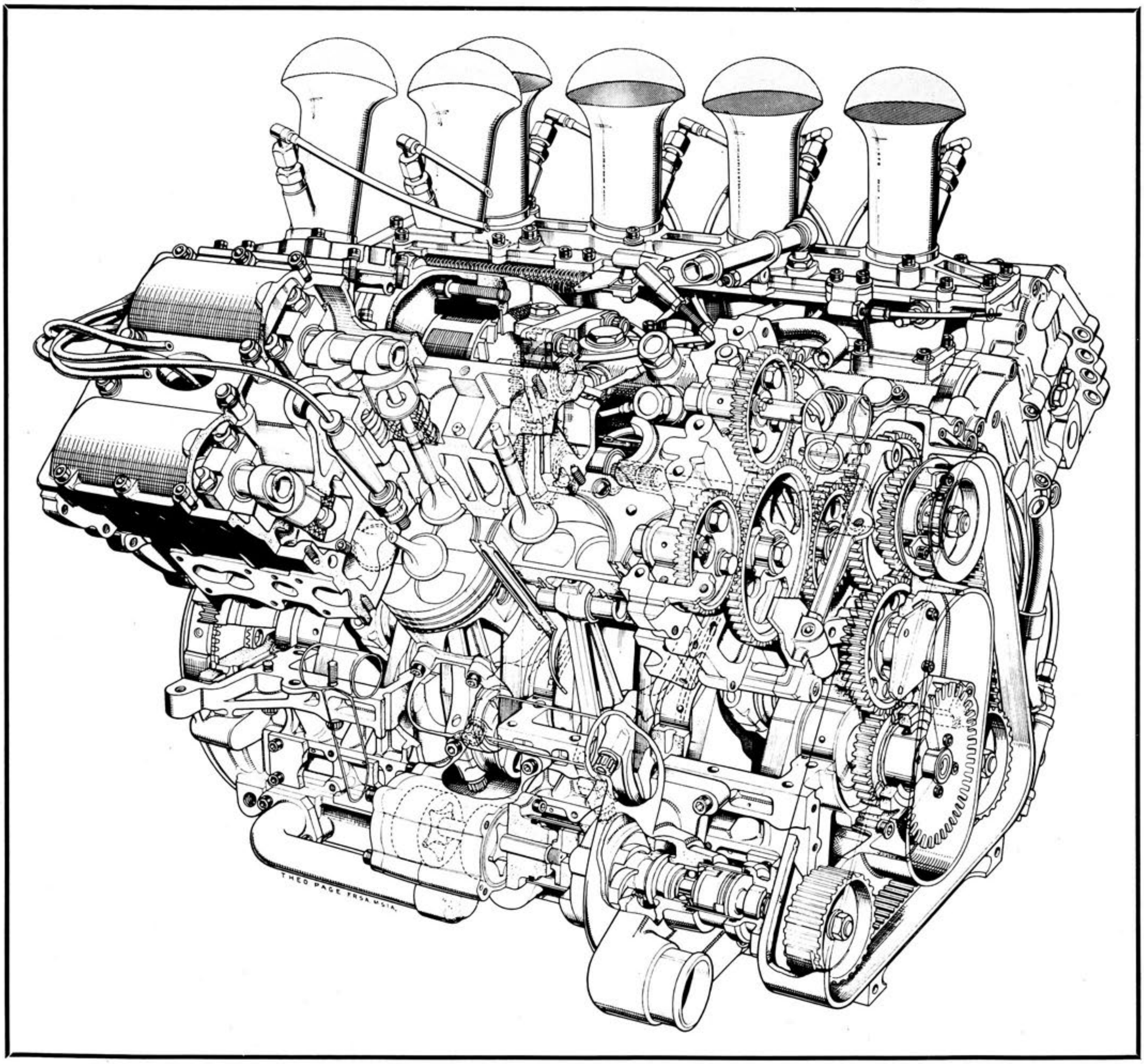
Although planned as part of an extremely slim car, the Ford GP engine has been arranged for extreme shortness, rather than to be exceptionally narrow. Camshaft covers determine engine width and, this engine being a structural unit that does not require box-section or tubular frame alongside it, all auxiliaries have been packed neatly into available spaces, at each side of the crankcase and between the cylinder heads.

In a line between the two heads of the V-8 engine there are the Lucas fuel injection metering unit, a 9-ampere alternator and the Lucas electronic ignition system's distributor unit, all on a shaft driven by gears at half engine rpm. Low at each side of the crankcase are an oil pump unit and a cooling water pump. Each coolant pump serves its own half of the engine, whereas one oil pump is the pressure supply and the other a duplex scavenger pump drawing from the two ends of the crankcase.

ALL THE AUXILIARIES are driven from the nose of the crankshaft, where there is a train of three gears to the half-speed shaft above the crankcase centerline. From this shaft separate trains of gears extend laterally to drive the two overhead camshafts on each cylinder head. The gears to the right hand camshaft are behind the other pair to take advantage of side-by-side big end bearings which require the right-hand cylinder block to be 0.8 in. behind the left-hand bank. Actually encircling the gear drive to the half-speed shaft is an internally toothed cog belt, triangulated to drive the lubricating oil and cooling water pumps alongside the base of the engine.

Ford's Formula I engine is a bold venture in several respects. Its sponsor, which has gained a reputation in European racing circles for buying success, now is attempting to beat complex machinery with something intelligent and simple—a gesture in the best traditions of old Henry Ford! Keith Duckworth as the designer has almost uninterrupted success with the various 4-cyl. Cosworth racing engines for which he has been responsible, but this is his first venture into the Grand Prix world. Neither the sponsor of this engine nor its designer will regard anything less than a World Championship as representing success for the project! ■

FOUR VALVES per cylinder are inclined at 32° included angle in pent-roof combustion chambers. Separate cam carrier castings are superimposed on aluminum head casting. These incorporate guides for 16 piston tappets and five cam carrier bearings each.



SUSPENSION

Part 2: Handling, or Understanding Understeer/Oversteer

BY JON McKIBBEN

HANDLING CERTAINLY is a misused, abused term in the language of automobilia. Wherever enthusiasts gather, a discussion develops around the handling of various vehicles. It soon becomes evident to one involved in such a discussion that handling means many things to many people.

Starting a discussion on handling is akin to sitting down to a poker game among strangers. Ground rules must be established. In analyzing handling, these rules are definition of terminology. Competent suspension engineers often disagree on terminology, so the ensuing discussion and definition should not necessarily be considered universally accepted. It is necessary, however, to define terms as used herein. Thorough understanding of principles as defined will permit application of these principles to any author's terminology.

Though frequently used by sporting motorists, understeer and oversteer are terms clouded in misunderstanding. Because these terms describe a phenomenon normally sensed by the driver's posterior, relation of theory to actual vehicle performance must be subjective. Theoretical discussion can, however be precise for a given set of definitions.

A violently descriptive analogy usually attributed to race drivers provides some clarification. "Cars that understeer go through the fence nose first, and cars that oversteer go through tail first." Less dramatic and more accurate is the definition graphically presented in Figure 1. Understeer results in the necessity for application of more steering lock (greater degree of steering wheel turn) as car speed increases around a constant radius turn. Oversteer results in less steering lock requirement as speed increases.

At the risk of introducing a "confusion factor," the relationship between transient and steady state conditions bears investigation. While it is necessary to use steady state conditions for detailed analysis of suspension system performance, the situation typically encountered by drivers is a series of transients.

Briefly, transient conditions are those encountered upon initial movement of the steering wheel. Steady state conditions are those arrived at in the proverbial long, sweeping curve. Long, sweeping curves, particularly of relatively constant radius, are extremely rare. Thus, a driver is generally operating in a continuous series of transients when traversing city streets or country roads.

Handling performance during transient conditions is significant because an automobile may create a different driving impression during transient periods than during steady state situations. Automobiles are produced today that give a definite feeling of oversteer with substantial application of initial steering lock, yet understeer under steady state conditions, near the limit of adhesion. These handling characteristics have little bearing on theory, but are mentioned to caution the reader in his attempts to apply theory to actual vehicle performance. Many enthusiasts, automotive engineers included, have mistakenly assigned basic handling characteristics to automobiles when actually describing transient performance. When defining transients, define them as transients! Beware of the statement, "This car oversteers," unless all qualifying conditions are specified.

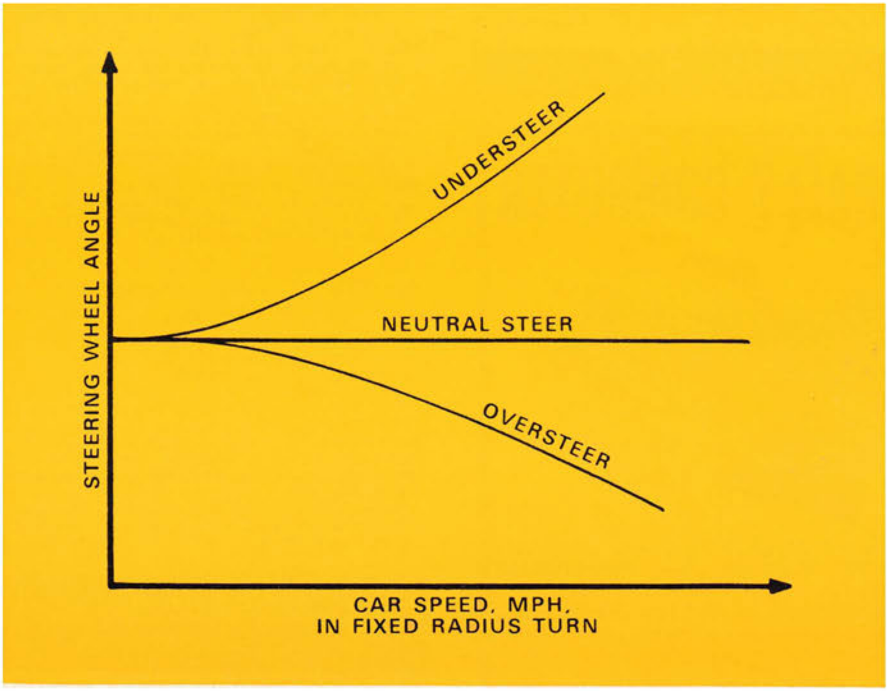
IN THE ARTICLE on ride control (*CL*, July '67), tires were considered only with regard to their spring rates. Before proceeding with a discussion of handling, tires must be viewed in a different light. All suspension system modifications and the majority of vehicle design parameters are based upon known tire characteristics.

Figure 2 shows deformation of a conventional tire during cornering. The right figure is a front view, the left is a view upward through a "glass roadway." Slip angle is defined as the angle between tire heading and vehicle direction. It is helpful to visualize this angle as the degree of steering "over-turning" required to force the car into a given heading.

Basis for 90% of all handling considerations is presented graphically in Figure 3. The convex shape of cornering force to vertical tire load curve dictates two restrictions fundamental to suspension and vehicle design:

1. Two equally loaded tires can develop more cornering force, at a given slip angle, than can unequally loaded tires supporting equivalent total mass.
2. Overloading decreases cornering

STEERING LOCK variation with vehicle speed increase as automobile negotiates constant radius curve is shown in Fig. 1.



power, while underloading increases cornering power.

Armed with this knowledge, the next step is to establish criteria for maximum roadholding. Maximum cornering power on a perfectly smooth roadway is generated by a vehicle with rigid axles which mount large, lightly loaded tires. Center of gravity of the vehicle should be at ground level, and weight distribution should be equal, front to rear and side to side. Tires must be held perpendicular to the pavement at all times.

THIS VEHICLE would develop minimum weight transfer to outboard tires during cornering and would maintain vertical loadings low on the characteristic tire curve, Figure 3. Such a car requires no suspension system whatsoever. Obviously, this automobile is impractical for passenger car use. It is impossible to construct a vehicle with center of gravity at ground level. Also, roads never are completely smooth. Some type of suspension system certainly is necessary if ride-control requirements are to be met.

Perhaps the most significant departure from the aforementioned ultimate cornering vehicle is tire loading found in typical passenger vehicles today. Highly loaded tires cause great losses in cornering power, as seen in Figure 3. These losses are not without gains, however. Highly loaded tires yield superior ride quality due to large static deflection and developing power. More obvious reasons for small tires are low cost and space limitations.

Ride quality, shimmy control and major component location in modern automobiles has made independent front suspension mandatory. This points up another compromise because no form of independent suspension can provide smooth road cornering power equivalent to rigid axles. This statement may appear absurd, in view of universal adoption of fully independent suspension in modern racing vehicles, but is nonetheless true.

Tire contact maintenance is the primary reason for racing car suspension systems. However, latest racing tires are extremely wide, with wide thread contact at the road surface. These tires are much more susceptible to camber change than previous narrow tires, and may force designers to return to solid axle suspension systems for proper tire/road relationship.

Handling characteristics are analyzed based upon slip angle effects. For example, a nose-heavy automobile imposes higher vertical loadings on front tires than on the rear. Therefore, tire characteristics imposed by Figure 3 dictate greater slip angles at the front. This results in understeer. Similarly, vehicles with rearward weight bias require greater rear slip angles, normally resulting in oversteer.

Understeer and oversteer are the major conditions in defining directional stability, which generally is discussed with respect to ability of a vehicle to maintain a straight course on a straight road. This term does, however, apply to stability of a vehicle in any circumstance, including curve negotiation. Typical domestic automobiles exhibit understeer in varying degrees, from pleasant and confidence-inspiring to unacceptable plow. Reasons for domestic attitude toward oversteer are largely founded upon inherent stability considerations.

Assume that an automobile with basic understeer enters a given curve at speed slightly over that at which it is capable of negotiating the curve. As front wheels lose traction, and front wheels will lose traction first if the vehicle understeers, the automobile begins to slide toward the outside of the curve. Increased steering lock results in much of the excess speed being scrubbed off by front tires sliding across the pavement. If car speed remains too high, removal of power and

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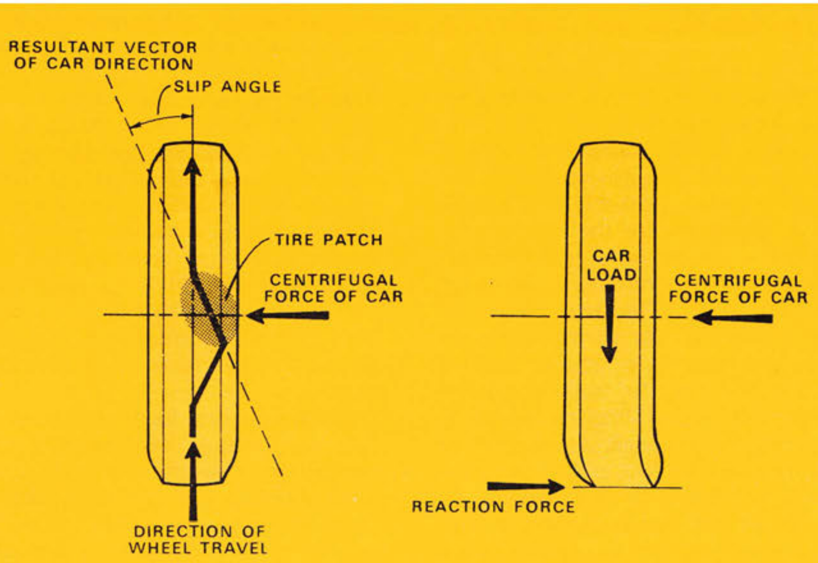
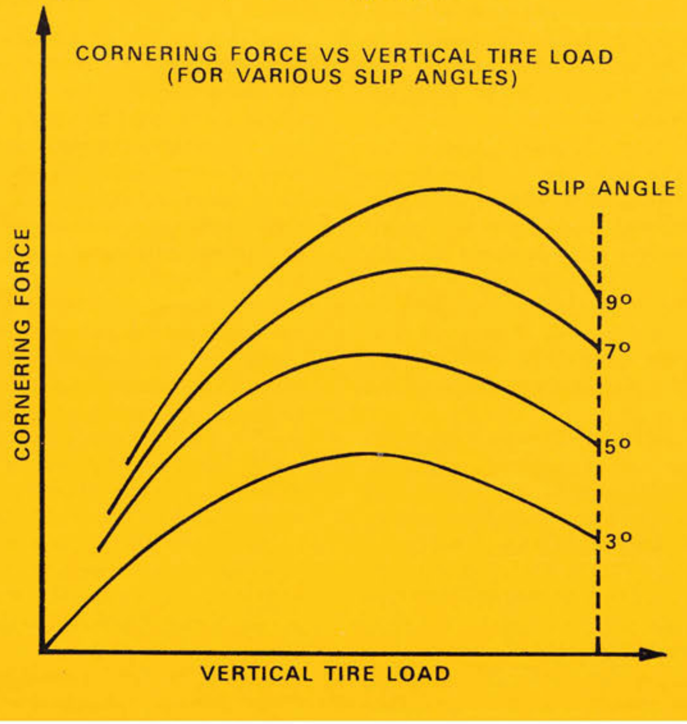


CORNERING FORCES deform tires as illustrated in Fig. 2, generating slip angle between vehicle direction and tire heading.

CHARACTERISTIC TIRE curve, Fig. 3, shows vertical load to cornering force relationship for several slip angles.



moderate application of brakes results in the vehicle continuing its slide toward the outside of the curve. Assuming initial speed was somewhere near the limit for negotiation of the curve, it is quite possible that the driver will be able to regain control before he runs out of road. Throughout power removal, brake application, and steering lock application, the vehicle has maintained a stable, forward directed attitude.

ASSUME THE set of conditions just mentioned are imposed upon a vehicle with basic oversteer. Excessive speed now results in loss of traction at the rear wheel. The driver, sensing this excessive speed, probably will release power application to the rear wheels. This causes weight transfer to the front end of the automobile. Reducing weight applied to the rear wheels removes some of the normal force on them and results in greater loss of traction, the result of both weight removal and engine braking added to cornering tractive load. As rear wheels lose traction, the rear end of the automobile will begin to slide toward the outside of the curve. Application of full power, contrary to popular belief, also will result in a loss of rear wheel traction, because the tires cannot deliver accelerative thrust in addition to maintenance of cornering traction demands.

In all cases, attempts to recover an oversteering car by any method other than to maintain road load power just sufficient to hold constant speed, and to steer into the slide while using all available room, is likely to result in a complete spin. Primary reason for this behavior is, of course, that an automobile with front wheels sliding is still directionally stable, and will maintain a relatively straight-ahead attitude. An automobile with rear wheels sliding is termed spin-unstable. That is, rear wheels cannot provide directional control, and the automobile will spin due to the effect of centrifugal force on the center of gravity.

Oversteer is, then, undesirable from the standpoint of recovery after inadvertently exceeding speed limitation on curves. Oversteer can, however, be desirable for negotiating low-speed curves. Experienced racing drivers often prefer a car that oversteers at low speeds, because the ability to slide the rear end of a vehicle around is useful in achieving maximum cornering speeds. Many of the world's competent race drivers, however, demand a car that understeers at high speeds, for the reasons noted above. Attempting to recover from an oversteer slide at 150 mph can be a harrowing experience, if not a fatal one.

Weight distribution is the major deciding factor in under/oversteer determination. There are refinements that can alter this relationship, and these will be investigated next. Many station wagons, particularly with a moderate rear compartment cargo load, are tail heavy. Thus, suspension system modifications are in order to insure against undesirable oversteer.

Best known of all handling control devices on modern automobiles is the antiroll bar. As noted last month, the antiroll bar's primary function is maintenance of relatively level body attitude during cornering, without excessively stiff spring rates. Antiroll bars also affect handling by altering roll stiffness at one end of an automobile relative to the other. Increasing roll stiffness induces greater side-to-side weight transfer at the end of a vehicle, raising the proportion of weight carried by the outboard wheel in a curve. This means that installation of a front antiroll bar will increase oversteer tendencies.

Tire pressures have significant effect on handling characteristics. Reducing tire pressure effectively lowers load carrying capacity of a tire. To promote understeer, then, front tire pressures are reduced with respect to rear, causing front tires to require greater slip angles. Readers should note this tire pressure effect, since it provides the enthusiast with an easy means of handling characteristic alteration.

FRONT SUSPENSION geometry of most domestic passenger cars is designed in such a way that the outboard front wheel leans with the body in cornering, assuming a positive camber angle. This causes reduction in cornering force generated by the tire, compared with forces generated by the same tire if perpendicular to the pavement, and promotes understeer.

Roll steer is another of the suspension engineer's tricks. Rear wheels are positioned by members located to cause the wheels to move fore and aft in jounce and rebound. If roll understeer is desired, the wheel forced upward in cornering moves forward, while the inboard wheel moves downward and shifts rearward. Rear wheels tend to steer the car out of the turn, resulting in understeer.

Toe steer is a phenomenon obtained by designing dissimilar geometry into tie rods and suspension members. "Tie rod interference" occurs as wheels move through jounce and rebound, steering front wheels a small amount as suspension travel occurs. Again, either under- or oversteer can be obtained, but the amount is limited to avoid wheel-fight over bumpy roads.

The roll center of a front or rear suspension is a geometrically determined point about which the body rolls. This point is determined by extending imaginary lines through pivot points of suspension members to locate the center of a circle along which wheel motion occurs in jounce and rebound. In general, the higher the roll center (up to the height of the car's center of gravity), the less roll will occur for a given lateral force caused by cornering. Raising the roll center will normally increase load transfer, and affect handling in a manner similar to adding an antiroll bar.

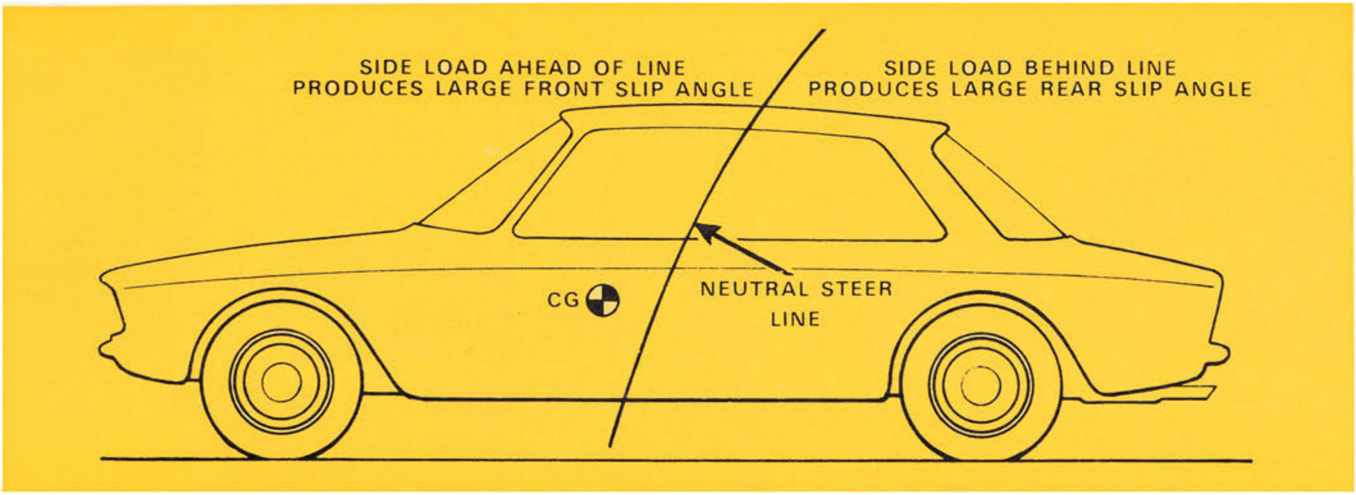
SPRING RATES, considered only as affecting ride quality last month, also are used to vary handling characteristics. Spring rate effects are much the same as the effects wrought by antiroll bars or roll center heights. Increasing front spring rates while retaining the same rear spring rates promotes understeer by increasing weight transfer at the front end during cornering.

All vehicles have neutral steer lines. This line is shown in Figure 4 as applied to an arbitrary example vehicle. Summation of basic vehicle parameters including weight distribution, suspension geometry, spring rates, etc., results in determination of a line, in side view, along which force applied has no effect on directional attitude. Cornering forces are considered as acting on the center of gravity. Thus, if the neutral steer line passes through the center of gravity, neutral handling results. Center of gravity location ahead of the neutral steer line dictates understeer, and location behind neutral steer line dictates oversteer.

Center of pressure is an aerodynamically determined point at which wind force on the side of a vehicle is concentrated for analytical purposes. Effective center of pressure is located based on shape and aerodynamic resistance of an automobile's body shell. This point generally falls near the front wheel opening in conventional sedan configuration.

Moving center of pressure rearward is beneficial due to the resultant decrease in moment arm to the neutral steer line. Center of pressure movement may be accomplished by increasing body profile area at the rear of car and decreasing area at the front. Tail fins, though subjects of ridicule for styling effects, are beneficial in rearward movement of effective center of pressure.

As is the case for cornering force



LOCATION OF neutral steer line and center of gravity are shown in Fig. 4 as on a typical front-engined sedan.

inputs, wind forces will be exaggerated or de-emphasized by basic handling characteristics of the vehicle. Understeer is desirable to minimize wind wander. The worst possible vehicle for directional stability in side winds is one with forward center of pressure location, center of gravity near the rear, and neutral steer line just ahead of center of gravity.

One other function of suspension, while not affecting handling in the strict sense of the word, is attitude control during hard acceleration and deceleration. Live axle rear suspensions are forced to react to drive train torque inputs. In domestic automobiles, engine rotational direction results in drive line torque removing load from the right rear wheel during acceleration. This phenomenon is well known by top drag race competitors, who vary pressures from side to side attempting to equalize traction of unequally loaded tires. In Chrysler Corp. automobiles, the left front torsion bar is adjusted to raise static height on that side. This throws a larger proportion of vehicle weight on the right rear wheel in static attitude. Thus, on acceleration, torque reaction force will equalize rear tire loadings.

AXLE CONTROL is necessary to control the rotation of the rear axle assembly caused by reaction to tire contact thrust. Acceleration causes the front of the differential assembly to be forced upward toward the vehicle floor pan. This motion must be limited by either leaf springs, control arms, or auxiliary "traction bar" type devices. Reaction to driving thrust can be utilized to control vehicle attitude during acceleration. Torque reaction causes an upward force at the rear spring front eye. By properly positioning the front leaf spring eye, or effective pivot point of control arms in a link-coil system, squat or rise of the rear of a vehicle may be controlled. Generally, raising this point results in more rear end rise in acceleration, and more squat during braking.

FRONT-END rise on acceleration is unavoidable, because inertia forces acting on the center of gravity always result in weight transfer from front to rear. By locating rear suspension front pivot points so as to provide slight rise at the rear during acceleration, much objectionable vehicle attitude change is avoided. The vehicle simply rises at each end. Rear rise during braking is another consideration of rear spring front pivot location. Because one suspension system must suffice for both braking and acceleration, system moment center generally is located to provide slight rear rise in both acceleration and braking.

Front suspension design must control "nose-dive" during hard braking. Again, it is possible to locate geometric center of motion to provide anything from severe dive to actual rise during deceleration. However, other suspension requirements, such as ride and handling, generally dictate a configuration that allows slight dive under moderately hard braking.

Design of what have come to be popularly known as "weight transfer bars," actually is a very exacting task. For such devices to perform with maximum effectiveness, it is necessary to relate auxiliary bar pivot points to effective pivot points of the existing suspension system. This is almost never done by drag racers. The fact that most extremely long, rear-to-front of car girder-like bars, often seen on many Gas class drag race machines, do not result in terrible overall performance is a vivid demonstration of the essentially rigid suspension of such vehicles. Fortunately, such machines need not ride comfortably or negotiate winding roads. Most of these control arms have no effect on weight transfer characteristics, but may improve traction on takeoff by eliminating adverse axle windup and resultant wheel hop.

The almost invincible Chrysler Corp. Super/Stock drag race cars of 1963-64 were known for impressive initial acceleration. The best of these vehicles had no traction bars fitted, relying instead upon rear leaf springs with carefully calculated rate and load characteristics.

To reiterate, handling eventually relies upon subjective human evaluation. Suspension design is based on calculation involving theoretical considerations briefly discussed herein. Finally vehicle handling characteristics are determined by modifications indicated by test driving, employing aforesaid techniques to alter directional stability properties. All suspension modifications must be analyzed with respect to effects on tire slip angle.

GENERALLY, HANDLING characteristics are varied by altering lateral weight transfer at one end of an automobile. Antiroll bars are used at the front of many domestic automobiles to promote understeer. Rear antiroll bars are added to certain racing machines to raise rear slip angles relative to front, increasing oversteer (or decreasing understeer, depending on degree of effectiveness).

Next month, a wide variety of suspension system designs, both past and present, will be analyzed to determine relative merits and handicaps. Investigation of currently popular systems will emphasize individual performance attributes contributing to noted popularity. Future design trends will be explored, primarily as affected by modern vehicle requirements. ■

AUTOS ABROAD: HERON HEADS

REAR-ENGINED cars have not yet lost favor in Europe, as they have in Ralph Nader country. However, as new models come along, familiar examples of the rear-engine principle may disappear. Exaggerated sensitivity to gusty cross-winds is more difficult to eliminate than the once-troublesome lack of cornering stability.

Stylists, when face-lifting a design, tend to conceal the fact that it is a rear-engined car. The new Hillman Husky station wagon, based on the Sunbeam Imp, is a prime example of this. Tilted to its right and with manifolds below the aluminum cylinder head, the sohc engine is quite low. Thus it has been possible to install a luggage deck only 27 in. above road level.

WHEN SAAB of Sweden introduced German Ford V-4 engines as optional alternatives to its own 2-cycle engines in front-drive sedans, doubts arose about a proposal for Triumph to build Ricardo-designed Saab engines in England. Apparently that Anglo/Swedish project involves larger cars than make up the present German/Swedish range and is progressing toward 1968 production.

Promised for this fall is another long-awaited model, the V-8 engined Rover 2000 sedan, which may carry an Alvis nameplate. Tooling for the aluminum V-8 engine was taken over from General Motors. Competition drivers who have tested prototypes say that doubled piston displacement actually improves the car's handling. Another bit of pioneering expected from Rover is a safety seat. This unit is to be mounted as a strong part of the car's structure. Safety harness is designed to retract neatly when passengers step from the car.

THOUGH THE name "Heron head" comes from an American research worker, it is in Europe that flat-faced cylinder heads above bowl-in-piston combustion chambers are making news. Rover uses the idea on its 2000 engine. Ford applies it to V-4 and V-6 engines built in Britain. Maserati is adopting the idea for racing, following its successful use on Cosworth competition engines. And a works-backed Morris Mini-Cooper sedan with a Heron head on its transverse engine has raced at Silverstone.

Race engine designers nowadays expect every fraction of a square inch of cylinder head surface to do something useful. There are four valves per cylinder on Eagle V-12 and Cosworth-Ford V-8 Grand Prix engines. These fill most of the available area, but leave room only for a tiny central spark plug. Ferrari is racing with three valves per cylinder, two inlets plus one larger exhaust. The two spare head areas for each cylinder are filled by dual ignition spark plugs, one at each side of the internally cooled exhaust valve.

Modern engine operating speeds seem to preclude revival of a fascinating idea, used with great success on Gnome "monosoupape" rotary aero engines in World War I. Those engines had each cylinder head's surface covered by one huge exhaust valve. Small quantities of very rich fuel/air mixture were admitted to each cylinder through the crankcase and a valve in the piston crown. The exhaust valve, which vented directly to the atmosphere without piping, remained open after the exhaust stroke to let pure air into the cylinder during the inlet stroke. This wasn't just an insane idea, it was an operational fact in one of the best engines of a half-century ago.

AUTOMOBILE MANUFACTURE has not been a tremendously profitable business in Europe recently. Some plants have expanded output without managing to increase total profit. Others seem to suffer alternately from labor troubles and a scarcity of buyers. For example, the first report to stockholders since Jaguar was merged with British Motor Corp. showed a group loss of some $20 million. Ford has reduced production rates on its largest British models and has delayed opening new plants in Germany. Restrictions on international trade become fewer each year. Thus, as markets become less sheltered against imports, Europe seems likely to concentrate its car production in fewer and fewer plants. Japan's graduation from major builder and user of motorcycles to major builder and user of cars is costing the European factories export sales.

—Joseph Lowrey

THIS REAR-engined car, the new Hillman Husky, displays the profile of a front-engined car. Slanted sohc engine installation permits cargo deck to be only 27 in. above road level. Fuel tank, spare tire and wheel, and a small additional luggage space are located forward.