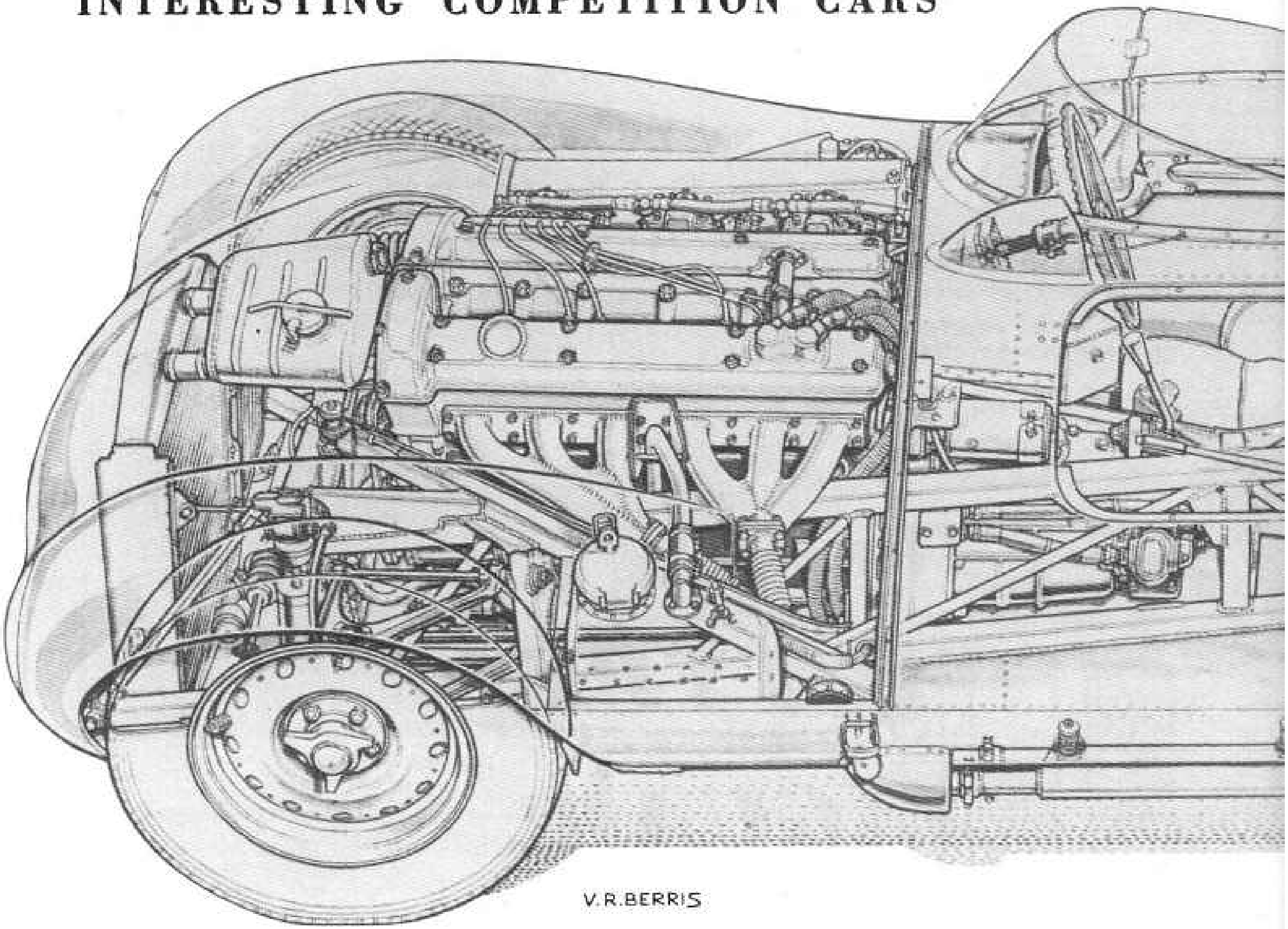
JAGUAR CARS LIMITED COVENTRY

The "D TYPE" JAGUAR

Reprinted from The Autocar

INTERESTING COMPETITION CARS



THE D-TYPE

MONOCOQUE CONSTRUCTION REPLACES

ON the two recent occasions when it has appeared in public, the new competition Jaguar has been extremely successful. At Le Mans in June it gained second and fourth placings, beaten only by the Ferrari powered by a 4,954 c.c. engine, while, soon afterwards at Rheims, it gained the first two places in the 12-hour Sports Car Race. The race averages were 105 m.p.h. at Le Mans (the winning Ferrari recorded 105.1 m.p.h.), and 104.55 m.p.h. at Rheims. So much for its performance, but what of the car itself?

How does it compare with previous competition Jaguars; for example, the cars that gained first, second and fourth positions in the Le Mans 24-hour Race of 1953? The current car is in the direct line of descent from previous models, although there are a number of important differences, outlined in the brief description in *The Autocar* of May 7, 1954.

There are at least two ways of improving a given car's performance: by obtaining greater power from the engine, and by reducing the resistance to motion. The first method increases the amount of work required from the mechanical components; the second can make their task less severe—both approaches have been exploited in the D-type Jaguar.

The C-type Jaguar was built around a tubular frame, the main frame members taking the stresses, while the body panels played a relatively small part in providing structural rigidity. For the D-type, the design of the chassis has been completely revised; there is no separate chassis as such, but the car is built around what may be called a centre-section of monocoque construction and immense strength. This provides a very rigid structure and also results in a useful weight reduction

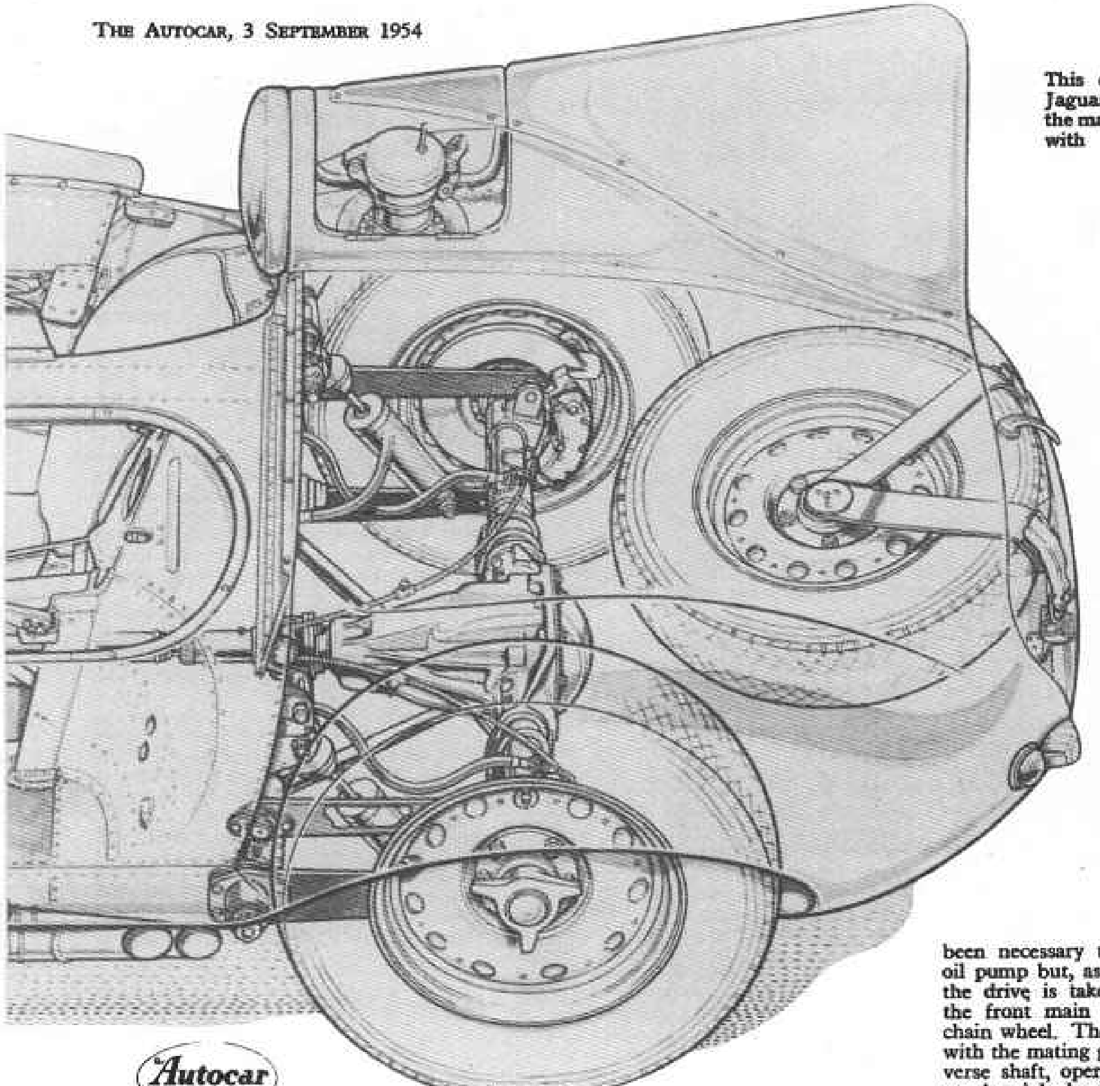
The Main Structure

To obtain a clear picture of how the body structure is designed, it is perhaps easiest to consider it as three sections; the centre portion, forming the basis of the structure; the front section, integral with the centre section and housing the engine and front suspension; and the tail assembly (containing the fuel tanks and spare wheel), which is bolted to the centre section.

The centre section consists of an elliptically shaped tube in which are cut suitable openings for the driver and passenger. Below the major axis of the ellipse, extra stiffening is provided by massive L-section pressings, riveted to the main section so that they form, in effect, two tubular members, approximately triangular in cross-section. Both ends of the centre assembly are enclosed by diaphragms which form the front and rear bulkheads.

At the front, a large box-section member is provided above the major axis of the ellipse by the use of two diaphragms and a lower closing plate. In the front bulkhead a central opening houses the transmission and provides additional space for the driver's legs.

The rear bulkhead requires only a small opening, for the propeller-shaft. The good torsional rigidity and beam strength of the centre section is also increased by four tubular members which extend diagonally forward and are welded to the front cross-member. These tubes embrace the complete power unit, while further stiffening is provided by two additional square-section tubes which



This drawing of the D-type Jaguar shows the layout of the major components together with the main structural members.

JAGUAR

TUBULAR FRAME

run forward diagonally from the front of the bulkhead to meet in the centre of the front cross-member frame. They pass over, and are welded to, the two upper main frame tubes. The whole of the body structure is riveted and arc welded from magnesium alloy, the skin being of 18 gauge material.

Two transverse box-section members are secured to the rear diaphragm, and to these are attached massive vertical assemblies, each of two vertical plates riveted to a channel-section spacer, the whole forming box-section members housing the bearings of the trailing-link rear suspension.

The rear section of the body, which does not carry the main loads, is attached to the centre section by bolts around the periphery of the ellipse, while four additional bolts secure the rear assembly frame members to the rear suspension housing assemblies.

Although the D-type Jaguar is a completely new car, as many standard components as posible are utilized. For example, although the power unit has dry sump lubrication and develops more power than the standard XK 120 power unit, standard production castings are used for both block and cylinder head —a fact which speaks well for the basic design and layout of the engine and demonstrates to the owner of the normal production machine that his power unit is by no means operating near to the bone!

Developments in the XK 120 engine were outlined in some detail in the April 24, 1953, issue of *The Autocar*. It is, therefore, intended to explain quite briefly some of the subsequent modifications. All details of modifications are not at present available, for, with any competition machine, detailed development continues until it is superseded by a later model.

Engine Details

A single iron casting forms the cylinder block and crankcase, and the bores (which are relatively long, with a bore to stroke ratio of 0.778 to 1), are machined direct in the casting. The general layout of the crankcase is simple, and there is ample structural rigidity, produced by the internal webbing and the arrangement of the housings for the seven main bearings. The crankshaft and big-end bearings are of indium-coated lead-bronze bearings, and the shaft itself is of EN16 steel.

The engine has no flywheel, but there is a substantial crankshaft torsional vibration damper at the front, and flywheel effect is produced by the mass of the triple dry-plate clutch and its housing, together with the starter ring which is pressed on the clutch assembly centre section.

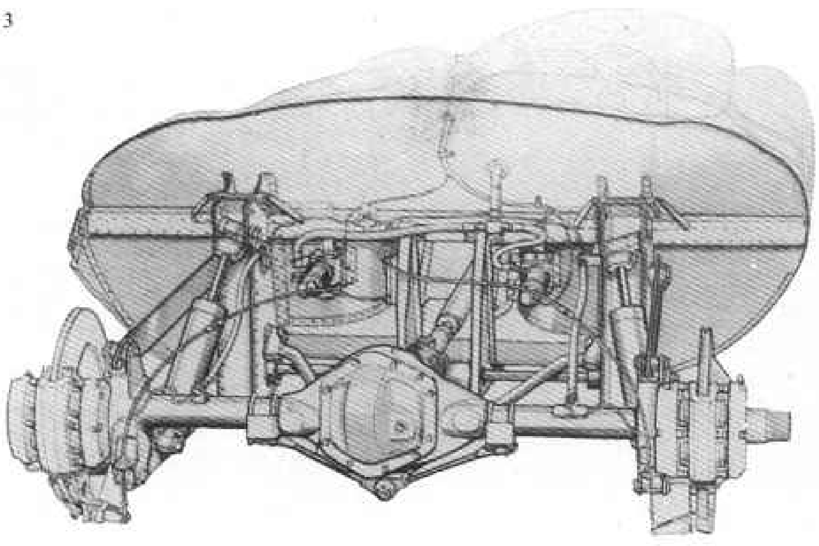
The most noticeable difference in the appearance of the engine is caused by the change from wet to dry sump lubrication, made to reduce the height of the engine, the sump height having been halved. This not only enables the bonnet line to be lowered considerably without adversely affecting ground clearance, but also lowers the centre of gravity of one of the major masses.

It has, of course, been necessary to provide an additional oil pump but, as on the standard engine, the drive is taken from a gear between the front main bearing and the timing chain wheel. The crankshaft gear engages with the mating gear which drives a transverse shaft, operating the pressure pump on the right-hand side of the engine and the scavenge pump on the left-hand side.

Oil from the tank is drawn by the pressure pump and directed to the bottom of the oil cooler. Forced through the cooler, it passes along an external pipe to the crankcase where it lubricates the bearings via internal drillings in the normal way. Falling to the base of the sump, the oil is returned to the tank by a dual scavenge pump. It is, of course, necessary to make provision for rapid return of the oil to the tank to prevent build-up of lubricant at the base of the engine, and it must also be remembered that oil produces more resistance than air to crankshaft webs rotating at high speed.

With dry sump lubrication, one of the main problems is to prevent aeration of the lubricant, and on the Jaguar engine this has been accomplished by baffles inside the oil tank, with a breather pipe from the top of the tank connected to the crankcase.

As with the production engine, a light alloy cylinder head is used, with valve seat inserts for both inlet and exhaust valves. It has hemispherical combustion chambers and inclined valves, and the engine operates on a compression ratio of 9 to 1. To aid installation, the engine is inclined in the chassis at an angle of 8 deg to the left when viewed from the cockpit. The barrels of the three double-choke Weber carburettors are set at a similar angle to the vertical centre line of the engine, so that they are truly horizontal when the unit is installed. Six



The rear suspension is by means of trailing links and a one-piece torsión bar which is anchored at the centre. Note the disc brakes and additional caliper hand brakes at each end of the axle.

tubular intake ducts are attached to the carburettor intake flanges, and connected by a large-diameter balance tube, the side walls of the intake tubes being cross-drilled at the appropriate points.

An intake duct in the bonnet conveys air from the radiator grille to an open-ended box which, surrounding the carburettor intakes, eliminates the need for pressure balancing pipes to the float chambers. The two three-branch, welded exhaust manifolds direct the gases via two short, flexible pipes into the two main outlet pipes. Just before the pipes terminate in front of the left-hand-side rear wheel, they are enclosed in a sheet-metal cover somewhat similar to a small silencer, which, in conjunction with drilled holes in the inner walls of the pipes, forms an effective expansion chamber and provides substantial mounting points for securing to the main body structure.

An orthodox arrangement of engine cooling is adopted, but to enable the bonnet height to be kept low a separate light alloy radiator header tank is placed between the front of the engine and the radiator. After passing through the head the coolant is conveyed to the tank which contains outlet pipes at each side, with a central, longitudinal baffle. The intake pipe discharges the coolant near the centre in order to feed both outlets equally and to prevent ineffective cooling that might be caused by the coolant being directed to one side of the radiator.

Both oil and coolant radiators are of light alloy and produced by Marston Excelsior. The radiator system is pressurized to 4lb per sq in by means of a valve unit mounted in the back of the tank.

A conventional fuel system is used, but an unusual feature is the use of flexible tanks, supported in light alloy boxes. To obtain the desired range between refuelling stops, two tanks are used. Twin petrol pumps, placed behind the rear diaphragm, connect to a common delivery pipe to the carburettors.

Power is transmitted from the engine via the triple-plate clutch to the four-speed synchromesh gear box. The main clutch body contains three sets of internal splines equally spaced around its bore, mating with the external splines on the two intermediate driving plates. The rear clutch driven plate is attached to a centrepiece which is internally splined to mate with the gear box input shaft, and contains three sets of external splines carrying the first and second driven plates.

The pressure plate assembly, bolted to the rear, contains six springs together with the toggle levers, which are operated by the ball-bearing thrust withdrawal mechanism. The actual clutch operation is hydraulic by a Girling unit. Radial holes are drilled in the clutch body, to assist cooling and allow lining dust to escape. The complete clutch assembly is housed in a conventional bell housing, with an opening at the back for the starter motor, which is above the transmission on the engine centre line.

Single helical gears are used in the gear box and special close ratios have been chosen. The gears are selected by a short change lever conveniently placed

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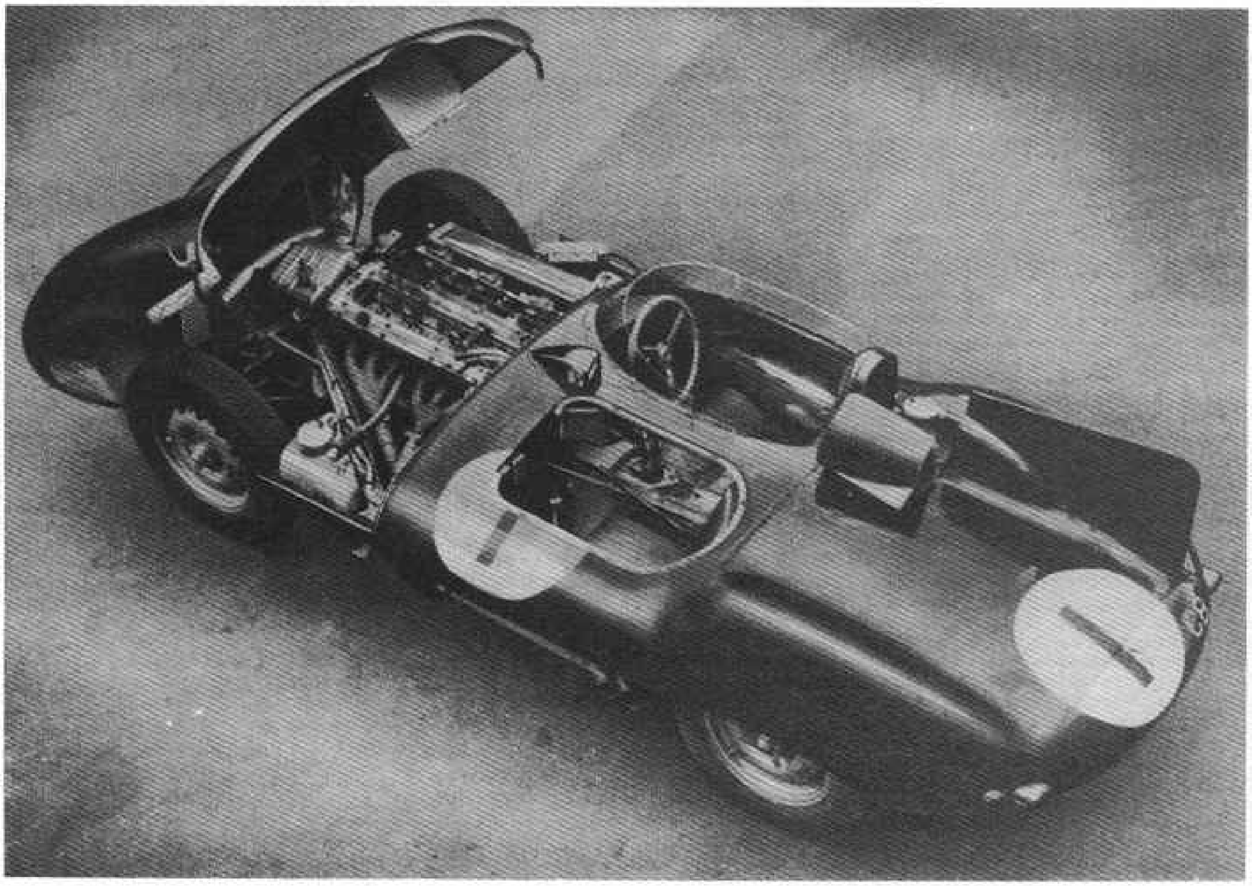
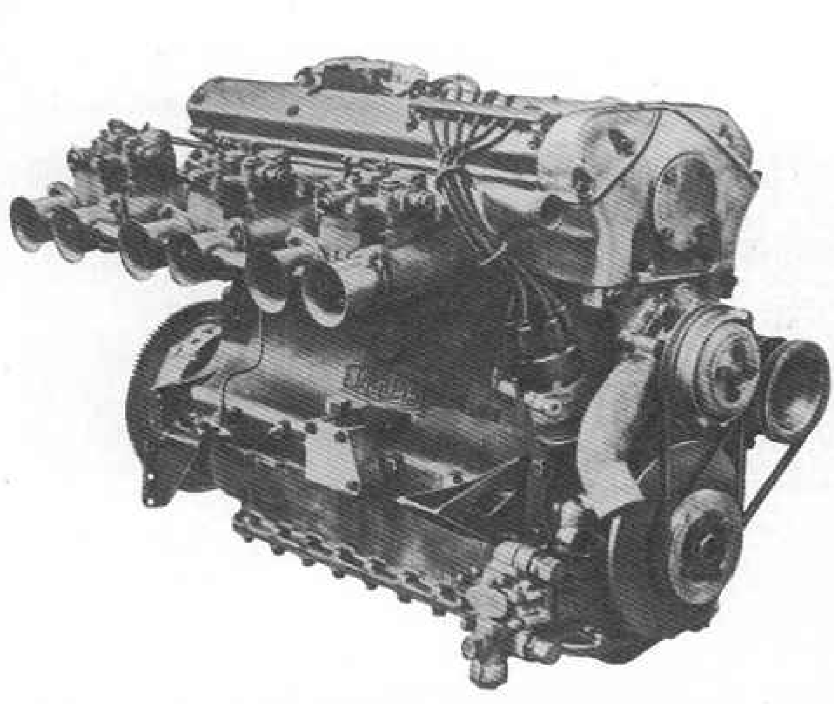
With the bonnet open the engine and front suspension are very accessible. The oil tank is carried just behind the left front wheel, while the small battery is placed in a similar position behind the right wheel. The large pipe running from the oil tank between the two exhaust manifolds is a breather which is connected to the engine.





The D-type engine can be distinguished by the very shallow sump used in conjunction with the dry sump lubrication system. The torsional vibration damper can be seen at the front of the engine behind the dynamo and water pump driving belts.

just aft of the gear box unit. A small, flexible breather pipe extends forward and upward to the front of the main bulkhead.

From the rear of the gear box, a short Hardy Spicer propeller shaft continues the drive to the Salisbury rear axle. Except for a change in ratio and modified length of the axle tubes, this unit is similar to that fitted in the production XK. It has a hypoid final drive with a ratio of 2.79 to 1 and, with the tyres

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used at Le Mans, this gives a speed of 183 m.p.h. at 6,000 r.p.m. engine speed.

The front suspension is by upper and lower wishbones and longitudinal torsion bars. The inner fulcrum bearings are in line with the longitudinal centre line of the chassis, and rubber bushes form both upper and lower bearings; the front bushes are conical, while the rear ones are parallel. The upper wishbone—a one-piece forging—contains the ball housing at its outer end to permit the required movement for suspension and steering, while at the inner end there are two split bosses with pinch bolts.

The front boss is threaded internally, while a smaller diameter, plain section is provided for the rear one, the shaft which forms the top wishbone inner fulcrum having screwed and plain portions to mate with the wishbone. These two portions are concentric with the axis of the shaft, but the portions which pivot in the rubber bushes are eccentric, and the combined effect of the screw thread and eccentricity enables the wheel caster and camber to be adjusted after assembly.

With a number of torsion bar front suspensions, the bar supporting the weight of the car is concentric with the lower pivot point, but in the Jaguar layout, the front member of the lower wishbone assembly extends from its fulcrum point towards the centre of the car, forming a splined attachment for the bar which runs at an angle of 2¼ deg to the centre line of the car. This enables the bar to be changed without disturbing the main suspension components, but it also means that the suspension characteristics are modified slightly by the combined effects of bending and torsion. To adjust the height of the car, a vernier arrangement of splines is provided.

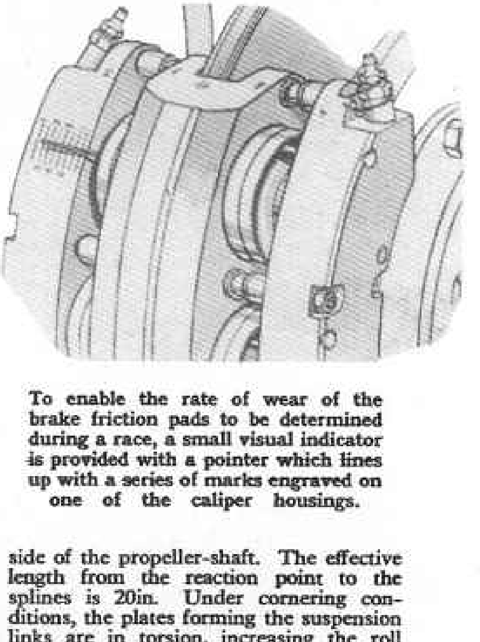
Rack and Pinion Steering

The steering arms, extending in front of the wheel centre line, are linked to the rack and pinion steering unit, which is placed fairly high in front of the main cross-member assembly. There is a universal joint in the steering column.

At the rear, the suspension consists of a live axle, trailing arms and a torsion bar. Two massive, box-section members attached to the main body structure provide bearing housings for the trailing-link units. The top links are 16in long and of flat steel plate of approximately 2×¼in section. Rubber bushes are used for both the inner and the outer bearings. Metal bushes used for the lower bearings are 1⅜in diameter, and are lubricated by grease nipples. Steel plates are also used for the lower links, and these have a similar centre distance to those above, so that a true parallelogram is formed.

To provide attachment of the lower links to the torsion bars, bearing units are riveted to the inner ends of the lower links; these are also bored to provide clearance for the torsion bar, and contain a larger diameter outer ring which is internally splined. The ends of the torsion bar, also splined, are of a much smaller diameter, so that, to connect the torsion bar to the rear links, rings are used which are externally splined to mate with the lower links and internally splined to connect with the torsion bar.

The single torsion bar used for the rear suspension has an enlarged centre section which is attached to a reaction plate bolted to the centre of the main body structure and containing arms which pass on each

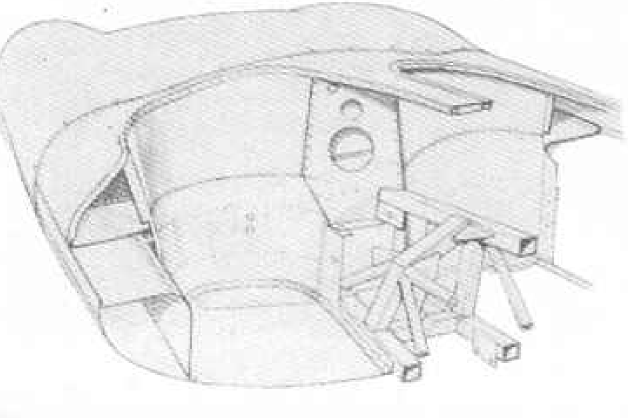


To enable the rate of wear of the brake friction pads to be determined during a race, a small visual indicator is provided with a pointer which lines up with a series of marks engraved on one of the caliper housings.

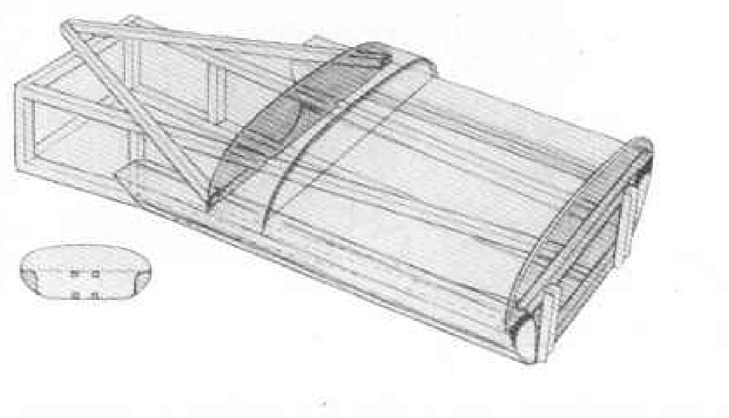
side of the propeller-shaft. The effective length from the reaction point to the splines is 20in. Under cornering conditions, the plates forming the suspension links are in torsion, increasing the roll stiffness of the car and necessitating the use of material for the links which will permit some flexibility.

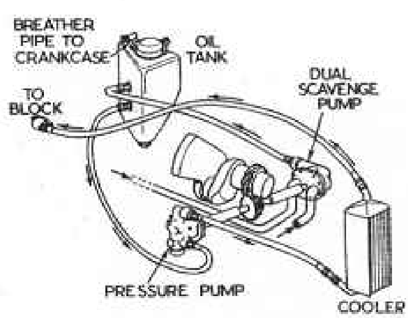
To provide transverse location of the axle unit, an open A bracket is pivoted to the main structural members, the bearings being slightly forward of the link bearing line, while the apex of the A

How the tubular frame members are united with the rear diaphragm plate. To provide extra clearance for the driver, a small diameter tube is used in place of a large square section one for the top right-hand member.



This sketch gives a diagrammatic representation of the main members which form the structure of the car; this complete magnesium-alloy structure has been carefully stressed to provide maximum rigidity with very light weight.





Engine lubrication: A cross shaft, gear driven from the front end of the crankshaft, provides the drive for the pressure and scavenge pumps.

attached to the lower link and bracketed to the main body structure. Built-in bump stops in the dampers consist of large rubber pads placed around the main damper spindle, which contact with the top of the main damper casing, while hydraulic rebound stops are also incorporated.

It was emphasized previously that one of the methods used to improve the performance of the new D-type car was to reduce wind resistance. When the drag of a car is reduced, so that it requires a relatively small b.h.p. to propel it at a high speed, it also requires extremely good brakes, since the retarding effect of air resistance has been reduced. As on last year's cars, Dunlop disc brakes are fitted to all four wheels. They have $12\frac{3}{4}$in diameter discs and three pairs of pads are used at the front, and two at the rear, to provide the required braking distribution. All the pads are $2\frac{3}{16}$in diameter, so that the total friction lining area for the foot brake is 45 sq in front and 30 sq in rear. To improve the brake life, the volume of the friction material has been increased by approximately 20 per cent since last year.

Structurally, the brakes consist of a caliper, machined from medium carbon steel, attached to a suitable flange on the front or rear suspension in the same way as the brake back plate is fixed on a drum-brake system. Bores in this caliper provide housings for the brake pads—which are circular blocks of brake lining material—so that torque reaction is taken by the caliper housing.

To eliminate the effect of disc distortion which might arise through deflection of the rear axle half-shafts when cornering, the rear brake pads are placed symmetrically about the horizontal axis of the wheel centre line. The brake discs are of mild steel, which is hard chromium plated to reduce the rate of wear.

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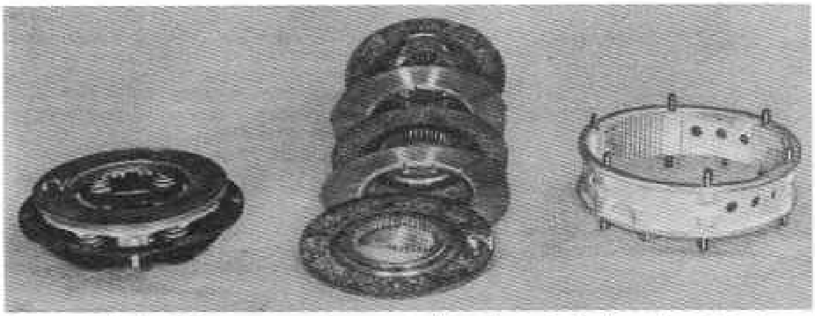


To transmit the drive a neat and compact triple plate clutch is used, and the two intermediate driving plates are splined into the centre portion of the clutch housing.

terminates in a bearing which is secured by a bracket to the axle tubes, serving not only to provide transverse location but also to determine the height of the rear roll centre.

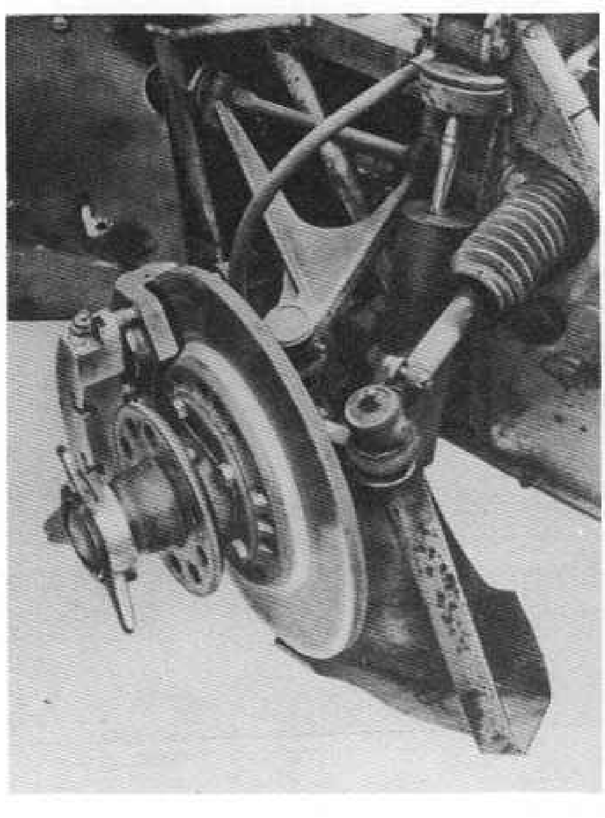
The suspension is damped by CDR $4\frac{1}{3}$ type Girling telescopic dampers. At the front these are attached to the upper section of the front cross member at the top and the lower wishbone at the bottom, while the rear dampers are inclined transversely to clear the upper suspension links, the damper itself being

Under very arduous conditions, the temperature rise in and around the caliper area might cause the brake fluid to boil. To provide adequate cooling, the brake-operating cylinders—one for each pad, twenty cylinders therefore, being required—are arranged in the form of light alloy blocks, attached to the calipers by bolts and distance pieces to provide adequate air space. The outer end of each piston has a spherical seating so that slight tilting of the brake pad does not produce severe side loading on the piston. A normal type of rubber diaphragm seal is fitted towards the outer end of the piston to prevent foreign matter from reaching the cylinder bores. Drillings in the light alloy block take the supply pipes, while nipples are provided at convenient points to enable the system to be bled.

Automatic Adjustment

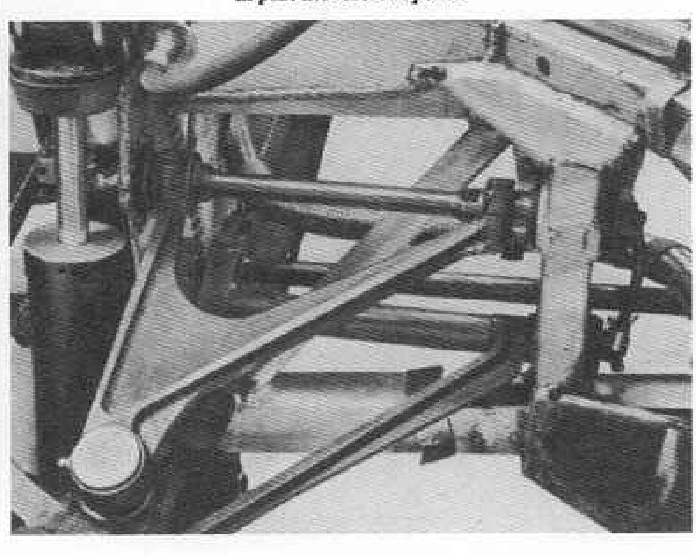
It is necessary to reduce to a minimum the movement required to bring the brake pads into contact with the disc, but at the same time to ensure that the pads are not rubbing when the brakes are not applied. If an unnecessarily large clearance were provided between pad and disc there would be an excessively long pedal movement before the brakes came into operation, owing to the large number of operating cylinders that are employed in this system.

To overcome this difficulty an ingenious system of retraction and automatic adjustment is provided to maintain



Left: Air scoops form part of the unsprung mass on the front suspension, and direct air over the front brake discs.

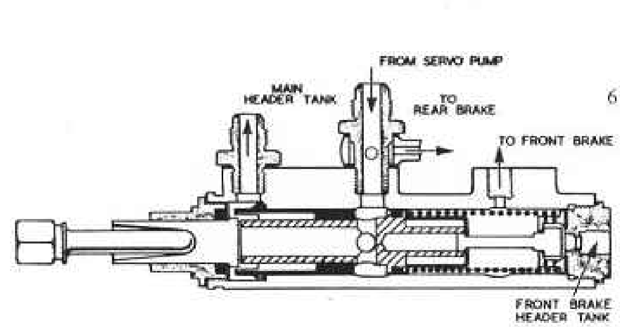
The front torsion bars are attached to an extension on the front portion of the lower wishbone, which is continued in past the fulcrum point.



only 0.010in to 0.015in clearance between the pad and the disc when the brakes are in the off position.

To apply the brakes, a dual hydraulic system is provided, with servo assistance by a Plessey pump driven, from the back end of the gear box, whenever the propeller-shaft is rotating. A simple hydraulic layout is used to operate the front brakes which, if necessary, can be applied without assistance from the servo, in the event of a failure occurring in the servo circuit.

With the servo in operation, the fluid is pumped from the header tank into the rear of the master cylinder, through four cross drillings into the hollow centre-



The layout of the pistons in the brake master cylinder. An hydraulic servo is used.

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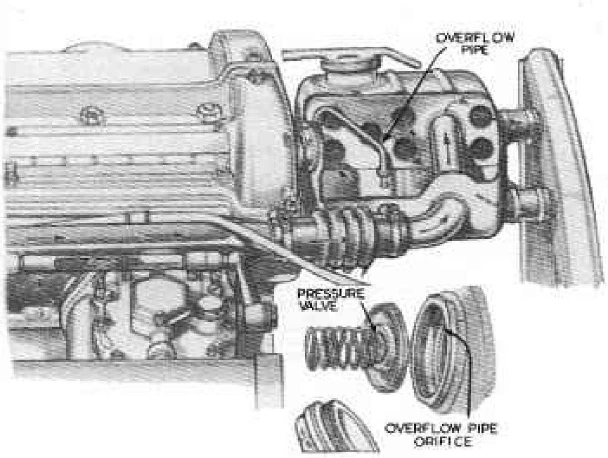


A baffle plate is fitted halfway across the radiator header tank to distribute the flow through both sides of the film block. The overflow pipe from the pressure valve runs out through the base of the header tank.

section of the rear portion of the piston, and out into another pipe which returns to the header tank. Whenever the car is in forward motion the fluid circulates in this way.

When the brakes are applied, the rear piston is forced against the main piston, applying the front brakes, and at the same time preventing the fluid from the servo pump returning to the header tank. The line pressure from the servo pump increases, and as this pipe is connected to the rear brakes they also are applied, and at the same time the build-up in servo pressure exerts a force on the back of the master cylinder piston which applies the front brakes.

Although it is necessary for the driver's foot to close the valve which increases the line pressure, the area so covered is much less than the area of the front brake master cylinder piston, and it is this difference which determines the servo ratio.

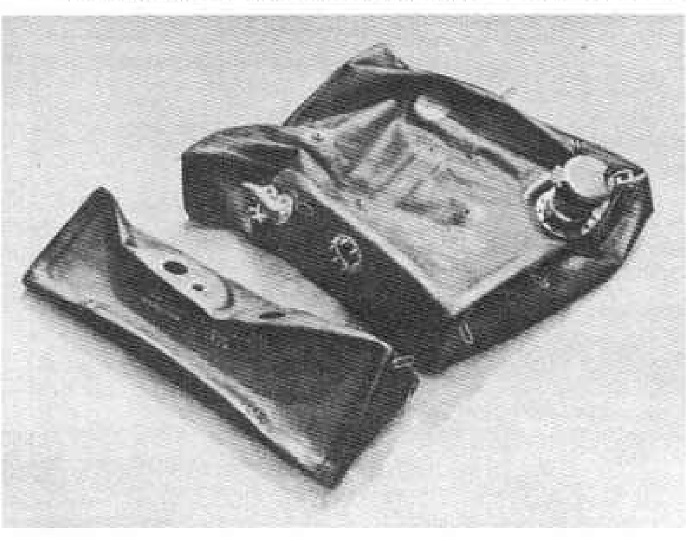
As the servo pump is driven from the output side of the propeller-shaft, it will be rotated in reverse whenever the car moves backward, and, unless precautions were taken, this might cause air to be drawn into the system.

A valve box is fitted between the input and output pipes from the pump, with a non-return valve so placed that pressure in the suction side of the pump causes the valve to open, providing a short open circuit between inlet and outlet sides of the pump. Two separate sets of mechanically operated calipers with triangular friction linings, fitted below the main hydraulically operated units on the rear brakes, are operated by a single cable connected to the handbrake lever by a pulley compensating mechanism.

To reduce weight, perforated disc light alloy wheels are used. They have a centre-lock fixing but, in place of the splined hub often used on a conventional centre-lock wheel, the wheel disc is attached to a steel centre portion by five bolts which have domed heads. These locate in holes drilled in the back flange of the hub and transmit drive or braking torque.

The cockpit is well laid out and is free from unnecessary equipment. It contains three instruments—a tachometer with an additional hand to record the maximum speed which the engine attains, an oil pressure gauge and a water temperature gauge. The steering wheel is adjustable and held on its splined column by a screwed clamp. In true racing tradition it has light alloy spokes and a neat wooden rim.

The curved plastic windscreen sweeps well round the sides of the cockpit, and the rear part of the body has a head rest just in front of the fuel filler cap and, to improve the direction stability under adverse wind conditions, particularly at speeds of over 150 m.p.h., a tail fin which neatly blends into the driver's head rest.



The fuel is carried in two flexible tanks which are neatly fitted into light alloy boxes in the tail of the car.

SPECIFICATION

Engine.—6-cyl. 83 × 106 mm, 3,442 c.c. Compression ratio 9 to 1. 250 b.h.p. at 6,000 r.p.m. Maximum torque 242 lb ft at 4,000 r.p.m. Seven-bearing crankshaft. Hemispherical combustion chambers. Overhead valves operated by twin overhead camshafts.

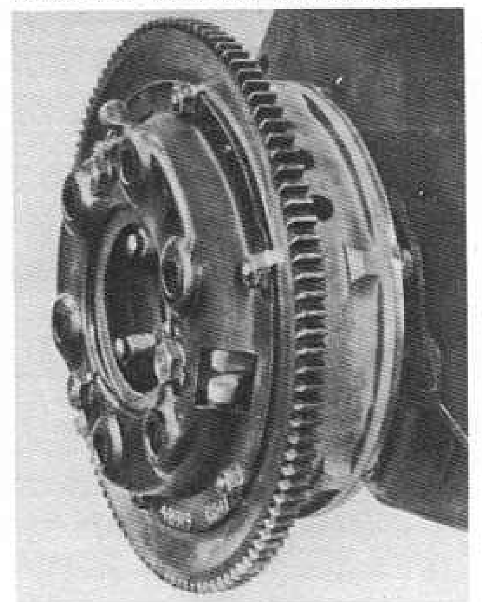
Clutch.—Three plates, six springs. Hydraulically operated, ball-bearing withdrawal mechanism.

Gear Box.—Ratios: Top 2.79; third 3.57; second 4.58; first 5.98 to 1. Reverse 6.1 to 1.

Final Drive.—Hypoid bevel, ratio 2.79 to 1 (14:39). Two-pinion differential.

Suspension.—Front, independent, wishbone and torsion bars. Rear, trailing link and torsion bar. Suspension rate (at the wheel) front, 120 lb per in; rear, 120 lb per in.

Brakes.—Dunlop disc. Three-pad front; two-pad rear. Discs: front 12¾in diameter,



The starter ring is attached to the centre of the clutch casing; no normal flywheel is used, the necessary flywheel effect being obtained by the mass of the clutch and ring.

rear 12¾in diameter. Total lining area: 75 sq in; 45 sq in front.

Steering.—Rack and pinion. Eight-toothed pinion. 1½ turns from lock to lock.

Wheels and Tyres.—Dunlop light alloy, perforated disc, centre-lock wheels. 6.50-16in Dunlop racing tyres on 5.00-16in rims.

Electrical Equipment.—12-volt; 40-ampère-hour battery. Head lamps, 48- or 60-watt bulbs.

Fuel and Oil System.—37 Imp. gallons in two flexible tanks. Oil capacity 3½ gallons.

Main Dimensions.—Wheelbase 7ft 6in; track (front) 4ft 2in; (rear) 4ft. Overall length 12ft 10in. Width 5ft 5⅝in. Height, at scuttle, 2ft 8in; at fin, 3ft 8in. Ground clearance 5½in under sump. Frontal area 10.85 sq ft. Turning circle 32ft.