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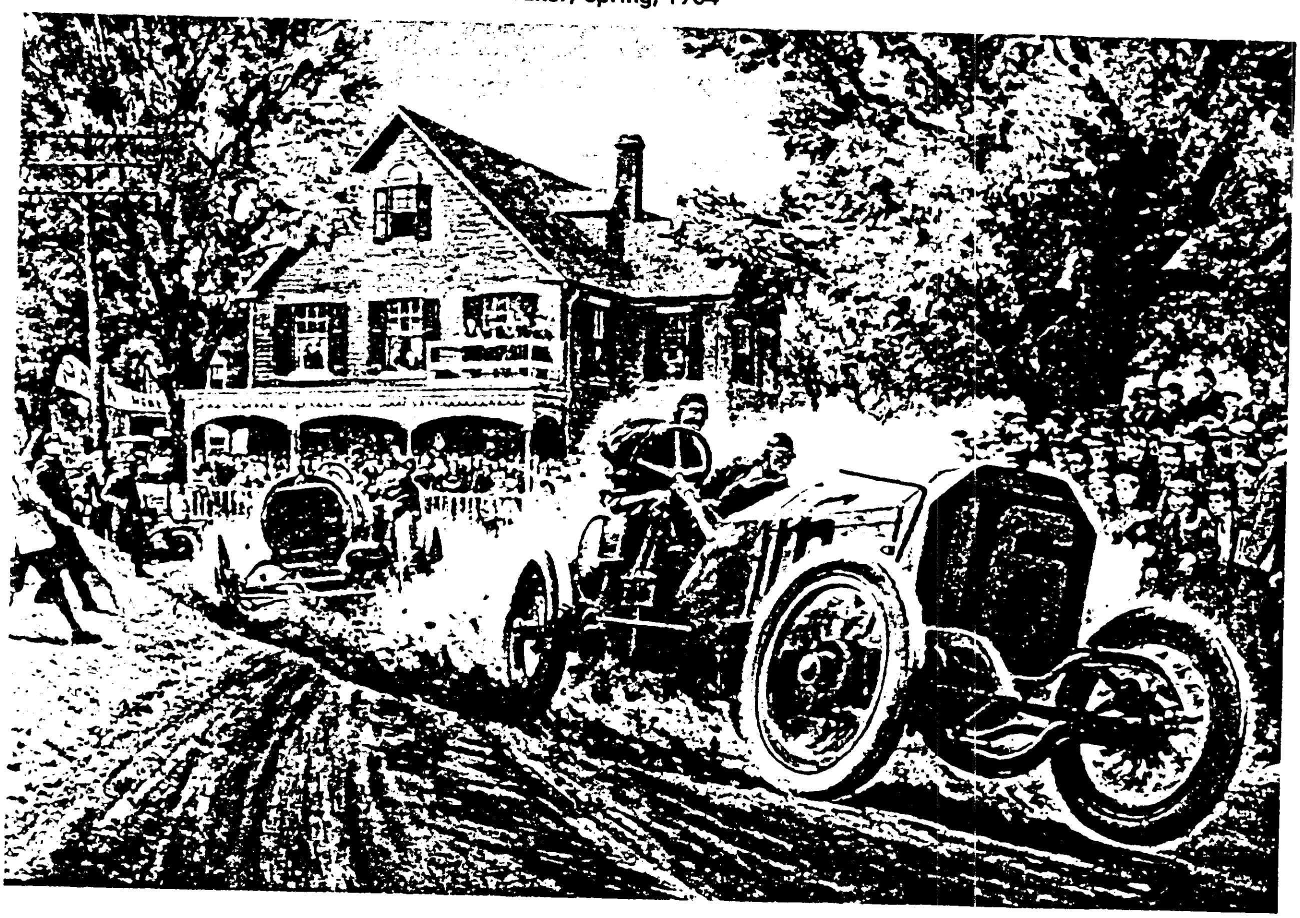
THE FORD GT SPORTS CAR

by
ROY LUNN
FORD MOTOR COMPANY

Painting by Peter Helck, AUTOMOBILE QUARTERLY, Spring, 1964



INTRODUCTION

The origin of automobile racing cannot be established easily, but it can be assumed that it all started with the build of the second car. In studying the history of racing, it becomes apparent that the emotions that generate the desire to invent and create are synonymous with the desire to demonstrate the results of creative efforts in open competition. Conversely, the desire to win also has generated technical advances which have contributed to, and accelerated the evolution of the present-day passenger vehicle.

Although modern industrial methods have devised other systems for developing products, racing still provides a unique opportunity for the exploration of new ideas and materials. To keep abreast of competition and meet a racing schedule necessitates quick model turnover, and, because this type of work is executed by small groups, the individuals involved develop a wide versatility of skills and experience relating to total vehicle concept and development.

The major advantages of the racing program can, therefore, be summarized as follows:

- The main line product benefits from the development and usage of new ideas and materials.
- The engineers are afforded a wide range of experience in a concentrated time period.
- An excellent promotional medium is provided by demonstrating products in open competition.

It was with this foregoing basic philosophy that Ford Motor Company, in 1962, re-entered racing in the fields of stock, drag, and rallies and made plans for participation with Ford power at Indianapolis. Early in 1963, the decision was made to extend Ford's participation in competition to the highly sophisticated form of road racing known as GT sports. This arena of racing had been dominated by European manufacturers whose vehicles, over decades, had reached an extremely high state of technical development. Such famous marques as Bentley, Talbot, Lagonda, Aston Martin, Mercedes and Ferrari had figured prominently in the sport, while American efforts were left largely to individual enthusiasts.

The decision to enter this highly developed form of racing was influenced not only by the technical challenge involved but also by the fact that the cars had to be road-legal and raced mostly on commercial highways, such as the Le Mans circuit in France. Consequently, GT sports vehicles are closely allied to normal passenger vehicles and encounter all the problems of highway driving including handling, driver environment, braking, stability and safety. The main difference, however, is that under racing conditions these problems are accentuated, thus providing an excellent development ground for new techniques and innovations.

In the early stages of the program, consideration was given to acquiring an established builder of GT cars, but it was finally decided to create a unique Ford vehicle to challenge the established European supremacy in this form of racing. This paper, therefore, has been prepared to provide the automotive profession with an account of the conception of the Ford GT and its evolution leading to the victory at Le Mans in 1966.

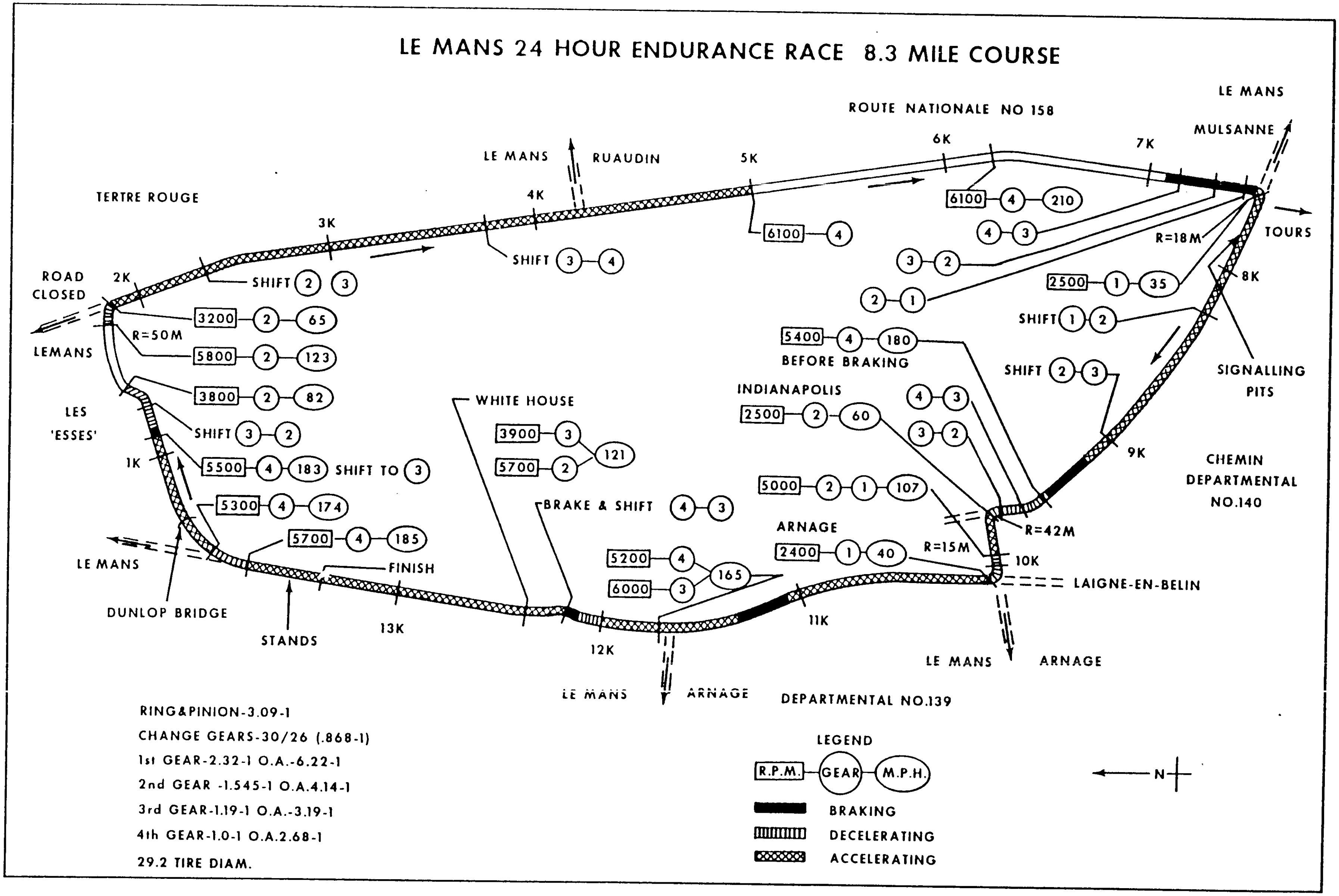
THE TECHNICAL CHALLENGE

Like most product programs, the design and performance objectives for the Ford GT project were largely established by the status of the leading competition. It was evident, from an analysis of competitors in 1963, that top speeds in excess of 200 mph, average laps of more than 130 mph, and durability to sustain an average of more than 120 mph for 24 hours would be necessary to compete successfully at Le Mans in the ensuing years.

The racing objectives were also established. They required the cars to be potential winners in the long-distance races such as Daytona, Sebring, Spa, Nurburg Ring, Targa Florio, as well as Le Mans, and to be capable of winning the FIA World Championship for this type of vehicle. Added to these targets was the timing objective that required the cars to be racing within one year of starting the program.

Attempting to meet these objectives was a scintillating technical challenge, particularly starting from scratch; whereas, competition had reached its sophisticated product level after nearly 40 years of evolutionary development. It was therefore considered necessary to pursue a highly analytical approach to the design in its concept stage rather than rely on evolutionary development.

The magnitude of the engineering problems involved may better be appreciated by a look at the conditions that exist on a race track such as Le Mans. Figure 1 shows this famous circuit, which is made up of conventional roads that are closed to commercial traffic only for the race in June and a short practice session in April. The cars travel clockwise on this 8.3-mile track and encounter road conditions which test every aspect of a car's capabilities. In the 1966 event, speeds ranged from 215 mph on the main straight to 35 mph on the slowest corner, incurring severe braking, acceleration


LE MANS 24 HOUR ENDURANCE RACE 8.3 MILE COURSE
LE MANS
ROUTE NATIONALE NO 158
MULSANNE
TOURS
LE MANS
RUAUDIN
TERTRE ROUGE
ROAD CLOSED
LEMANS
LES 'ESSES'
LE MANS
DUNLOP BRIDGE
STANDS
FINISH
WHITE HOUSE
BRAKE & SHIFT
INDIANAPOLIS
BEFORE BRAKING
ARNAGE
SIGNALLING PITS
CHEMIN DEPARTMENTAL NO.140
LAIGNE-EN-BELIN
LE MANS
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3800 2 82
5500 4 183
5300 4 174
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6100 4
6100 4 210
4 3
3 2
2 1
2500 1 35
5400 4 180
2500 2 60
4 3
3 2
5000 2 1 107
2400 1 40
3900 3
5700 2
121
4 3
5200 4
6000 3
165
RING&PINION-3.09-1
CHANGE GEARS-30/26 (.868-1)
1st GEAR-2.32-1 O.A.-6.22-1
2nd GEAR -1.545-1 O.A.4.14-1
3rd GEAR-1.19-1 O.A.-3.19-1
4th GEAR-1.0-1 O.A.2.68-1
29.2 TIRE DIAM.
LEGEND
R.P.M.
GEAR
M.P.H.
BRAKING
DECELERATING
ACCELERATING
N

Figure 1

and constant shifting up and down through the gears. Other corners had to be negotiated at speeds up to 175 mph, and there was full power application for the major part of the circuit. The 24-hour duration of the race, with its night-day aspect and varied weather conditions, necessitates a fully-equipped road vehicle in every sense. For reference against the original objectives, the 1966 event was won at an average speed of 126 mph, despite considerable rain, and a new lap record was set at 142 mph.

VEHICLE CONFIGURATION AND PACKAGE

In 1962, a group from Ford Product Research and Styling areas had designed, constructed, and developed the Mustang I sports car (SAE Paper No. 611F). These same personnel were then assigned to the GT program, and the information which evolved from the Mustang I study served as a starting datum for concept work on the GT sports car.

The initial problem was to select a vehicle configuration which was likely to meet the performance objectives and could be packaged within the FIA rule limitations. The Mustang I exercise had clearly shown the advantages of using a midship engine configuration to attain a low, sleek vehicle silhouette. This arrangement also offered excellent weight distribution characteristics and had been well-proven in other spheres of racing, such as Formula I. It was therefore decided to pursue this same configuration for the GT car.

Initial package studies showed that the essential components could be installed in a vehicle silhouette of 156 inches long, 40 inches high (hence the name GT 40), and 95-inch wheelbase, and still meet the FIA requirements. The

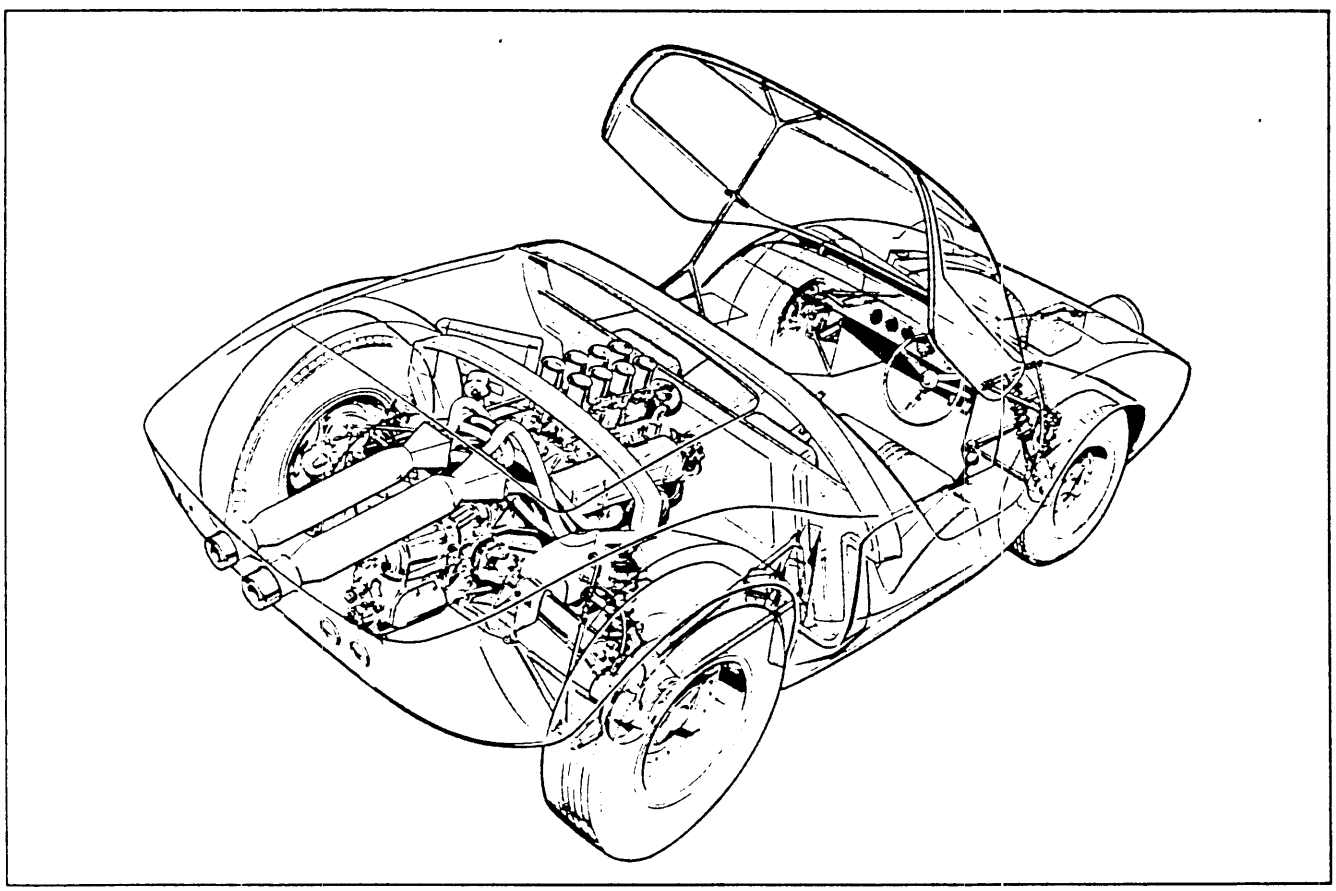

Figure 2 – Original Concept Sketch of GT 40

over-all arrangement included a forward-hinged canopy top; twin radiators located behind the seats with side-ducting; the 256 CID V-8 engine developed for Indianapolis; cross-over tuned exhausts; forward-located spare wheel, oil tank and battery; fixed seats and movable controls; side-sill gas tanks; and, because no suitable transaxle existed within the Company, a proprietary vendor-developed unit was selected. The original sketch showing this combination of ingredients is shown in Figure 2.

Concurrently with package development, a full-size clay was constructed for over-all shape appraisal. The essential requirement was to encompass the basic mechanical ingredients and meet the FIA rule limitations. With these exceptions, however, the choice of shape was largely determined by what seemed right at that time as there was no previous knowledge of road car forms developed for speeds in excess of 200 mph. The result of this original shape study is shown in Figure 3.

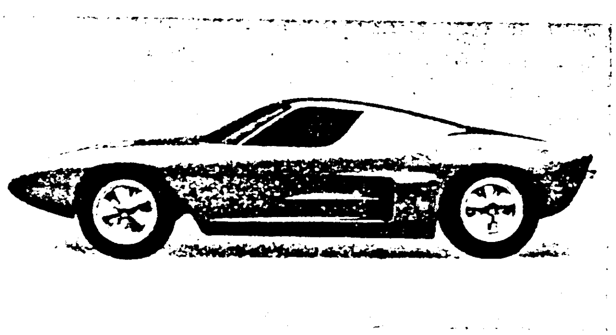

Figure 3 — First Concept Clay Model of GT 40

Subsequent analysis of side radiators showed heat dissipation to be marginal, and a forward-located unit was therefore adopted. The hinged canopy was also dropped in favor of two separate doors in order to clearly meet the FIA rule requirements.

Having arrived at a basic configuration and initial shape, an analysis program was then planned for the following areas:

- Aerodynamics
- Engine
- Transaxle — Driveshafts
- Body
- Suspension — Steering — Brakes — Wheels
- Interior — Driver Environment
- Fuel System

AERODYNAMICS

It was evident from the outset of the project that aerodynamics would play a major part in the program. With the exception of land-speed record cars, no vehicle had been developed to travel at speeds in excess of 200 mph on normal highways. The speeds involved were greater than the take-off speed of most aircraft, but, conversely, the main problem was to keep the vehicle on the ground.

Following initial package and shape studies, a 3/8 aerodynamic model was constructed, and a series of tests were carried out at the University of Maryland wind tunnel (Figure 4). Early tests showed that, although the drag factor was satisfactory, the lift at 200 mph was over half the weight of the vehicle. Subsequent tests with variations of nose height showed the low nose to have some advantage, but lifts were still totally unacceptable. The major improvement came with the addition of "spoilers" under the front end which not only reduced the lift to an acceptable standard, but, quite surprisingly, also reduced drag. A selective summary of these early test figures is shown in Figure 5. It should be remembered that these tests were conducted with a 3/8 model with equivalent speed readings of 125 mph. Results, therefore, had to be extrapolated to 200 mph, and ground effects could not be recorded.

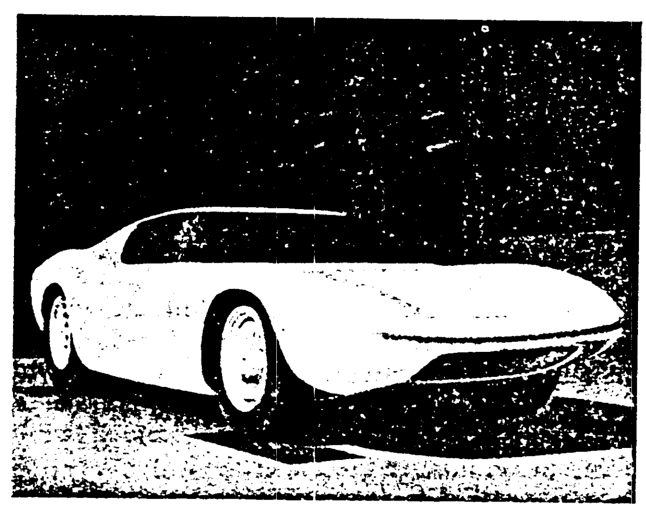

Figure 4 — 3/8 Model in Maryland Wind Tunnel

TABLE OF LIFTS AND DRAGS IN POUNDS

Configuration	Front End Low-Positioned Spoiler	Drag	Lift Front Axle	Lift Rear Axle	15° Yaw Drag	15° Yaw Lift Front Axle	15° Yaw Lift Rear Axle
Basic Car	None	503	528	168	590	768	384
High Nose Shape	None	519	540	108	614	844	362
Low Nose Shape	None	507	445	199	596	704	422
Low Nose Shape	3.50 deep Flat Faired	488	236	272	591	309	343

Figure 5

Shown in Figure 6 are the total drag and rolling resistance curves plotted against available horsepower. This shows that the car should reach approximately 210 mph. In actual fact, the original GT 40's could only reach 197 mph in still air, although they did exceed 200 mph when passing other cars. The reason for this discrepancy was established when the actual prototype was tested in a full-size wind tunnel. It was found that 76 of the 350 horsepower available were being absorbed in internal ducting such as radiators, brake ducts, engine air, and interior ventilation; whereas, only 30 hp had been allowed for these items in the original calculations. Another item which did not show up in these early wind tunnel tests was the aerostability problem, which will be discussed later in the paper.

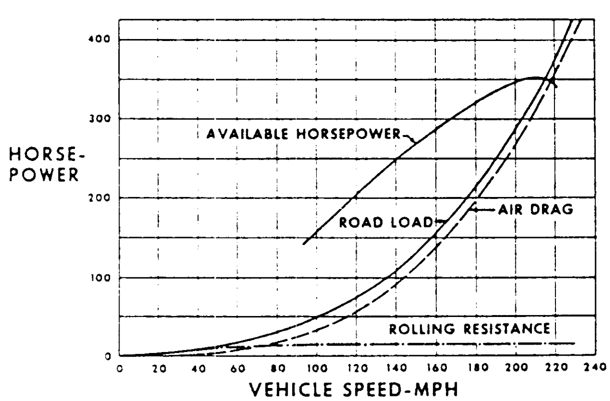

Figure 6

ENGINE

As previously mentioned, the engine selected for the GT 40 was the 4.2 liter (256 CID) unit that had been developed by Ford Motor Company for the 1963 Indianapolis Race. It was derived from the 289 Fairlane engine but included the use of aluminum block and heads, and a dry sump oil system, but, unlike the present Ford double overhead cam Indianapolis engine, still retained push rods. To adapt these units for road racing required detuning to run on commercial pump fuel; addition of full-sized alternator and starter systems; changes to the scavenge system for greater variations of speed and cornering; providing an induction system with greater flexibility for road use in adverse climatic conditions; and general detail changes to suit the package installation. These engines gave approximately 350 hp in their detuned state for long-distance races.

TRANSAXLE

The vendor-developed transaxle was packaged into the concept despite its disadvantage of having only four speeds and non-synchromesh engagement. This unit had been used previously on lightweight vehicles in sprint events, but analysis showed that it should be capable of handling the GT 40 power requirements. In addition, it was the only commercially-available unit that would meet the timing objectives.

Figure 7 shows the engine and transaxle combination, and Figure 8 shows the unit being installed in the vehicle with the cross-over-tuned exhaust system.

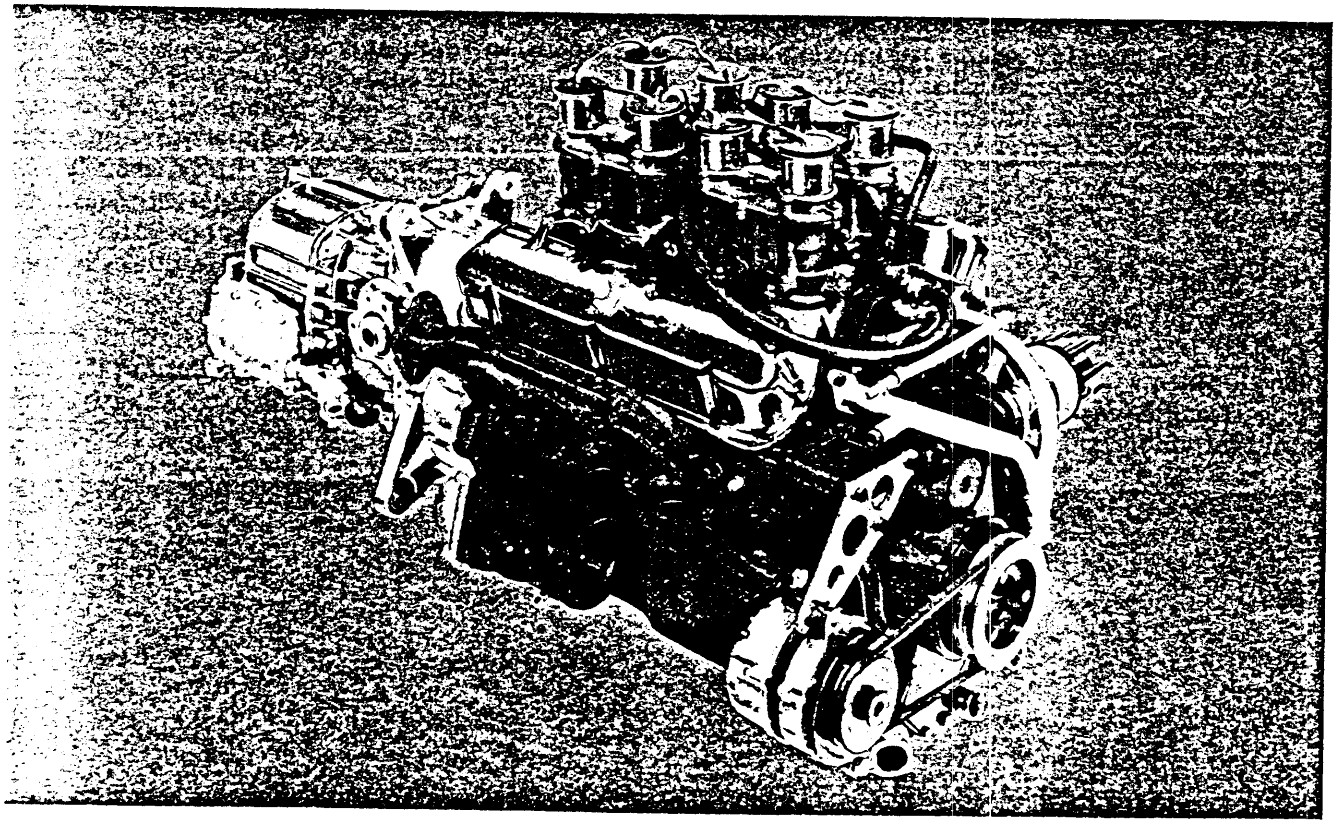

Figure 7 – 256 CID Engine and vendor-developed Transaxle – the Power Train Used in the Original GT 40's

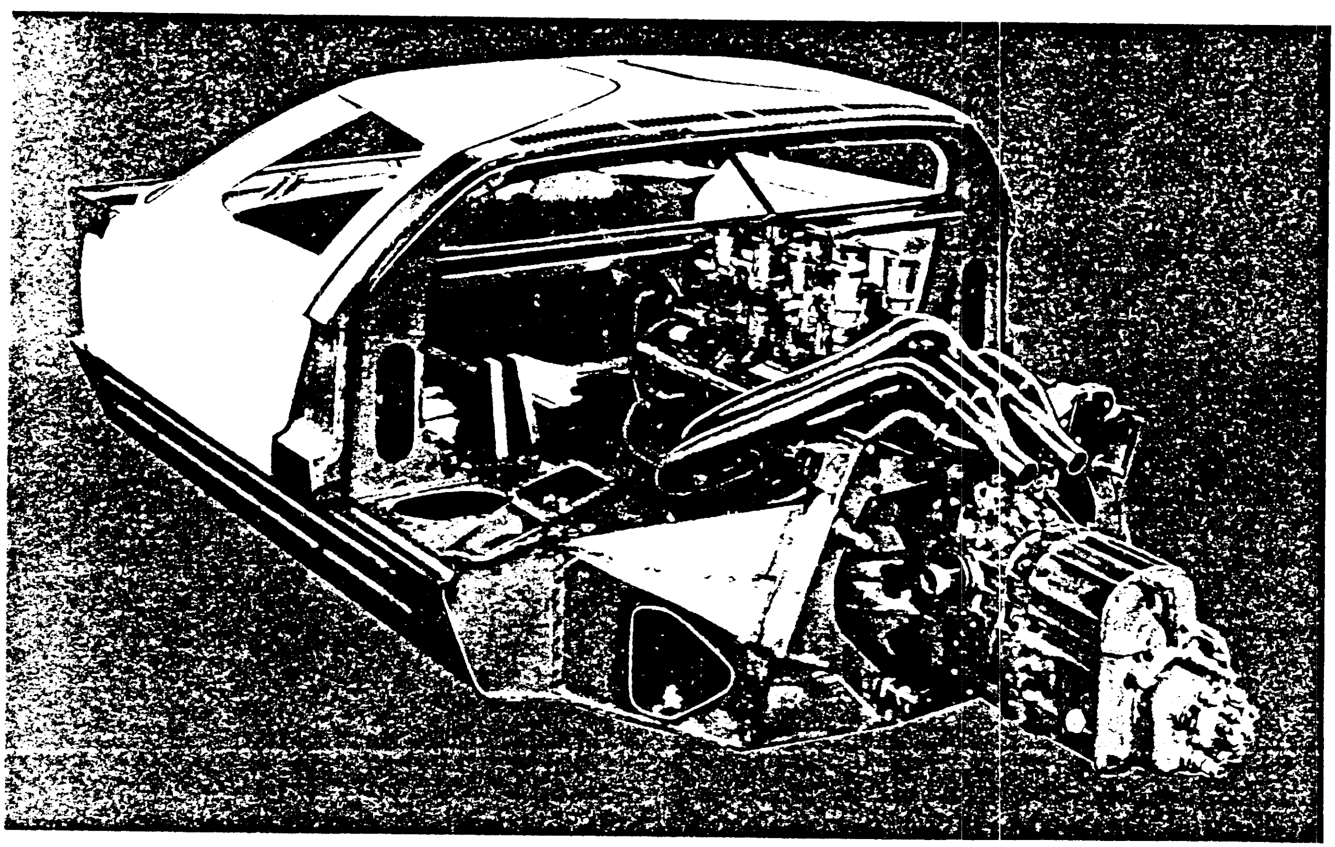

Figure 8 – Installation of 256 Engine Showing Tuned Exhaust System

The driveshafts were originally planned with single Cardan universal joints at the outboard end and pot joints inboard. Rubber couplings were later selected for the inboard end, mainly in an attempt to dampen out harshness and improve general driveline durability.

BODY

It was elected to use a thin sheet steel (.024"-.028") construction to avoid lengthy development of exotic lightweight materials. The strength-carrying structure consisted of a unitized underbody with torque box side sills to house the fuel cells, two main bulkheads, a roof section, and end structures to pick up suspension mountings. Front and rear substructures were attached to provide for body support, spare wheel, radiator, and battery mounting, and to give supports for the quick-lift jacks. The doors were cut extensively into the roof to provide reasonable entry and exit and, together with end sections and rocker panels, were made of hand-laminated fiberglass materials.

Great care was taken to design all fittings flush with the body panels, including the glass sections which were installed by adhesive techniques.

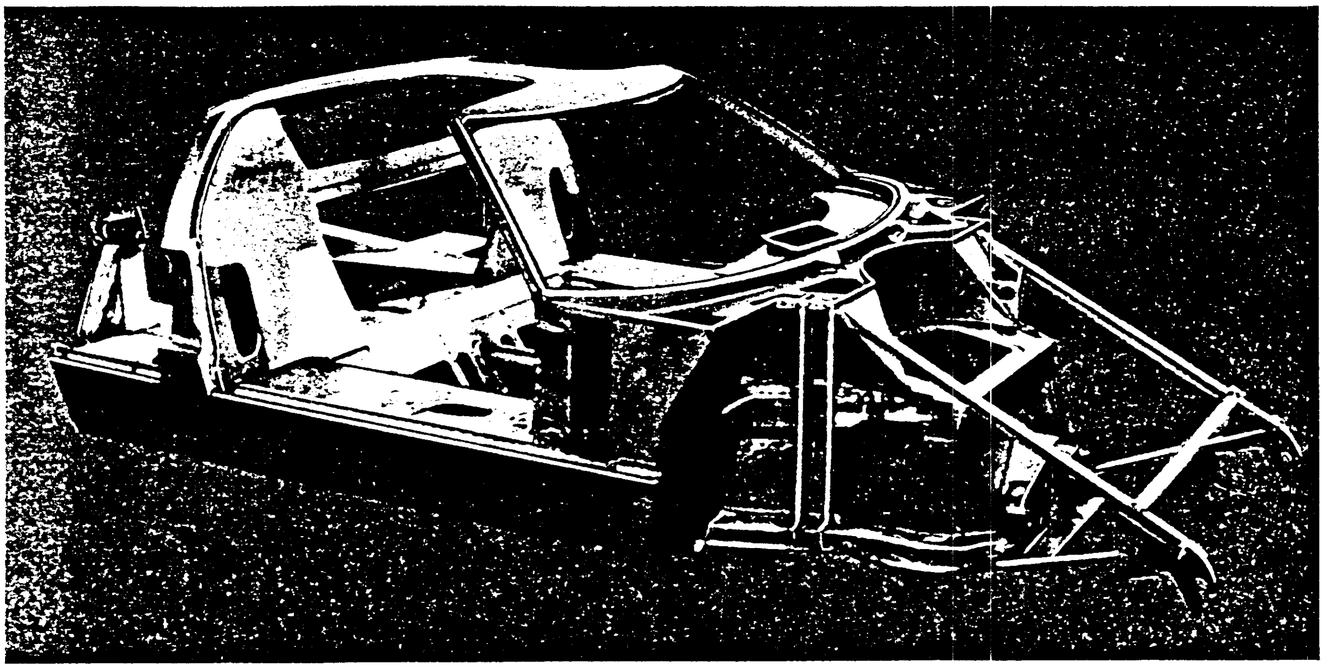

Figure 9

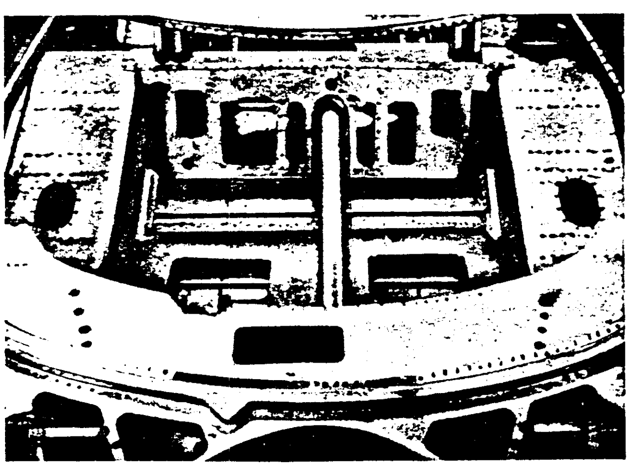

Figure 10

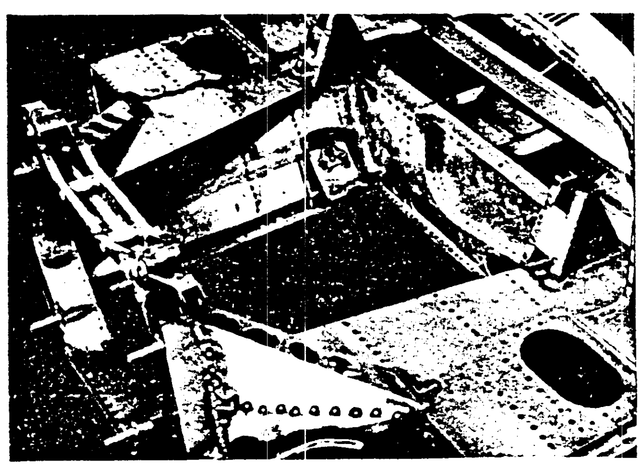

Figure 11

The use of steel sheet for the structure allowed normal methods of welding and brazing in the fabrication. Projection welding was used extensively because of the many blind sections in the structural members. The resulting structure provided an extremely strong unit, giving over 10,000 ft./lb. per degree in torsional rigidity. Figures 9 through 14 show the body structure in the process of fabrication and assembly.

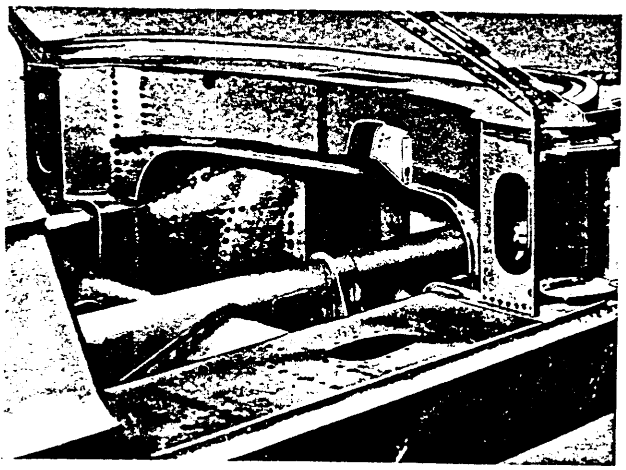

Figure 12

SUSPENSION, STEERING, BRAKES, AND WHEELS

A number of factors governed design of the suspension units. The package size imposed space limitations; the lightweight structure required spreading the attachment points to minimize point loadings; the high-speed aerodynamic tests indicated the desired use of "anti" features; the units required adjustability to suit the varying circuits; and the resulting balance of compromise still had to provide for excellent road-handling characteristics.

The front suspension was designed as a double "A" frame, with the cast magnesium upright supporting the live wheel spindle and

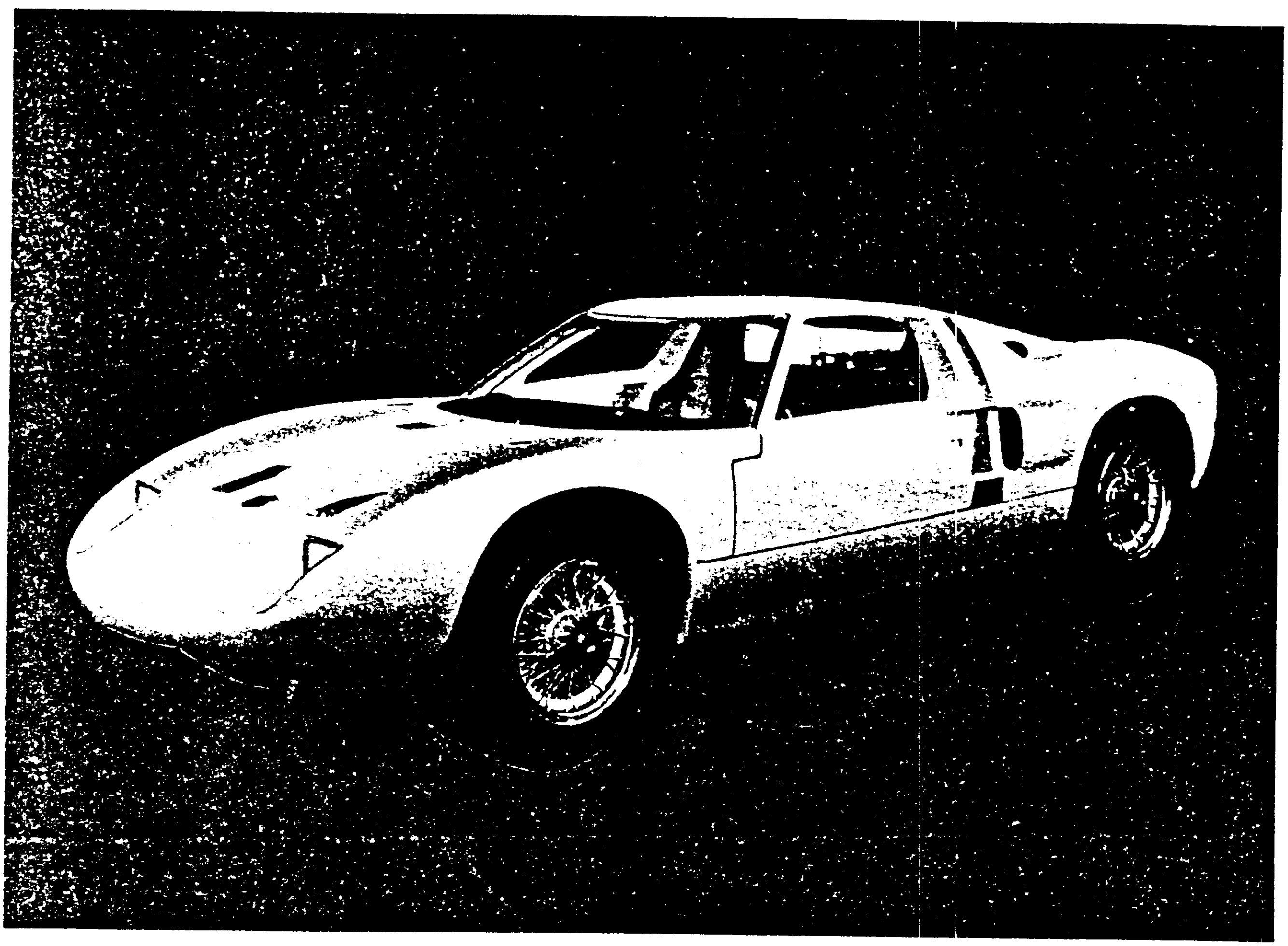

Figure 13

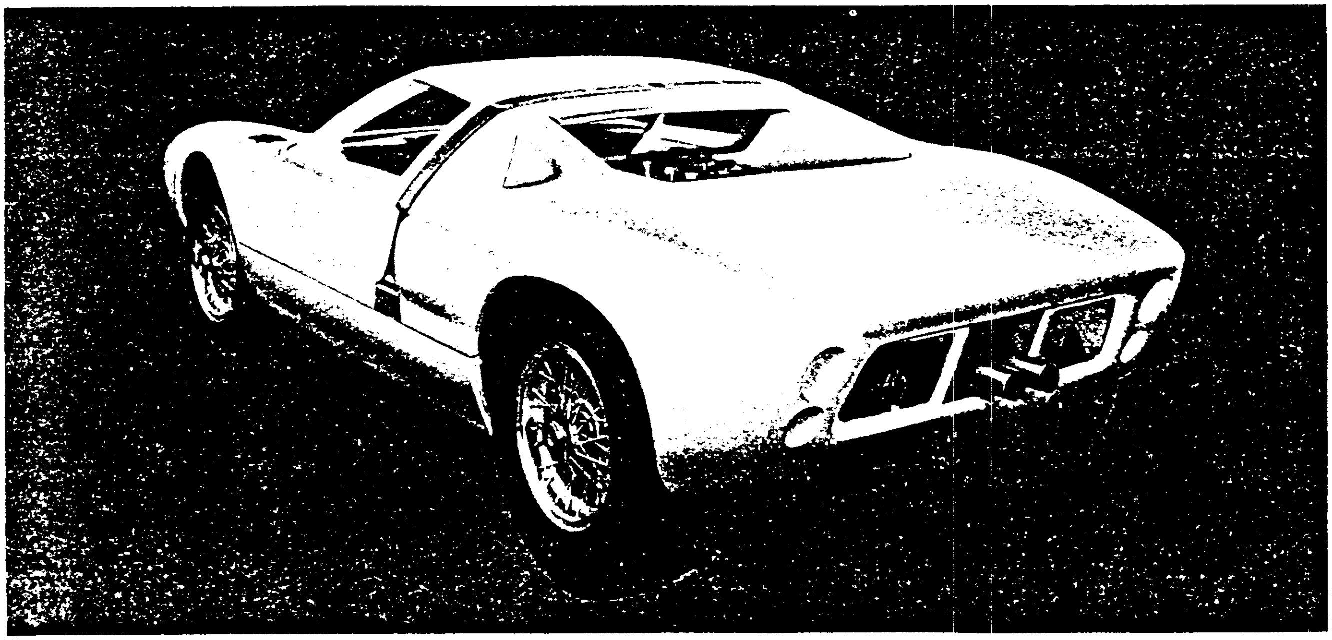

Figure 14

the Girling aluminum brake caliper. The foot well and the position of the spare wheel necessitated an unusually short top arm. The support axes of the "A" frames were arranged to provide an anti-dive feature of approximately 30 per cent.

The rear suspension used double-trailing links from the main bulkhead and transverse links comprising a top strut and an inverted lower "A" frame. The angling of the "A" frames to the magnesium upright casting, combined with the arrangement of linkage geometry, provided anti-lift and anti-squat features of approximately 30 per cent.

These multi-link suspensions presented a problem in establishing wheel geometry. Extensive use of the computer was required with so many links moving in different planes and on canted axes. Once the basic configuration of suspension linkage had been established, a computer program was formulated that took into account all the factors involved. Curves could then be plotted in a matter of a few hours to meet a given condition — a process which speeded up the design period and aided the balance of compromise involved.

A rack and pinion was selected for the steering system, mainly because it was particularly suitable for the package conditions involved. The rack had a ratio of 16:1 which

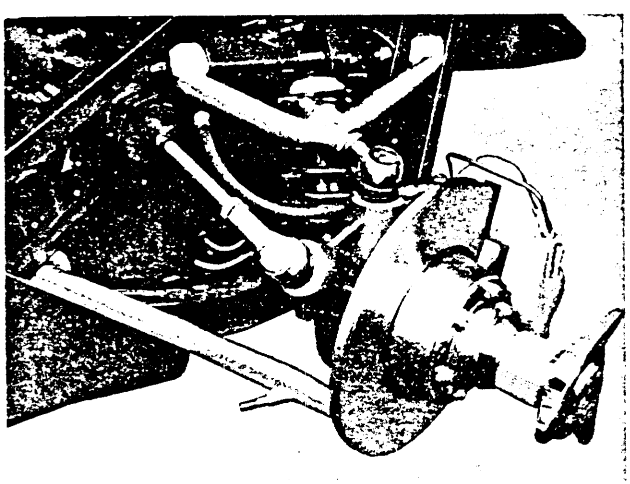

Figure 15 — Front Suspension and Steering Assembly

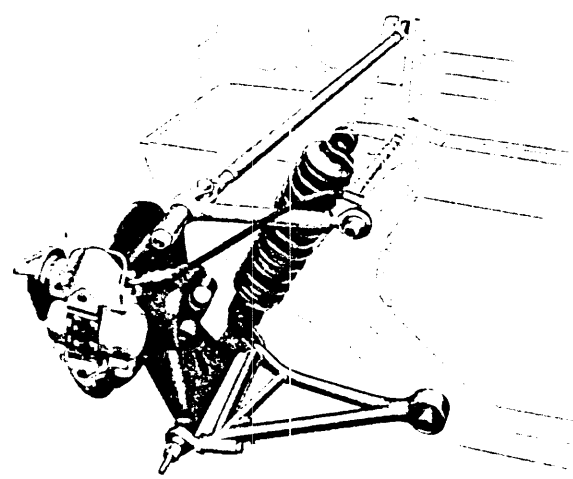

Figure 16 — Rear Suspension Assembly

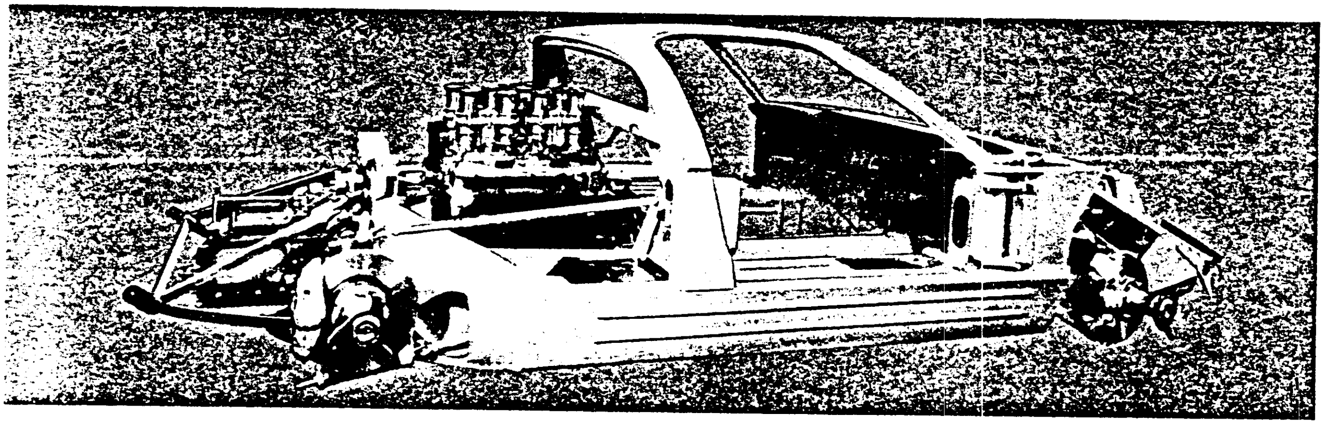

Figure 17 — Basic Structure with Suspensions and Engine Installed

in turn gave an over-all ratio of 2-1/4 turns of the steering wheel from lock-to-lock.

Girling CR and BR racing calipers were used front and rear, respectively, with solid cast iron discs, which were 11-1/2 x 1/2-inch thick. A dual master cylinder was employed for separate front and rear systems which incorporated a balance mechanism for adjustment of braking distribution.

Cast magnesium wheels were originally specified, but development problems precluded their use on the first cars. Prototypes were therefore fitted with wire wheels with alloy rims of 15-inch diameter with a 6-1/2-inch wide front rim and an 8-inch wide rear rim.

Figures 15 and 16 show the front and rear suspension units, and Figure 17 shows these units in an over-all context with the chassis.

INTERIOR — DRIVER ENVIRONMENT

Driver environment was a major consideration as long-distance races require maximum driver concentration for periods of up to four hours. An interior buck was constructed as a physical aid in developing seating conditions and to determine optimum positioning of instrumentation and controls.

The fixed-seat, movable-pedal concept was carried over from the Mustang I project. This arrangement offered structural advantages and provided snug support around the driver to help prevent fatigue from high-speed cornering effects. A nylon netting was used for the basic support medium and was covered with a pad containing ventilation holes to help evaporate driver perspiration. The pedals were mounted on a cast alloy member which could be adjusted for variation in driver size (Figure 18).

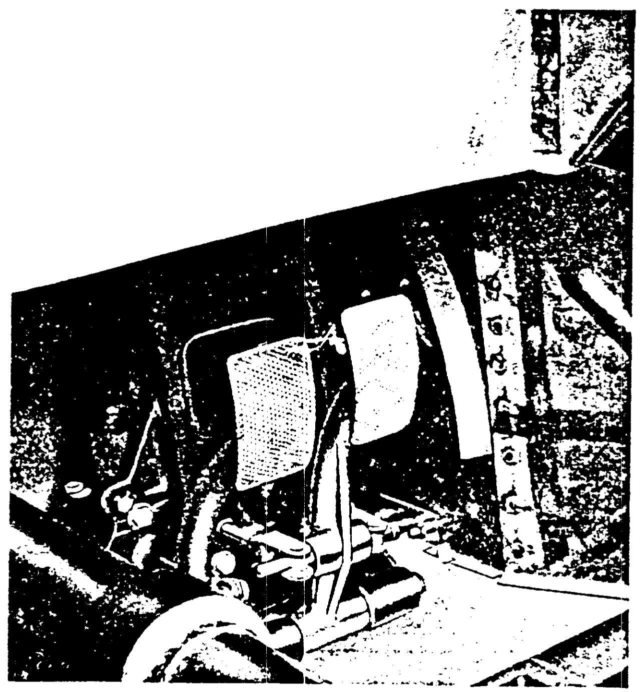

Figure 18 — Adjustable Pedal Mechanism

Instruments were positioned so that their faces pointed directly at the driver in order to minimize distortions and reflections. All switches and controls were located and formed so that they could be reached easily and recognized visually or by touch. Flow-through ventilation was provided, together with full protection from adverse weather conditions.

The general arrangement of the interior is shown in Figure 19.

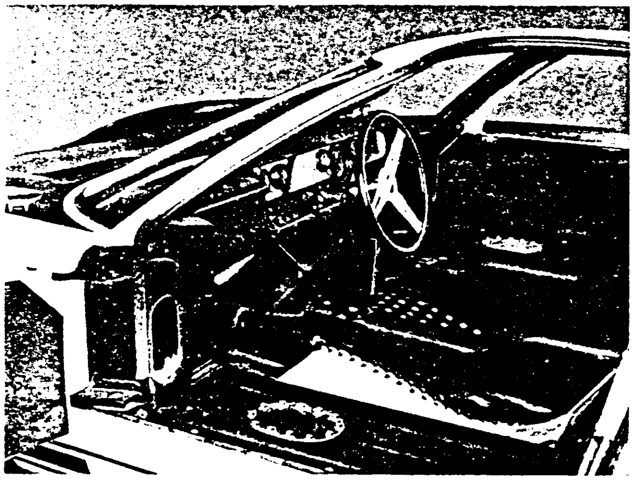

Figure 19 — Interior Showing Fixed Seat Arrangement. Passenger Seat Trim Removed to Show Nylon Net Support.

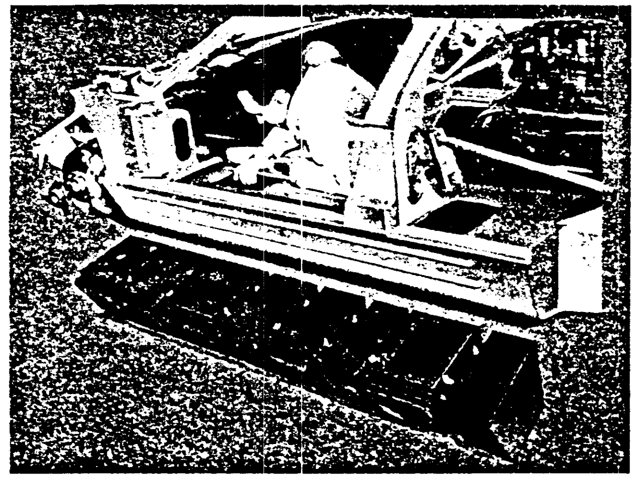

Figure 20 — Structure Being Prepared for Fuel Cell Installation

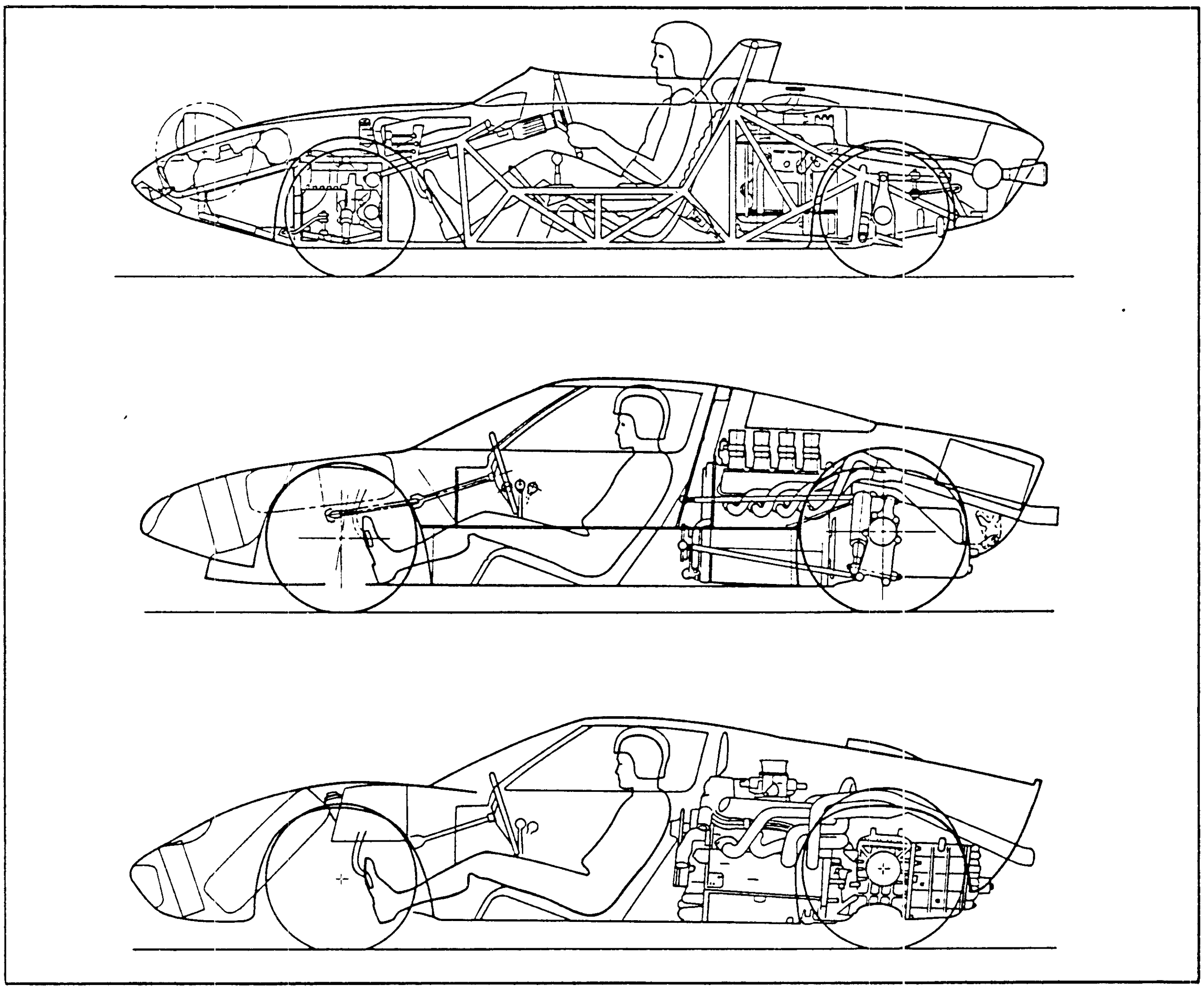

Figure 21 — Outline Packages Showing Evolution of GT 40 from the Mustang I. The Later Development of the MK II Package is Shown for Reference

FUEL SYSTEM

To contain the allowable 42 gallons of fuel in this small package, provide for rapid filling, devise a means of picking up the fuel, and provide adequate driver safety was a study within itself. The arrangement selected was two separate tank systems in the side sills, each with its own filler cap and fuel pickup box. These separate systems were designed with individual electric pumps feeding a common supply pipe to the carburetors. Provision was also made in one tank for a reserve pickup unit. The steel shell of the tanks was, of course, part of the main structure. In these were fitted neoprene bags to aid in crash safety. Baffling was attained by means of a plate supported from the top inspection cover. A fuel cell is shown prior to assembly, in Figure 20.

The findings and effects of each of the specialized studies were continuously reflected in the package layout and full-size clay model. The evolution of the package can be seen in Figure 21, which shows the Mustang I as a datum, the GT 40 package, and the later MK II layout is shown for reference.

PROTOTYPE BUILD

The design and analytical studies were completed during the summer of 1963, together with a clay model reflecting the package changes (Figure 22). The problem was then how and where to execute the final design build and development.

It was finally decided to execute this phase of the program in Europe, since many of the proprietary components were readily available in this area, as were experienced craftsmen in this field of racing. An arrangement was made with the Lola Company to use their resources and facility for one year, as they already had some experience in GT sports cars with a midship engine configuration. In forming this alliance, we were also able to use one of the Lola prototypes for the installation and development of the Ford suspension and driveline components.

In September of 1963, the center of activity was therefore moved from Dearborn to England, together with a nucleus of Ford engineers, car layouts, power pack components, and full-size models.

Component testing was completed by the end of November, 1963, and the remainder of that winter was spent in detailing and procuring items for the first prototype builds. The first GT 40 car was completed on April 1, 1964, some eleven months after putting pencil to paper in Dearborn. This car is shown in Figures 23 and 24. A second vehicle was completed ten days later, and hectic preparations were made to get both vehicles to the Le Mans practice on April 16. Bad weather conditions in England prevented any serious testing and the cars had an aggregate of only four hours running time with no high-speed experience before being shipped to France. The first day of practice also proved to be rain drenched and after very few laps, the first car was totally wrecked on the Mulsanne Straight when it left the road at over 150 mph. The second vehicle also experienced trouble and suffered a minor collision. Luckily, both drivers were unharmed,

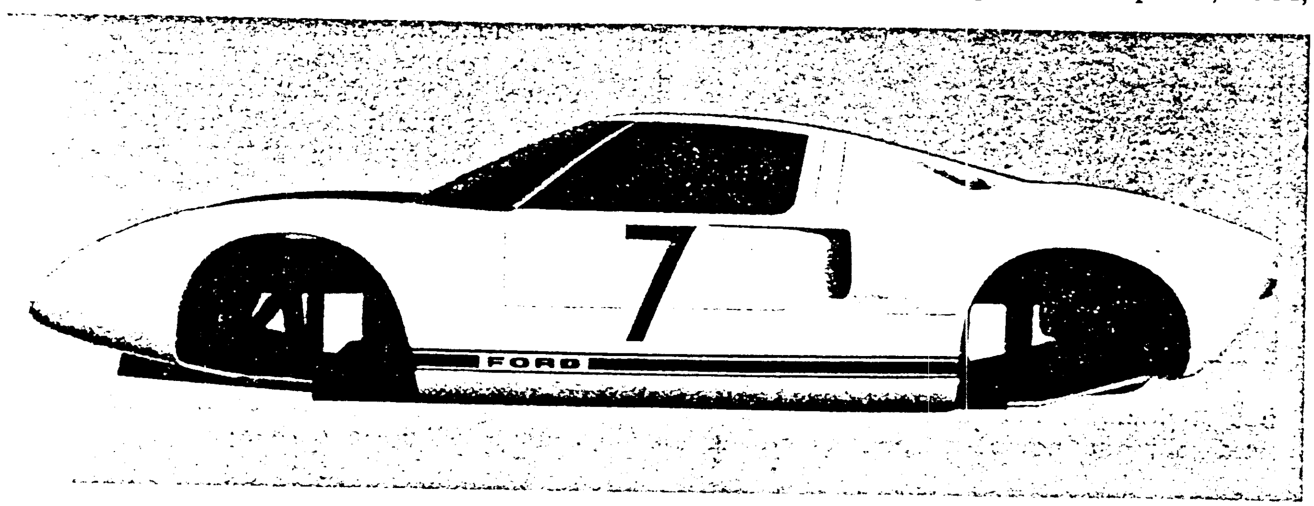

Figure 22 – Developed Model of Original GT 40

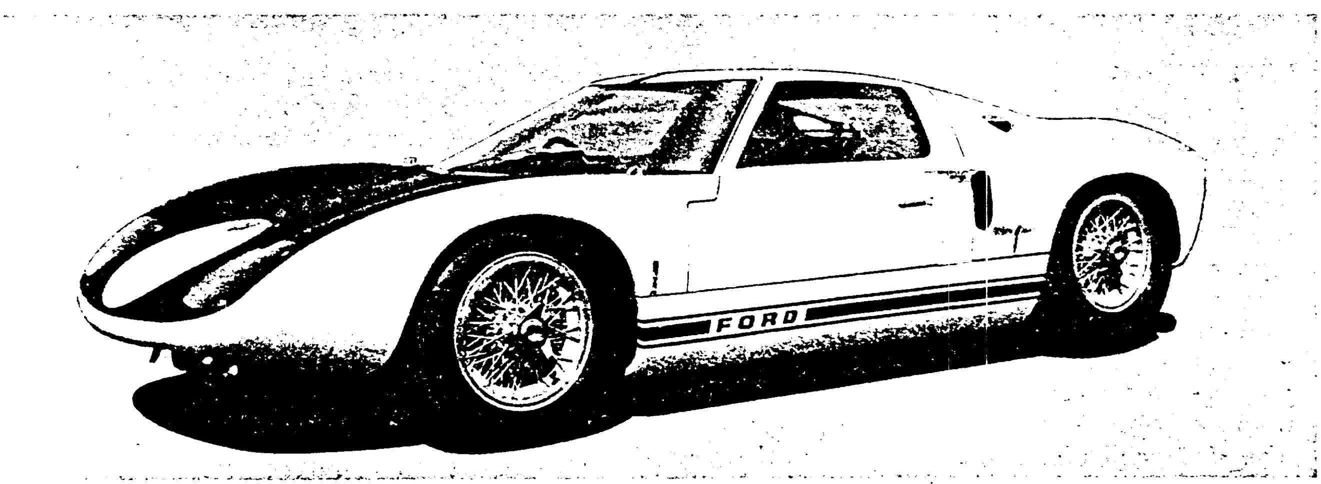

Figure 23 — Original GT 40 Prototype

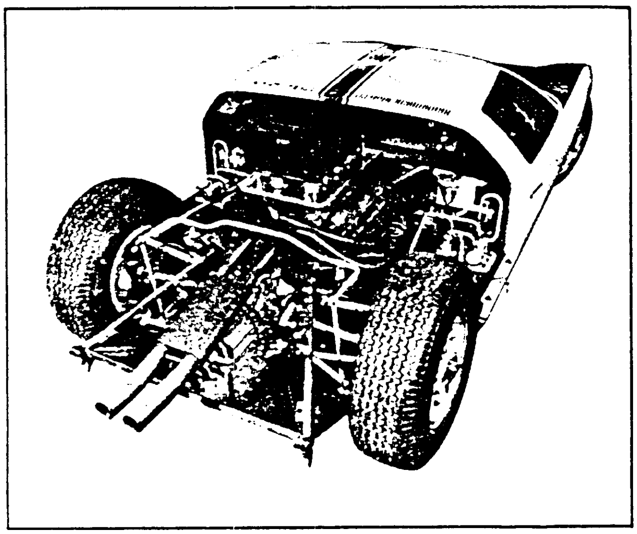

Figure 24 — Original GT 40 Engine Compartment

but obviously some stability phenomenon existed that had not been apparent during the design analytical phase. The problem and the solution were found within one week after returning to England, where further testing was carried out at the MIRA proving ground. The fault was found to have been an aerostability condition which caused a rotary motion of the rear end of the vehicle comparable to that of an arrow without feathers. The motion had increased with speed and, accentuated by the wet track, eventually resulted in rear end breakaway. Subsequently, it was found that the adaptation of a rear end "spoiler" not only had the effect of putting feathers on an arrow, but also slightly reduced drag. Apparently, the "spoiler" creates an airtail which artificially increases the vehicle's aspect ratio and moves the center of pressure rearwards. It also increases the adhesion of the rear wheels and, surprisingly, the effect of this small addition could be felt down to 70 mph.

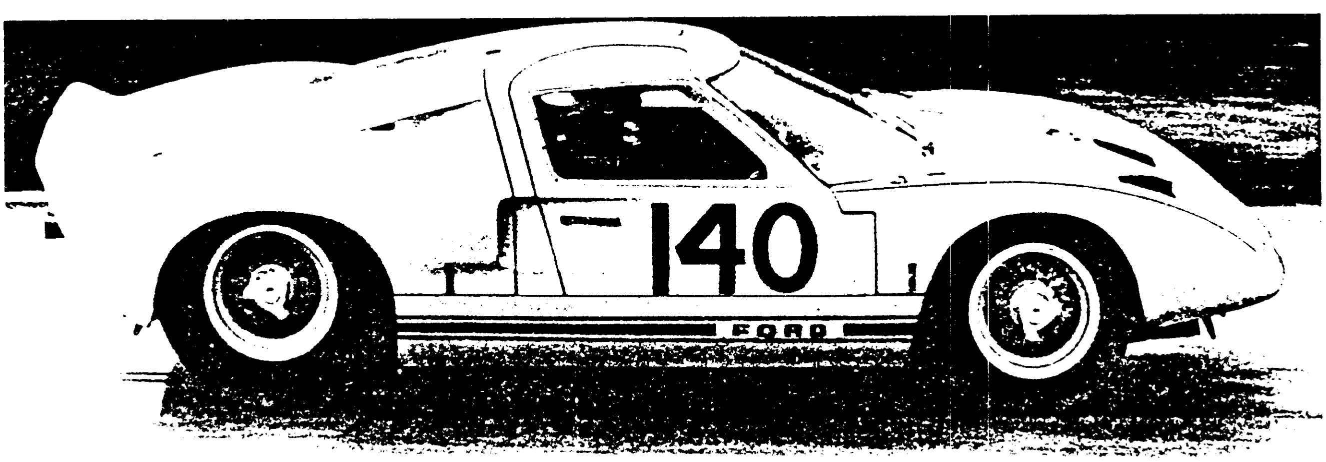

Figure 25 — Prototype at Nurburg Ring 1964 with "Duck-Tail Spoiler" Added to Rear End

The second car from the Le Mans practice was modified by the addition of the "spoiler" (Figure 25) and was rebuilt in readiness for the GT 40's first race outing at Nurburg Ring on May 31, 1964. The car performed most favorably in practice and qualified second only to the fastest Ferrari. It also ran second in this 1000 Kilometer race in the early hours but retired after 2-1/2 hours. The reason for the retirement was a suspension bracket failure because of an incorrect welding process, but when the vehicle was examined, there were several other areas showing distress and near failure. The outing was, therefore, most successful as a development exercise, and the lessons learned were quickly incorporated in the three vehicles being built for the Le Mans race in mid-June, 1964. These vehicles were completed and weighed in at Le Mans scrutineering at 1960 pounds, less driver and fuel.

In practice, the cars qualified second, fourth, and ninth. During the race, one car held the lead for the early hours before retiring with a transmission failure. The second car retired after five hours with a broken fuel line, and the third car retired after 13-1/2 hours with transaxle problems but not before establishing an all-time lap record.

Every attempt was made to correct the transaxle problems within the limited time available before the next race at Rheims, France, on July 5, 1964. Again, the cars led the race in the early hours, set new lap records, but all retired with transaxle failures. In addition, the nature of this circuit showed insufficient cooling of the brake discs which remained red hot during the entire time the cars were running.

The GT 40's first season of racing in 1964, therefore, showed seven starts in major events with no finishes. The cars had demonstrated that they met the performance objectives but failed badly on durability aspects. The winter of 1964 was devoted to detail preparation of the cars for the 1965 season and at this stage, the responsibility for racing the vehicles was given to the Shelby-American racing team. Twenty-one modifications were executed on the transaxles, the rubber driveshafts were replaced with Dana couplings, and the decision was made to install standard 289 C.I.D. cast iron engines, using wet sump lubrication. The original cast wheels were also installed and increased to 8-inch front and 9-1/2-inch rear rims. Two of these cars made their first appearance in the 1965 season at the Daytona 2000 Kilometer Race on February 28, 1965. They finished first and third in this event, setting an average speed record of 99.9 mph for the distance in 12 hours and 20 minutes (Figure 26). Two vehicles also were entered in the Sebring Race in March, 1965, and finished second over-all and first in class, once more demonstrating that a fair degree of durability had been attained. These cars were raced by the Company once more in 1965 at Le Mans, but without success.

The decision was then made to manufacture 50 of these cars in order to qualify them for the production sports car category. These cars were completed in the 1965 period after detailed changes and the adoption of the 5-speed ZF transaxle. These GT 40's were sold to the public and, in the hands of private race teams and individuals, won the World Championship for production sports cars in 1966.

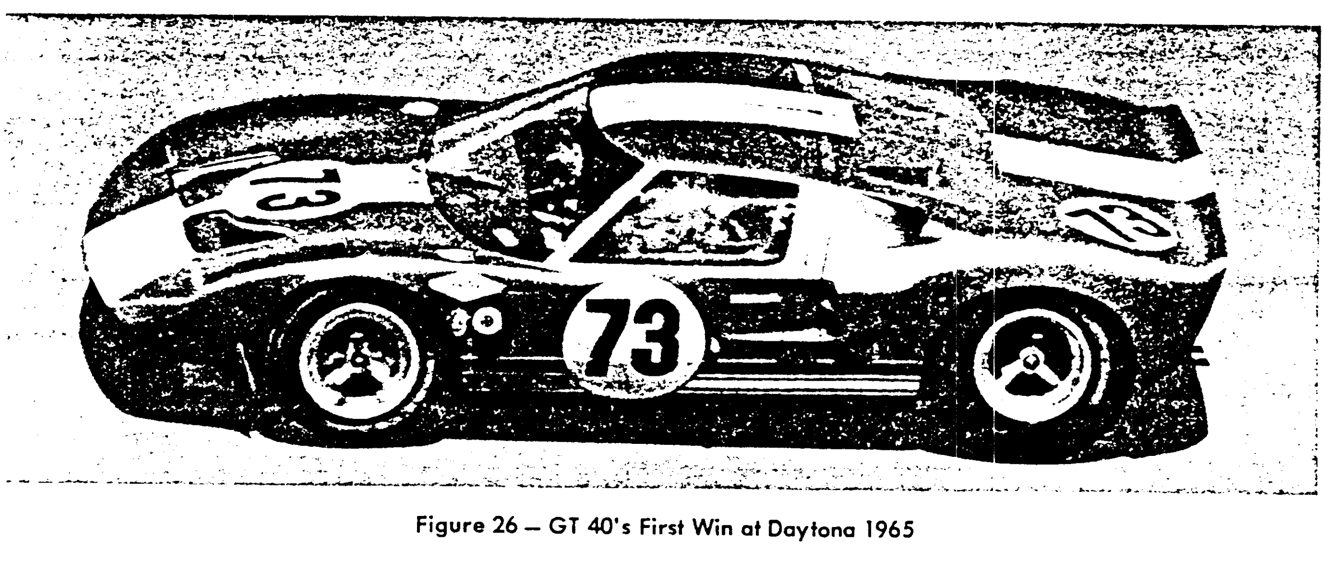

Figure 26 — GT 40's First Win at Daytona 1965

MARK II PROGRAM

In the fall of 1964, the engineering team relocated in Dearborn and started operations at Kar-Kraft, a Ford contracted facility. This team continued engineering on the GT 40 and also started a new experimental vehicle project.

The 1964 season had shown the prototype GT 40's were currently competitive on performance factors but lacked durability. Although work was progressing on correcting durability problems, it was obvious that the GT 40 performance, in the fast-moving racing field, would soon be outmoded. The problem was, therefore, how to get an improved power-to-weight factor and at the same time achieve a high durability level. The alternatives were to generate more power from the 289 C.I.D. series engine or adapt the 427 C.I.D. engine which had been developed for stock car racing. This latter approach would also involve the development of a unique transaxle to handle the higher power. The other indeterminates were whether the additional weight (some 250 pounds) for the larger engine and heavier transaxle and driveline would unduly deteriorate handling and accentuate braking problems. It was decided, however, to explore this approach by constructing a test vehicle and physically evaluating its performance. The program was initiated in the winter of 1964 and was designated the MK II project. At the outset, it should be emphasized that the exercise was intended to generate information for a future model, and there was no intention of racing the car.

Package studies showed the 427 C.I.D. engine could be accommodated in the GT 40 basic structure by modifying the seating position and rear bulkhead members (Figures 27 and 28). The basic suspension units were unchanged, but provision was made for 8-inch wide cast magnesium front wheels and 9-1/2-inch rear wheels. Housing of the wider spare wheel necessitated revising its position, and the new front end arrangement made provision for a remote engine oil tank on the bulkhead and a larger radiator (Figure 29).

A major problem was to generate a transaxle unit which would handle the 427 C.I.D. power and the extra weight of the vehicle. For expediency the gear cluster from the conventional 427 C.I.D. driveline was used but with completely new housings and axle unit. This approach resulted in a heavier and less efficient arrangement than a direct transfer box, but had the advantage of using developed components. The housings were designed in magnesium, and a pair of quick-change gears

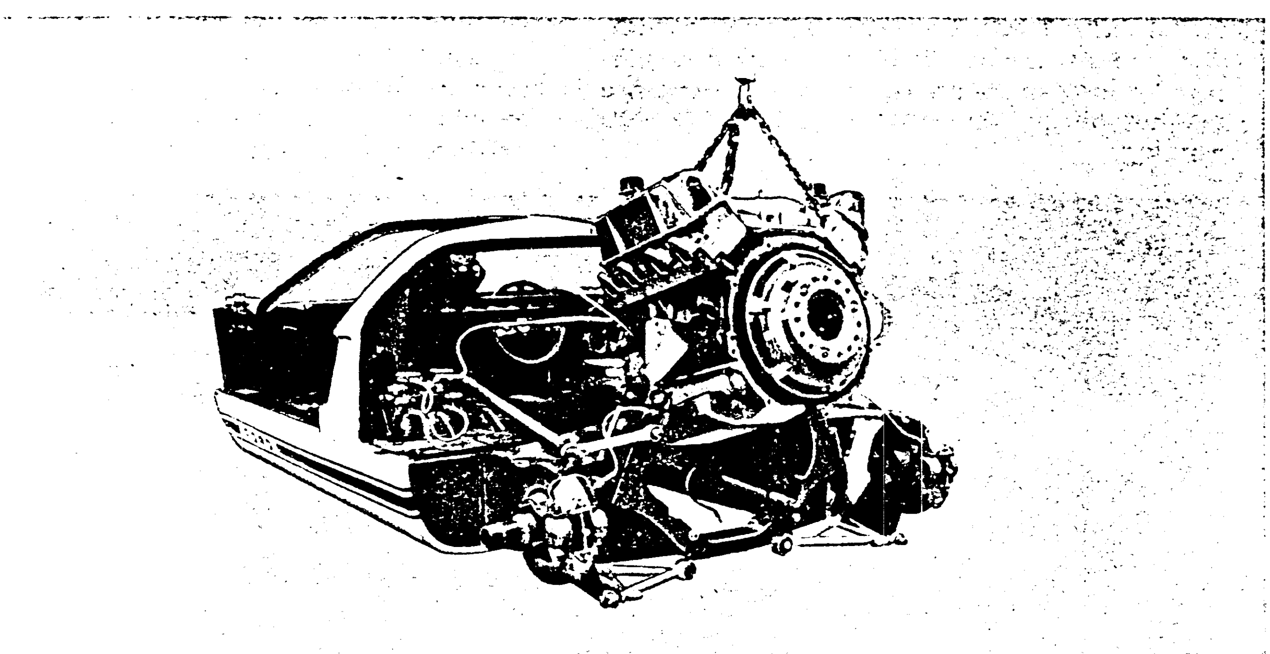

Figure 27 – Installation of 427 Engine in MK II Chassis

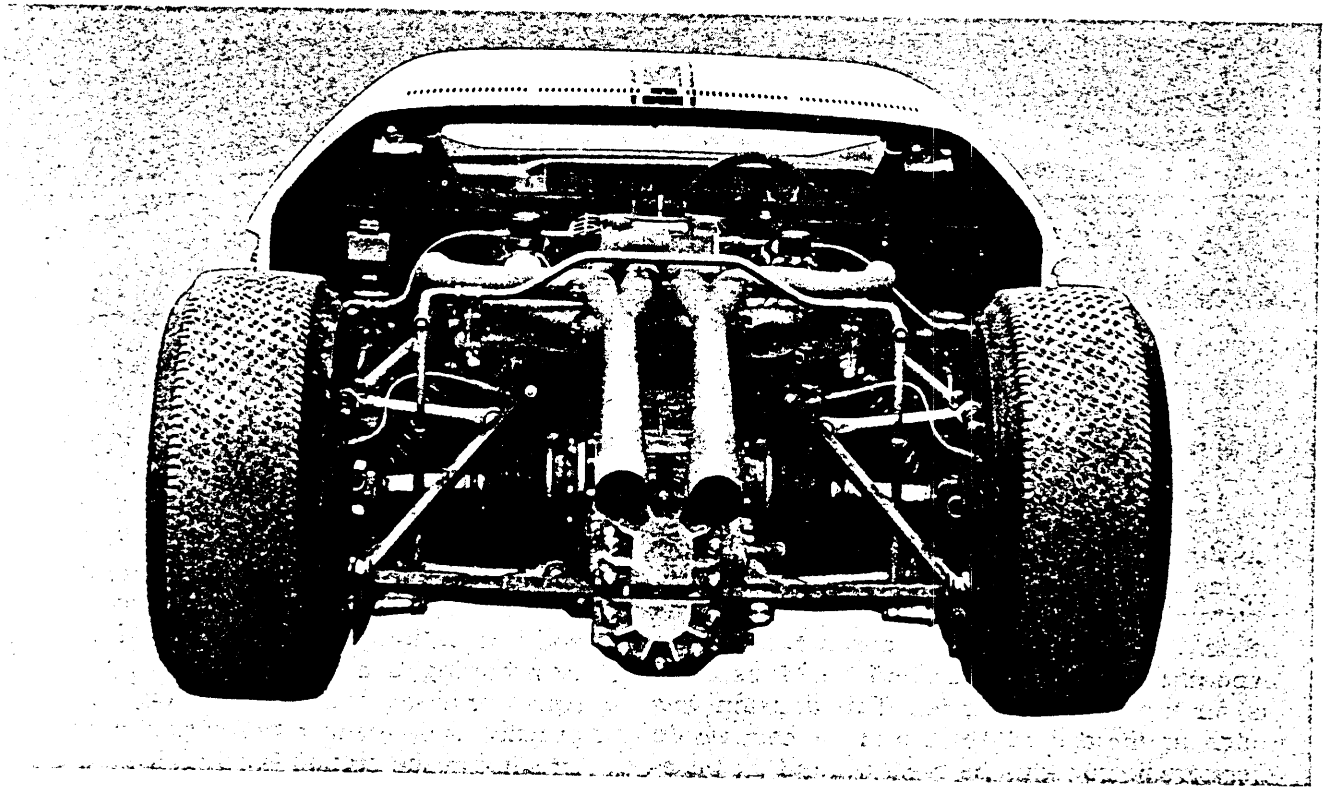

Figure 28 – Original MK II Engine Compartment

transmitted the power to the pinion shaft. The resulting over-all package from these changes required new front and rear structures and body shells.

The first experimental MK II vehicle was completed during April, 1965, and was evaluated on the 5-mile oval at Ford's Michigan Proving Ground (Figure 30). After only a few hours of tailoring, the car lapped this circuit at an average speed of 201-1/2 mph and exceeded 210 mph on the straight-away. Subsequent testing on road circuits showed that handling had deteriorated only slightly. From the results of these tests, it was calculated that this vehicle should be capable of lapping the Le Mans circuit in 3 min. 30 sec. to 3 min. 35 sec. without exceeding 6200 rpm. If these

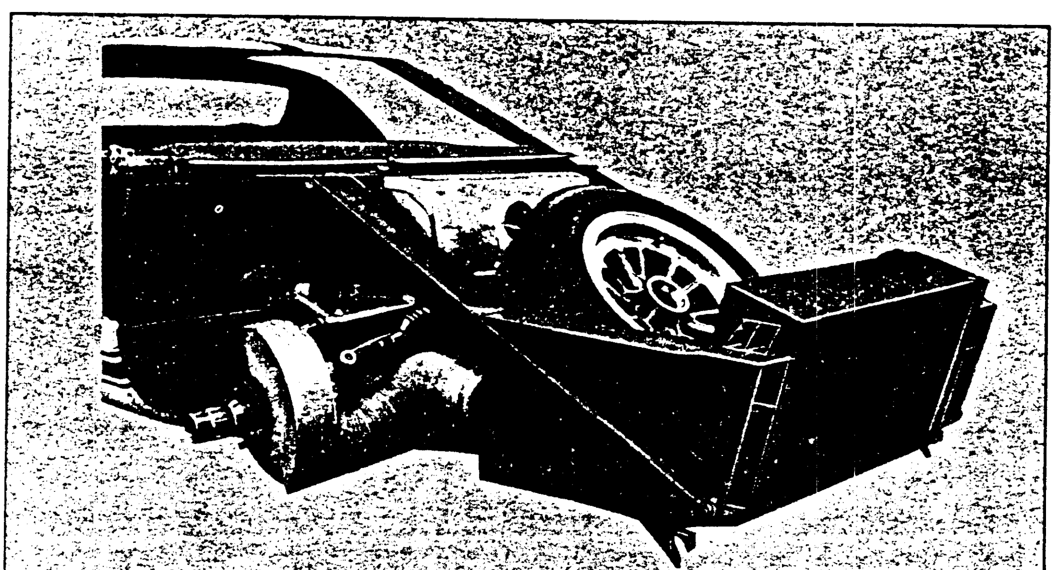

Figure 29 – Original MK II Front End Arrangement

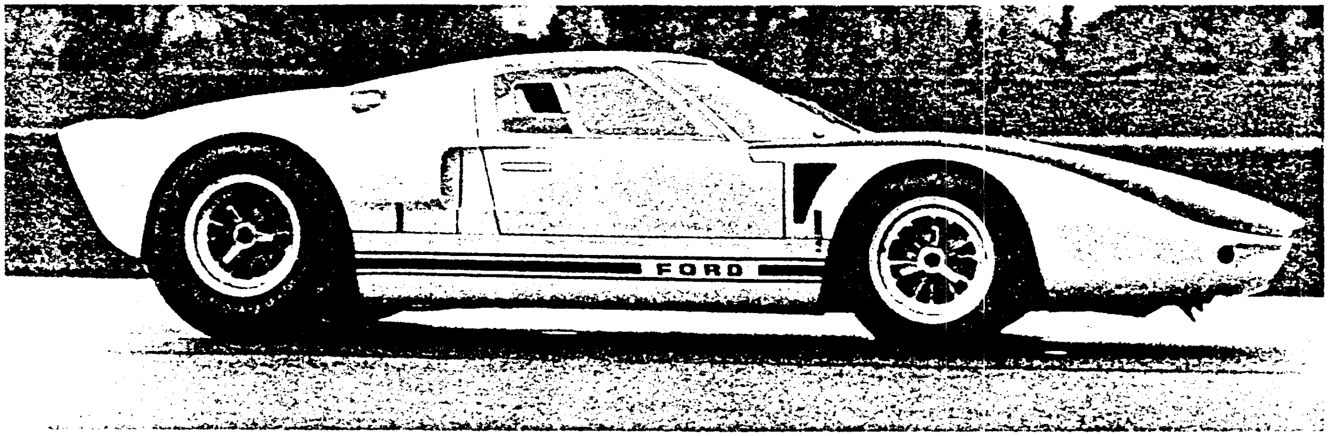

Figure 30 – Original MK II Prototype with Long Nose Configuration

lap times could be realized at this relatively low engine rpm, the car would obviously have high potential to win at Le Mans. The decision was made, therefore, to attempt to run two of these experimental cars in the 1965 Le Mans event as an exploratory exercise. This decision was made at the end of April, and the cars would therefore be going to the event without the benefit of the practice week-end.

In the ensuing five weeks, the first car underwent initial testing and rebuild, and a second car was hurriedly constructed. The second car actually arrived at Le Mans without even having turned a wheel. Having missed the April practice, the first evening of pre-race practice was spent in tailoring the cars to the circuit. On the second evening, the car that had never turned a wheel before arriving at the

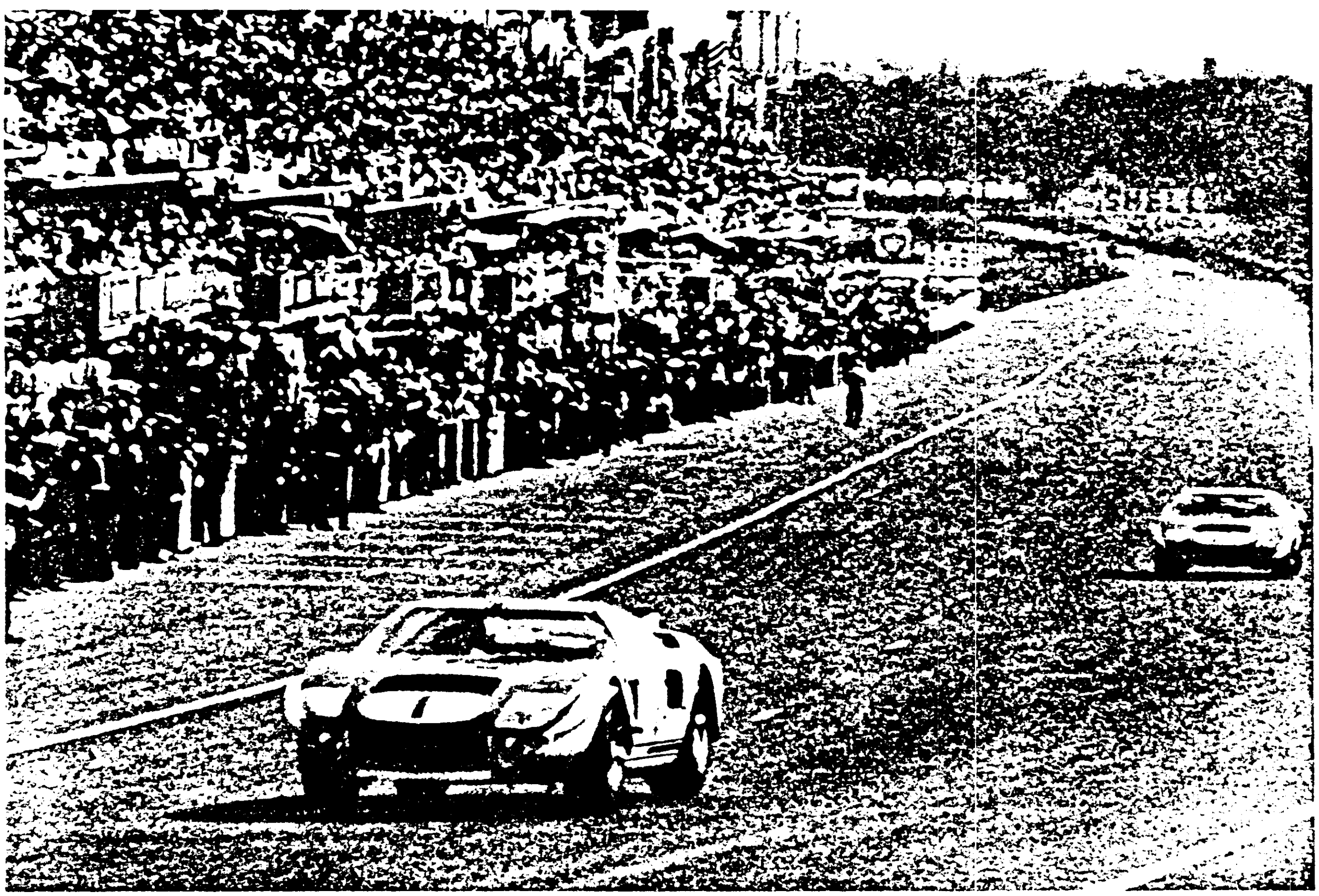

Figure 31 – Two Original MK II Cars at Le Mans 1965

track set an all-time record lap of 3 min. 33 sec. — an average of 141 mph.

One car qualified first, and when the race started on Saturday, both cars went out ahead of the field and comfortably lapped at 3 min. 40 sec. without exceeding 6000 rpm (Figure 31). Unfortunately, hurried preparation resulted in the cars being retired after two and seven hours, respectively, with non-fundamental driveline problems. One car had a speck of sand in the clutch slave cylinder which caused the piston to stick and generate heat at the throw-out bearing. The heat, in turn, softened an oil retaining ring in the axle ultimately resulting in loss of oil. The second car broke a gear which had been incorrectly drilled. The cars, however, achieved their purpose of establishing the capability of the engine-driveline combination. The potential indicated in this initial experimental outing resulted in the 1966 program being based on the MK II vehicle.

The following chart shows the MK II power-to-weight factor compared to the original GT 40 and the production version. Vehicle weights are quoted, less fuel and driver.

	Vehicle Weight	HP	HP/Lb.
MK II	2400 Lbs.	485	.202
Production GT 40	2150 Lbs.	385	.179
Original GT 40 Prototype	1960 Lbs.	350	.179

In preparation for 1966, a concentrated vehicle development program was planned using the Daytona, Sebring, and Riverside tracks. In addition, specialized component developments were initiated on items such as engine (SAE Papers No. 670066, 670067) ignition and electrical system (SAE Paper No. 670068), transaxle (SAE Paper No. 670069), driveshafts and brakes (SAE Paper No. 670070). Although some fundamental changes emerged from this development program, the main emphasis was on refinement to establish durability rather than improve performance. The final engine-driveline arrangement is shown in Figure 32.

A major contribution to speeding up development was originated by the Ford engine and transmission engineers. They evolved a dynamometer which could run the engine and

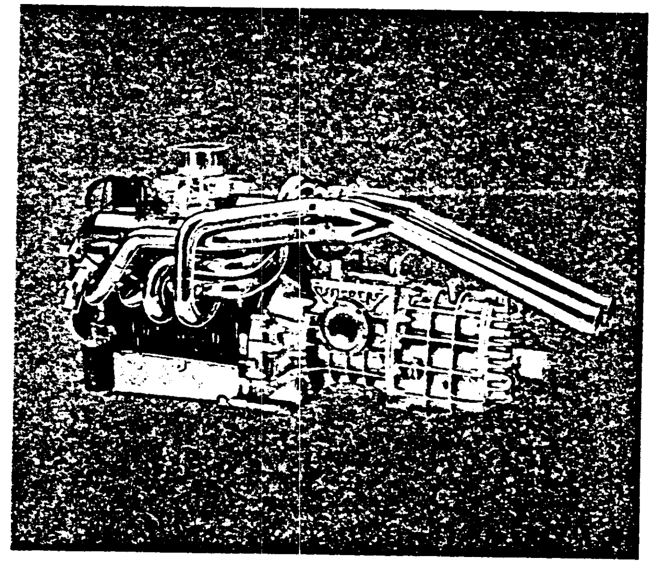

Figure 32 – Developed Engine and Driveline Assembly

driveline units under simulated road conditions that had been recorded on tape in an instrumented vehicle (SAE Paper No. 670071). This device allowed component testing to proceed independently of vehicle availability and climatic conditions.

Major changes that resulted from testing and development included:

- New shorter nose configuration to save weight and improve aerodynamics.
- Addition of external rear brake scoops.
- Higher efficiency radiators.
- Strengthened chassis brackets for durability.
- Live rear hubs for improved durability.
- Internal scavenge pump to minimize vulnerability and save weight.
- Generally improved ducting to radiators, carburetors and brakes.
- Crossover fuel system with a single filler neck.
- Ventilated brake discs to improve durability.
- Quick-change brake disc design to facilitate changes during pit stops.

All of these changes were incorporated in the vehicles that made their first appearance at the Daytona 24-Hour Race on February 5-6,

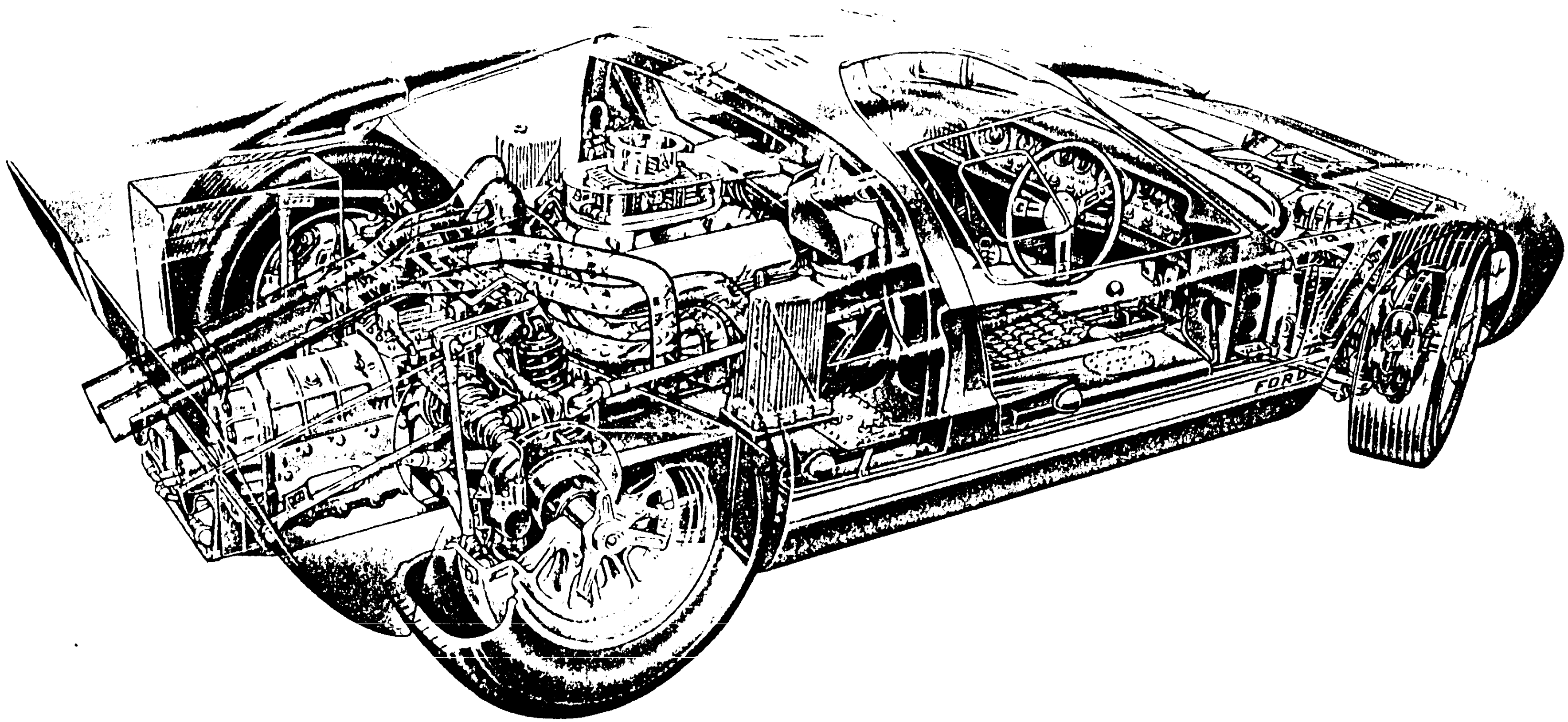

Figure 33 — Final Layout of Components for the MK II

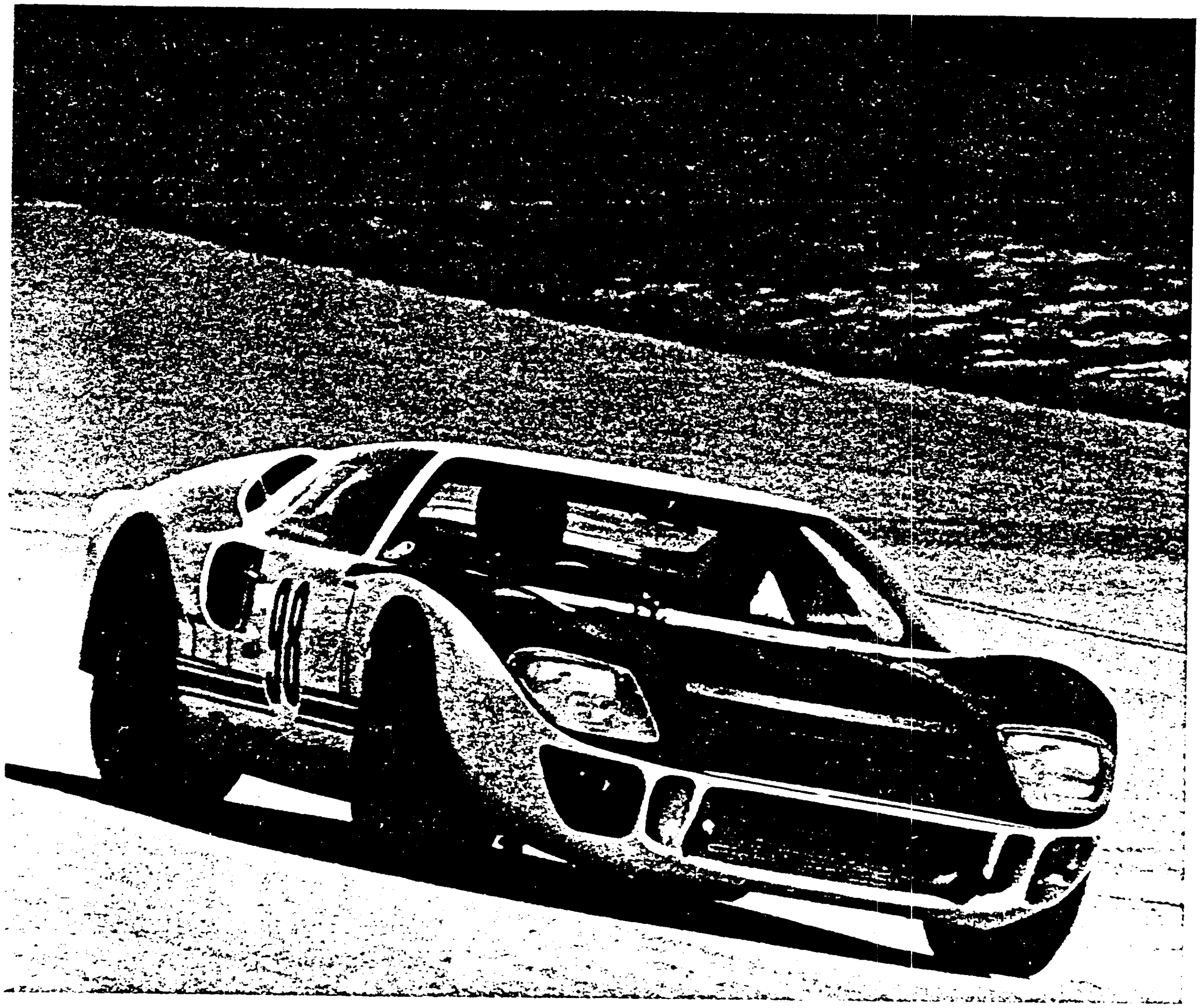

Figure 34 — Winning MK II at Daytona 1966

1966 (Figure 33). The MK II cars virtually led the race all the way, finishing first, second, and third for their first victory (Figure 34). It is interesting to note that in 1965 when this race was approximately at the half-way point, the winning GT 40 averaged 99.9 mph. In 1966, the event was of 24 hours duration and the winning average was 109 mph. This indicates the fast-moving nature of this field of competition.

The second race in 1966 was the Sebring event, where MK II's finished first and second, setting new distance and lap records, and a GT 40 finished third over-all. The car that finished first was an open version of the MK II with an aluminum underbody that was designated the XI (Figure 35).

One car was entered in the Spa 1000 Kilometer Race and finished second.

After attending the practice session in April, eight cars were prepared for the Le Mans event that took place on June 18-19, 1966. MK II's qualified in the first four places and set a new lap record of 3 min. 31 sec. or 142 mph. The race took place in cloudy weather with intermittent showers during the 24 hours. MK II's finished first, second, and third and, despite the weather conditions, established a new record for the 24 hours of 126 mph (previous best was 122 mph on a dry track), (Figure 36).

As a result of winning Daytona, Sebring, Le Mans, and finishing second at Spa, the MK II also won the World Championship for prototype cars in 1966, thereby meeting the original objectives set forth in 1963.

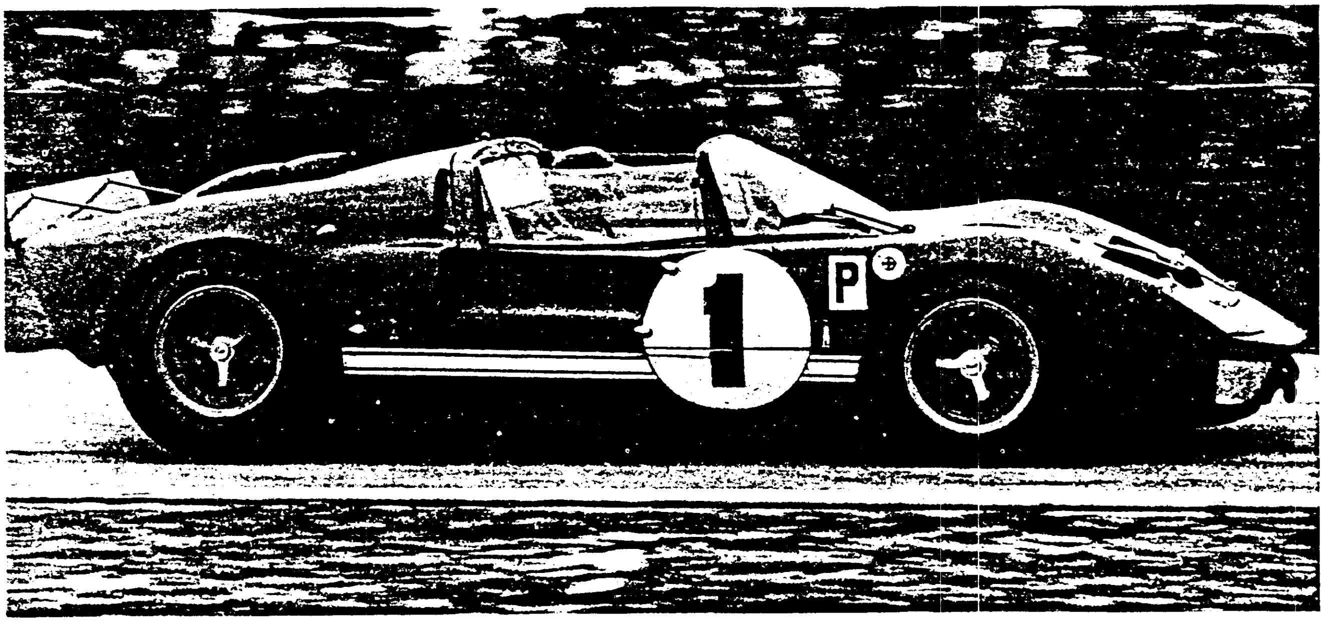

Figure 35 — XI Car Winning Sebring 1966

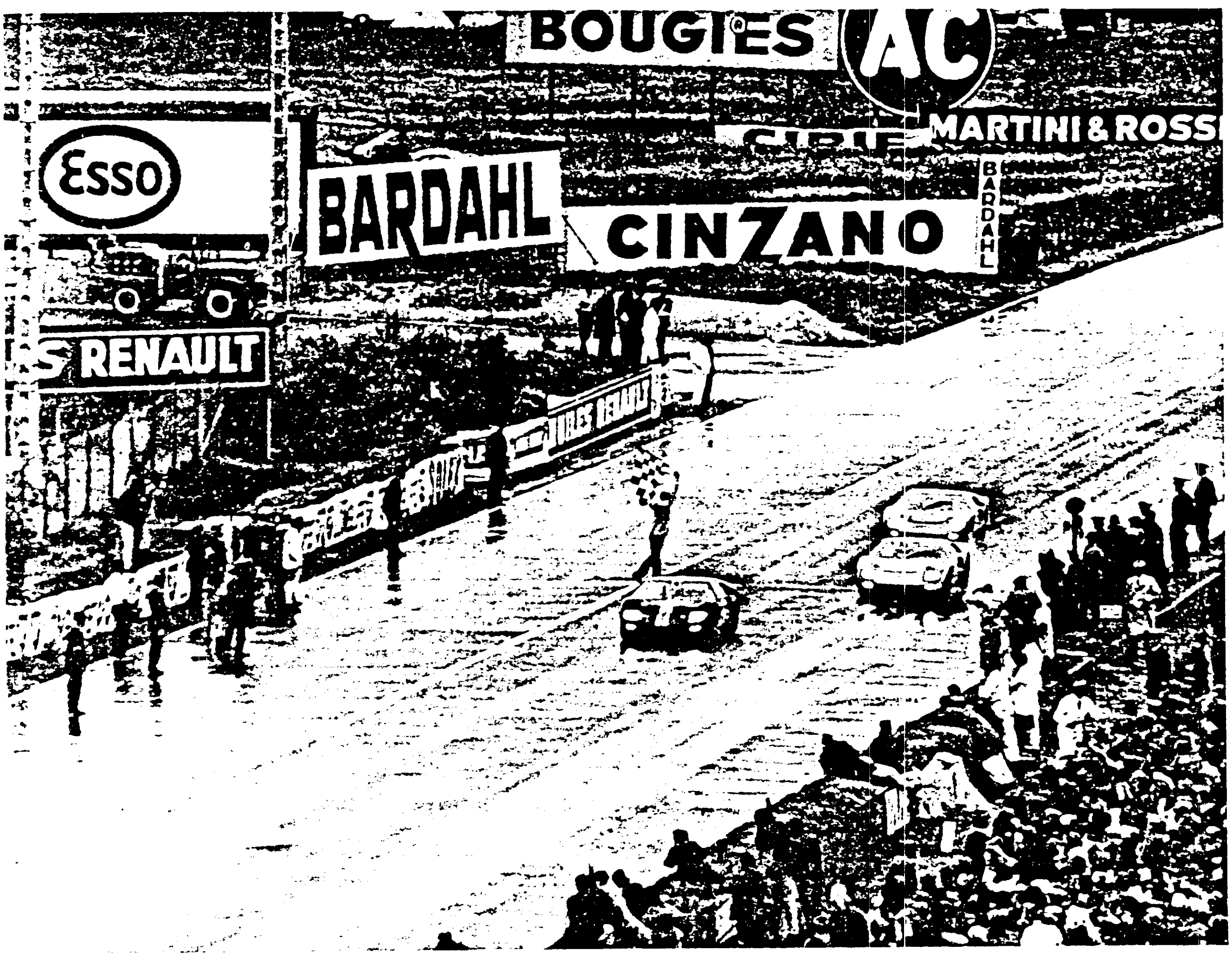

Figure 36 — The Three MK II's Taking Checkered Flag at Le Mans 1966

SUMMARY

It required three years, new technology, facilities and financial backing to take the Ford GT from the drawing board to the checkered flag at Le Mans. But above all, it required personal effort, ingenuity, skill, incentive and courage on the part of individuals to bring the project to fruition. The racing achievements will undoubtedly become a notation in the record book, but the contributions to automotive technology should provide a lasting satisfaction to all those who participated in the program.