THE NEW 23-60 H.P. VAUXHALL CHASSIS.

A Four-cylinder Overhead Valve Engine with Lanchester Balancer.

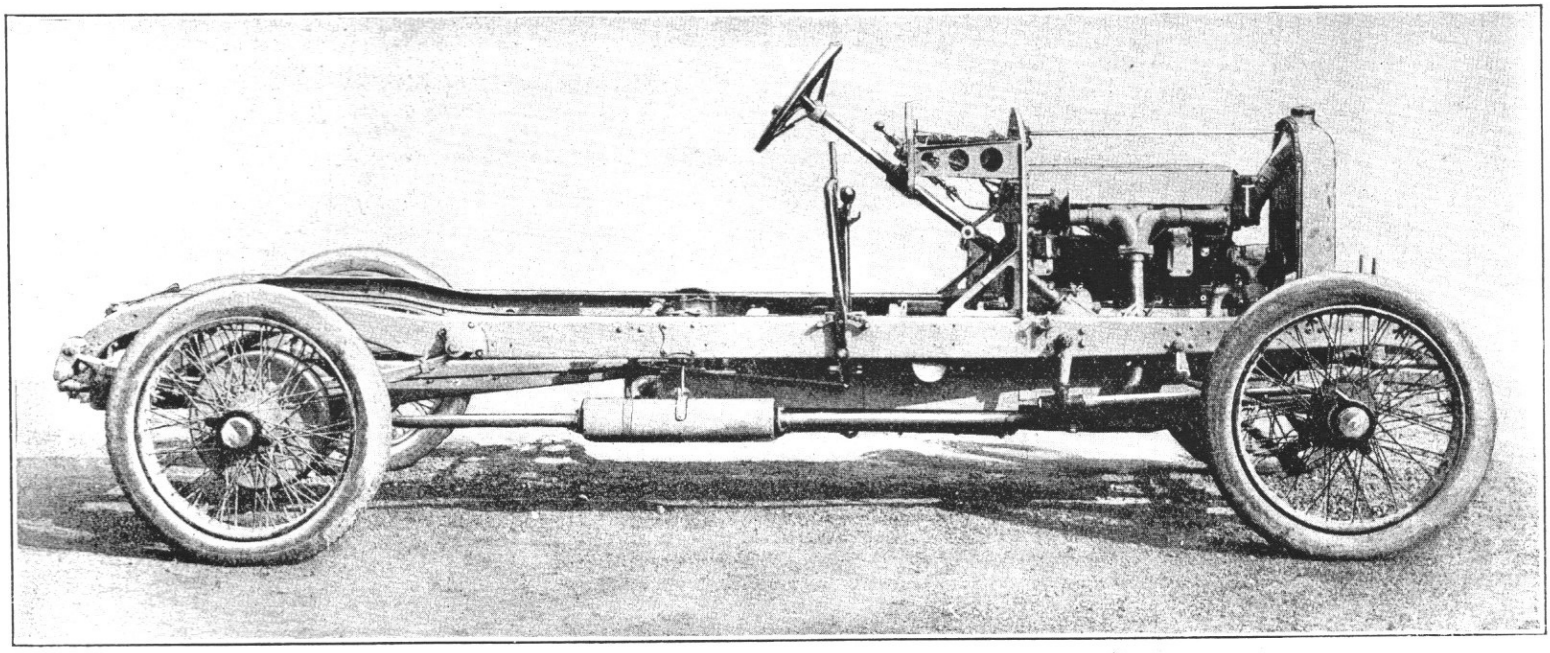
ALTHOUGH somewhat overshadowed by its companion model, the 30-98 h.p., the original 25 h.p. Vauxhall had the reputation of being a fast car of robust construction, well able to withstand the severe conditions accompanying sustained high speed over ordinary roads. It was for this reason largely employed as a Staff car during the war and gave excellent service.

The new chassis forming the subject of the following notes, embodies a few alterations to the 25 h.p. car, but it is of this model that it is the offshoot, and not of the 30-98 h.p. The important new features are the push-rod operated overhead-valves in a detachable head and the use of the Lanchester harmonic balancer to counteract the secondary out-of-balance forces in the four-cylinder engine.

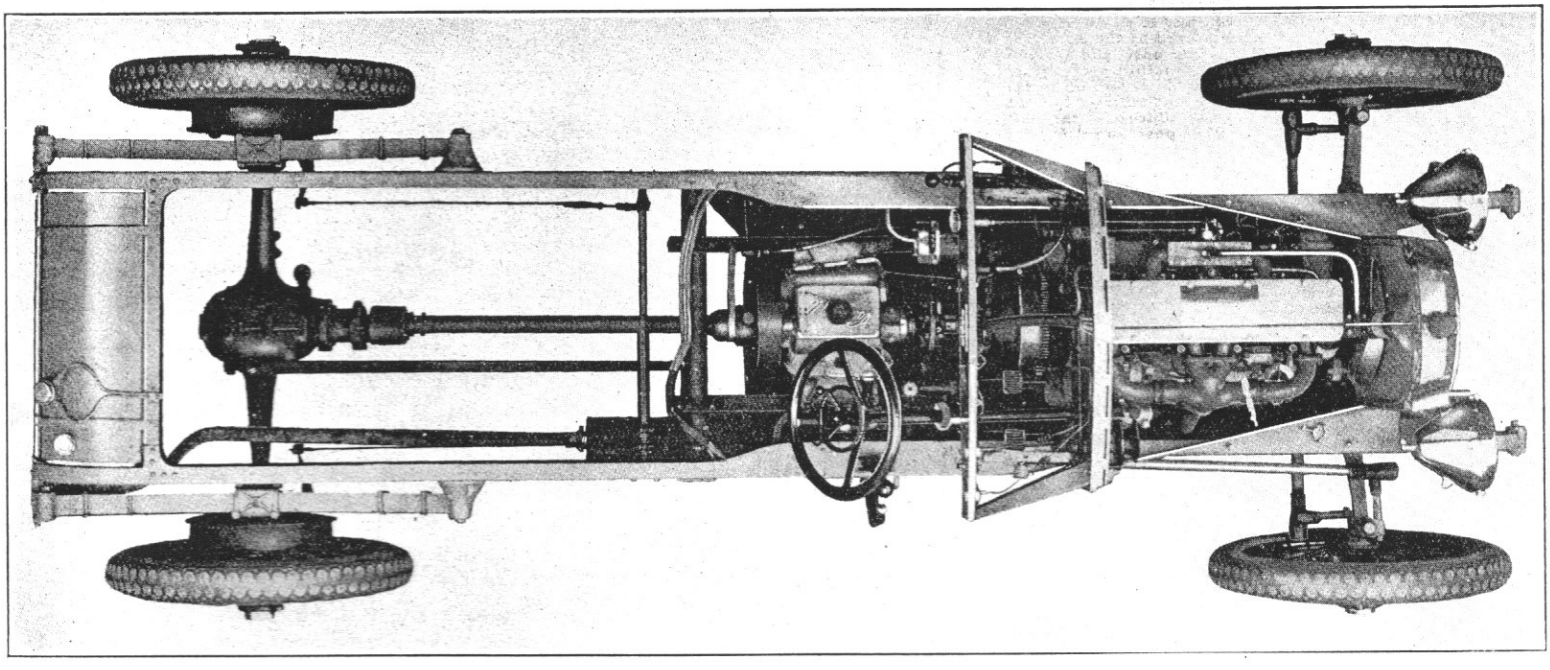
In the previous model, the engine had very large valves, placed side by side in pockets which had of necessity a considerable surface exposed to the hot gases and was of the type that performs best when run at a fairly high speed.

On the new engine, the reduced combustion chamber surface has given a much higher efficiency and better torque at low speeds. This has resulted in the new model being more suitable for use with covered bodies and for town work, although as the same dry disc clutch with its low moment of inertia making for easy gear-changing and the same gear ratios have been retained, the car has lost none of its previous speed and hill-climbing characteristics.

The chassis layout is fairly orthodox, and no attempt has been made to cut down weight at the expense of durability, such parts as the frame, the front and rear axles being particularly robust. Generous also are the proportions of the engine, which has a stiff crank case providing five large bearings for the crankshaft, while the camshaft and valve tappets have ample bearing surface.



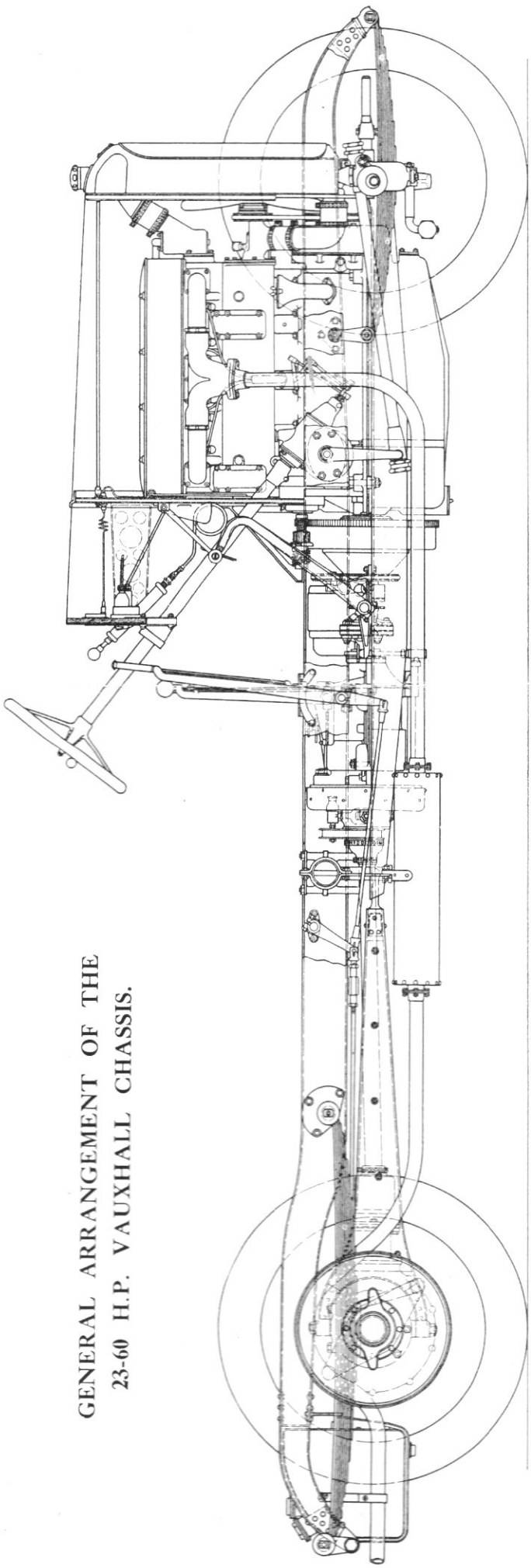
The 23–60 h.p. Vauxhall chassis.

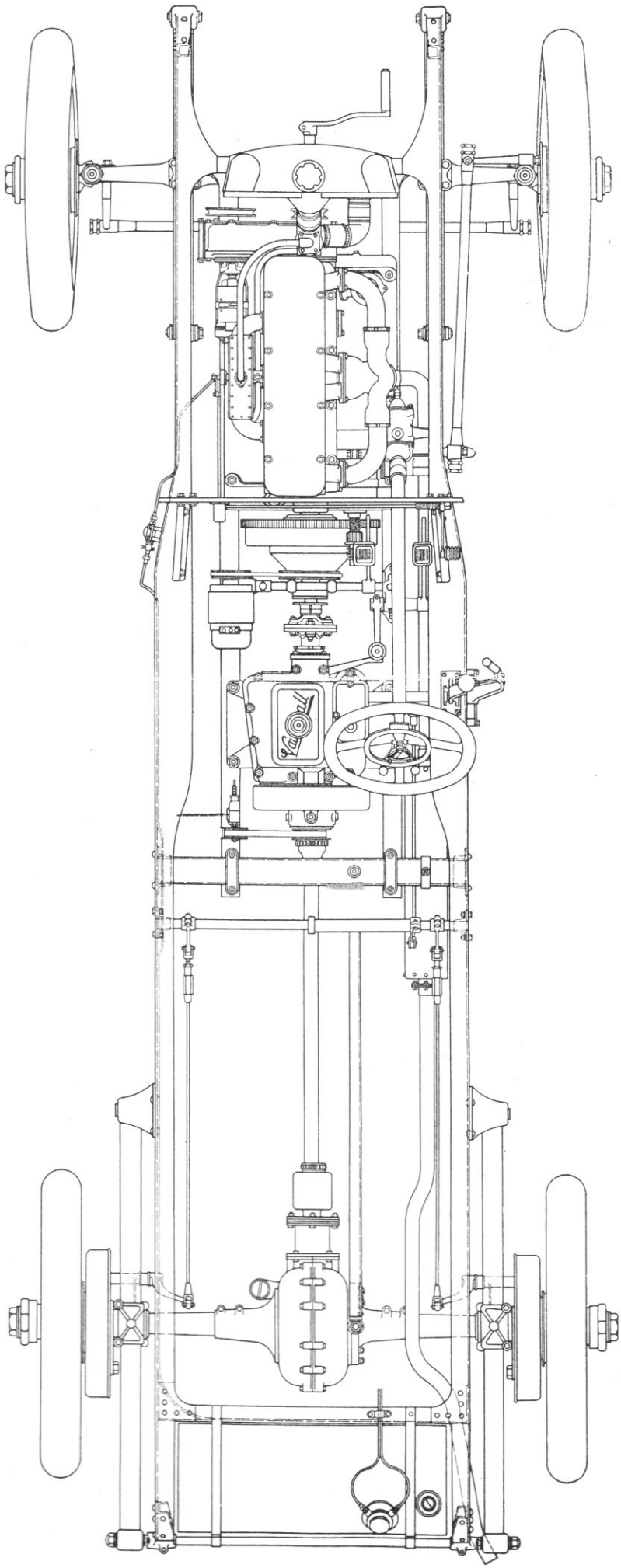


Plan view of chassis.

Engine.

With a bore and stroke 95 and 140 mm. respectively, the nominal horse-power is 25, the R.A.C. rating being 22·4 h.p.





GENERAL ARRANGEMENT OF THE
23-60 H.P. VAUXHALL CHASSIS.

Compared with the original side-valve Vauxhall engine, the new overhead-valve type develops greater power at high speeds, with the same compression-ratio (4·2 to 1) and identical cam-profile, notwithstanding the fact that the diameter of the valves ($1\frac{3}{4}$in. clear port opening) is less than on the previous model. When pulling at slow speeds the improvement is still more marked, and the torque at 500 revolutions per minute is nearly double that given by the previous engine, while the fuel consumption per horse-power-hour is much lower.

As a result of the reduced combustion chamber surface, the heat given up to the cooling water is noticeably less, the radiator temperature being lower in spite of the greater power developed. While these results are in accordance with what theory would lead one to expect, they are particularly interesting in this case, where no alteration has been made except in the valve location and combustion chamber form, so that an accurate comparison of the two systems is possible.

Cast in one piece, the cylinders are secured to the crank case by bolts screwed into the aluminium from underneath and retained by nuts on top of the cylinder flange. Large water spaces are provided and an additional outer wall, arranged with inspection openings above the tappet guides, encloses the tubular duralumin push-rods for the valves.

No less than three rows of studs are employed to retain the detachable cylinder head, one set being arranged on the centre line between each cylinder. The water connection takes the form of two aluminium cover-plates with cored passages on the off side of the engine bolted to vertical facings on the cylinder and head. The main joint has, therefore, only to seal the combustion chambers and it is understood that a copper-asbestos washer has been found unnecessary, reliance being placed on the direct contact of cylinder and head, which are carefully ground on a Pratt & Whitney surface grinder.

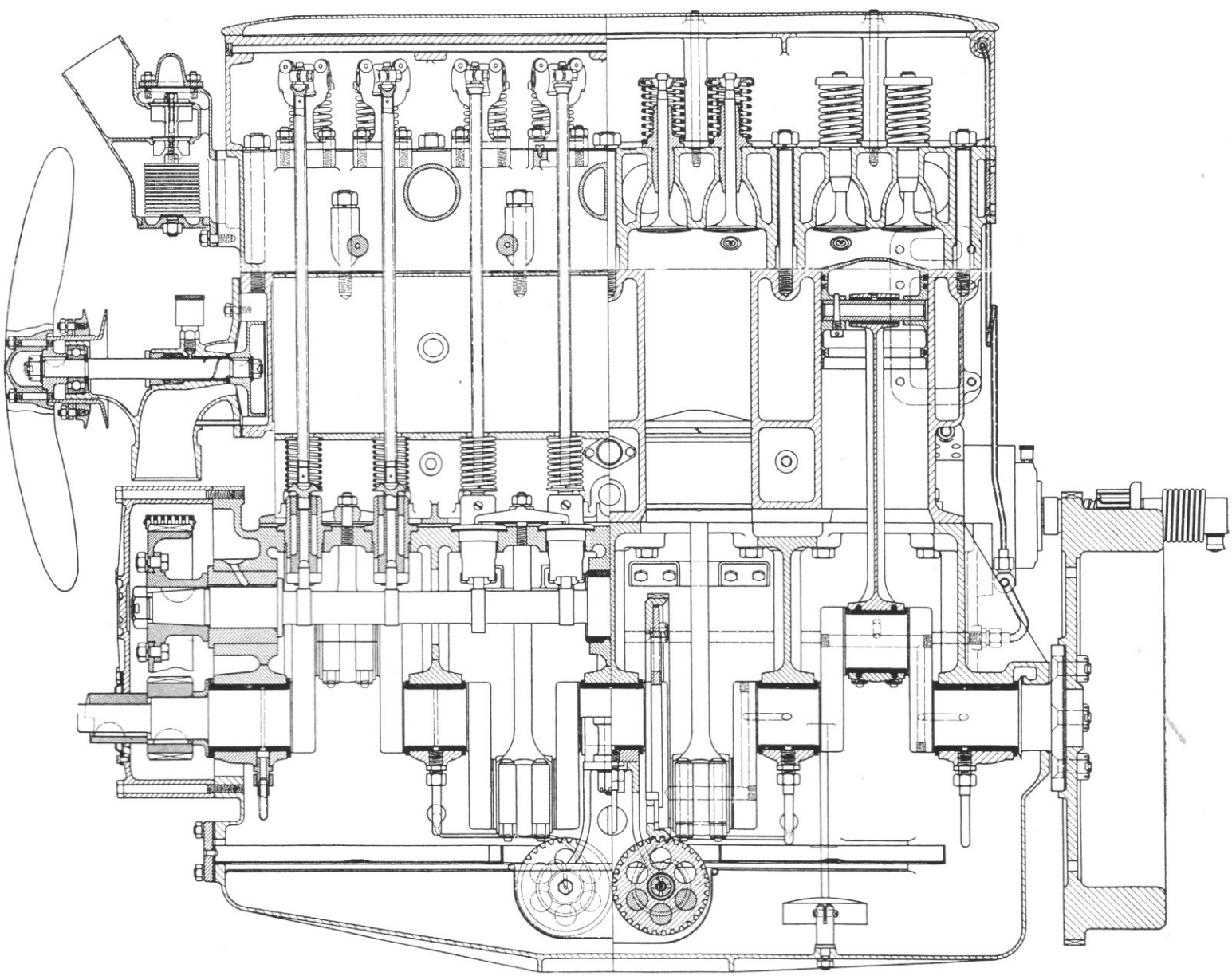
Following the usual practice of the Vauxhall Co., the "stainless" steel valves have seats formed at an angle of 30 degrees, instead of the more customary 45 degrees. A split conical collar enclosed by the usual washer retains the double valve springs, while the return of the valve tappets is ensured by strong springs surrounding the push-rods and bearing against a horizontal web on the cylinder casting.

Clearance adjustment is effected by ball-ended hardened screws which are locked in the split bosses of the rockers by small clamping bolts. Made of a nickel-chrome steel of fairly high carbon content, the rockers are not hardened where they bear on the ends of the valve stems, neither has it been found necessary to harden the stems themselves. Supplied by a small pipe from the main oil pressure system, a copper tube is cast into the aluminium valve rocker cover and is drilled at intervals to allow lubricant to fall on to the pivot bosses of the rockers. These are mounted on case-hardened pins clamped into the split forks of individual stampings fastened to the head by studs.

A spring-loaded ball valve is fitted in the oil supply pipe to ensure a minimum working pressure in the main system at low speeds, while the orifices in the copper tube are restricted by inserting split-pins.

Access to the overhead-valve gear is provided by a separate lid held down on to the valve rocker cover by studs screwed into the detachable head, the whole forming a rigid structure likely to be free from any resonance which might accentuate valve gear noise.

In view of statements that have been made to the contrary, it is, perhaps, desirable to emphasise the fact that no "hydraulic" tappet-cushioning device is



General arrangement of engine.

fitted to this engine. Following standard Vauxhall practice, the cams are made with a base circle having an eccentricity of $\frac{1}{16}$in. which operate roller-ended tappets working in large bronze guides secured in pairs by forked dogs.

Of cast-iron, the pistons are of orthodox design, and have two rings at the top and a scraper-ring in the skirt.

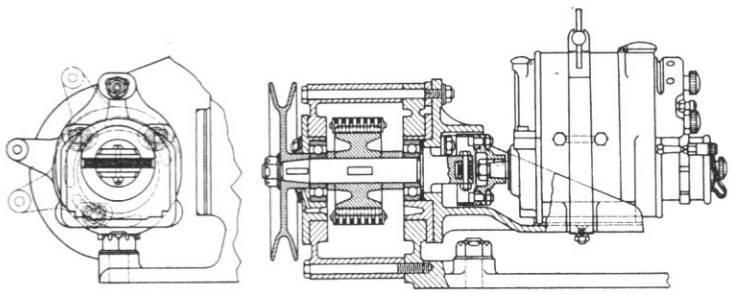
It will be noticed that the gudgeon-pin is secured by a taper-ended setscrew, a method which, in some applications, has been the cause of considerable trouble, which, to ensure complete satisfaction, would appear to demand a high standard of workmanship and great care in fitting.

Of rigid construction, the crank case is formed with ample metal-thickness and wide lateral extensions of the bottom flanges. A five-bearing crankshaft is employed, all the bearings being 2in. in diameter, the front and rear ones being 3in. long, while the remaining three are $2\frac{1}{4}$in. long. Die-cast white-metal shells are used, the caps being held by bolts passing through the upper half of the crank case. The white-metal is run direct into the tinned connecting rod, a good feature being the fitting of four cap-bolts in place of the pair usually considered adequate for a touring car engine.

Machined from a stamping of nickel-chrome steel, the crankshaft is end-located by the flanges of the front bearing shell, the clutch-withdrawal pressure being taken by a flange, held in position by the starting dog sleeve with the interposition of the camshaft driving pinion. It is somewhat unusual to find that no nut is provided to draw these parts together, a taper-pin passing through the starting sleeve and the crankshaft being the fixing employed, with large Woodruff keys to take the torque.

For some little time the Lanchester harmonic balancer has been fitted to the side-valve model and is standard on the new engine. To those of our readers who are not familiar with its principle, it may be explained that its purpose is to balance the secondary out-of-balance force always present in a four-cylinder engine due to the fact that the connecting rods have a finite length and the motion of the pistons is not simple-harmonic. This force changes sign four times in one revolution of the crankshaft and can, to a first approximation, be balanced by the vertical component of the centrifugal force of a suitable mass rotating eccentrically at twice crankshaft speed. In order to eliminate the horizontal component the mass is divided into two masses which are rotated in opposite directions at equal speeds in the same plane.

On the Vauxhall engine these masses take the form of lead plugs inserted into three out of six holes drilled in each of



The Magneto drive.

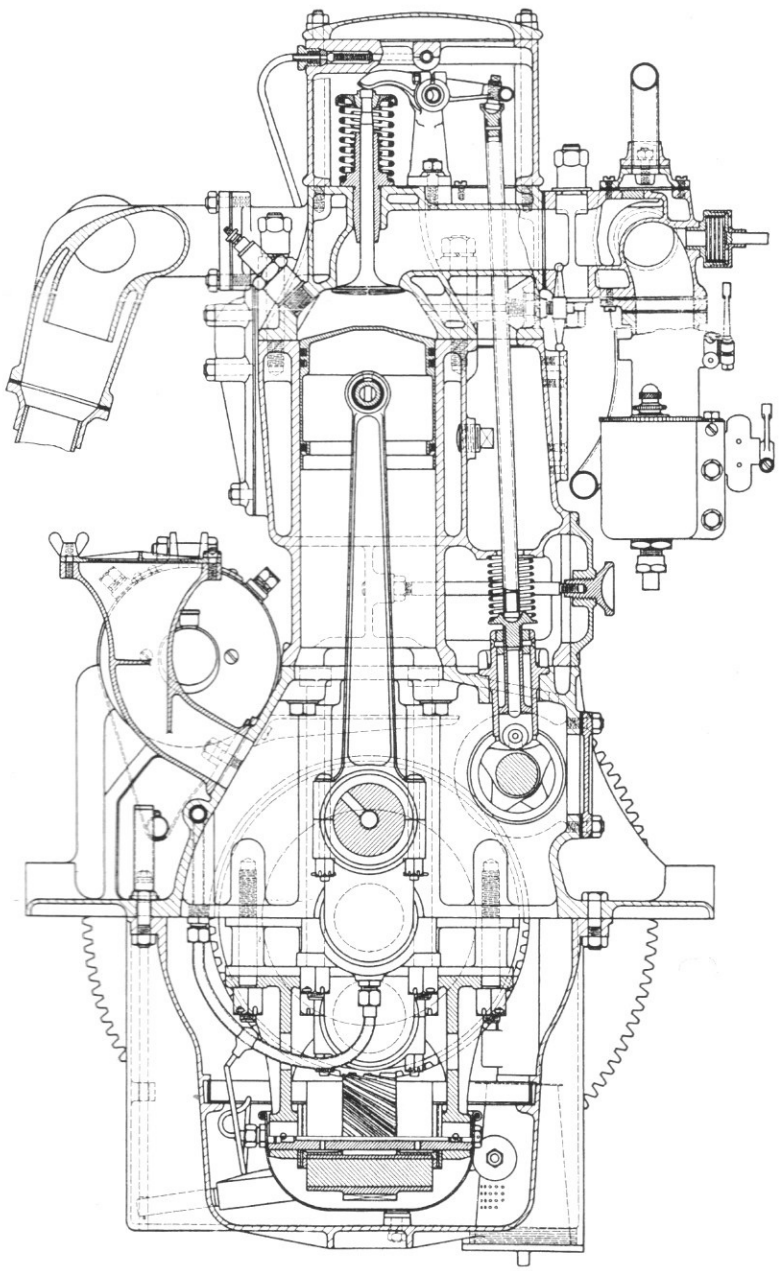
gether by helical wheels and run on case-hardened pins carried in a bronze frame secured to the cap of the centre crankshaft bearing by the lengthened cap-bolts and by two additional studs. Oil is supplied under pressure by small pipes to the hollow pins, and it is of interest to note that the bronze bushes of the drums are lined with white-metal, this having been found to give better service than a phosphor-bronze bush running direct on the case-hardened pin.

Large steel washers are provided to take up any end-play, but it should be realised that the device absorbs no power other than that required to overcome the friction of the only additional pressure on the teeth of the driving gears being that required to accelerate or retard the revolving masses as the engine speed rises and falls.

Considerable ingenuity has been exercised in securing to the crankshaft the large bronze helical wheel which drives the balancer, without modifying the crankshaft stamping in any way.

A groove is profile-milled along one edge of the crank-web, round the inner end of the web and along the other edge. A steel centre-piece, machined with an open-ended slot, fits tightly into this groove, while its outside diameter is turned concentric with the crankshaft axis.

Bolted to this centre-piece is the bronze gear-ring, the smallest diameter of which fits snugly on a shoulder turned on the front face of the web, and thus prevents the whole assembly from working off the groove in the web.



Engine cross section.

Owing to the engine and gear box being mounted on a separate underframe which is only attached to the main frame at the front and at a point behind the gear box, the improvement effected by the harmonic balancer is not so marked as it probably would be in a chassis in which the rear crank case arms were bolted direct to the frame side members. The most noticeable benefit is found when covered bodies are fitted, as it entirely eliminates the objectionable "drumming" often set up at certain engine speeds.

The camshaft runs in three cast-iron bushes, the centre bearing being sufficiently large to permit the shaft to be drawn out from the front. Of 0·40% carbon steel, the camshaft chain-wheel is bolted to a mild steel centre, an unequal number of holes being drilled in the two members, providing a vernier adjustment for timing. A Hans Renold segmental bush silent chain forms a triangulated drive to the camshaft and the magneto-shaft, both of which are on the near side of the engine.

Mounted on ball bearings carried in stamped brass eccentric bushes, the magneto-shaft can be moved to adjust the timing chain. This is an improvement on the method previously used, which consisted of coupling together the two eccentrics by a distance-piece secured to arms extending from them, there being with the present scheme less chance of the shaft being thrown out of line when taking up slack in the chain.

On the older Vauxhall models the magneto was mounted direct on the crank case, but on the new engine it is carried on a bracket spigoted into the bore of the rear ball-race housing. The clamping studs for the rear eccentric pass through slots in it and also through elongated holes in the magneto bracket. This is kept in an approximately upright position by a stud

through a hole having sufficient clearance to permit the very slight vertical movement caused by the motion of the eccentrics when adjusting.

A laminated spring type of magneto spring coupling is employed, the outer shell being vernier-bolted to a flange fitted to the magneto spindle.

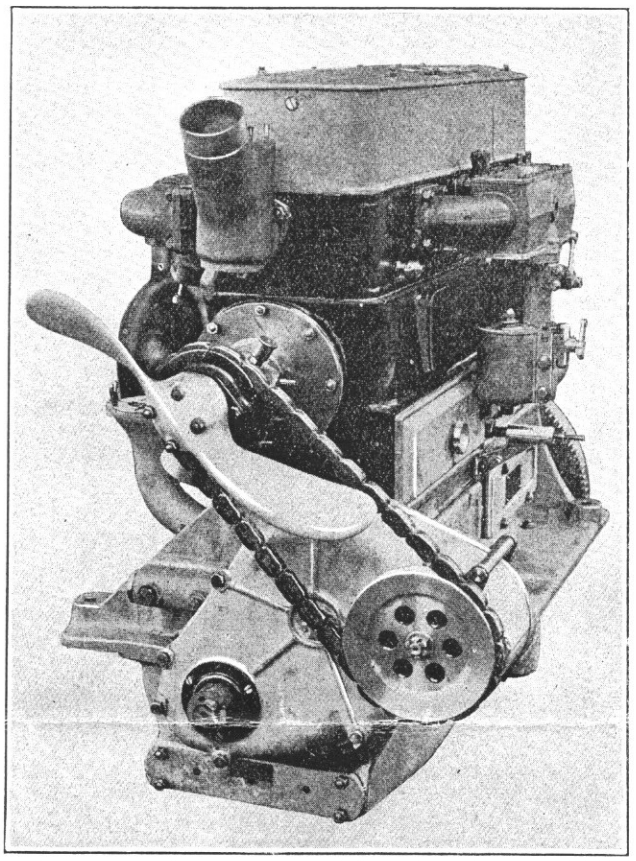
At the forward end of the magneto-shaft a pulley is fitted for the Whittle belt which runs diagonally up to the fan. The pulley boss is coned to fit the shaft, the securing nut also serving to clamp the two ball races and the chain wheel on the parallel part of the shaft, an arrangement which necessitates the accommodation washers being carefully fitted if all the parts are to be firmly held.

A combined fan and water pump has always been a feature of the Vauxhall cars, but the arrangement has been considerably altered on the present model. The front end of the spindle is now carried on a ball journal bearing housed in an extension of the gun-metal water elbow, the stuffing box being at the back. It will be observed that the combined end thrust of the fan and the water pump impeller is still taken on the flange of the spindle bush, the ball race being free to slide in its housing.

Adjustment of the driving belt is effected by screwing the front flange of the fan pulley along its malleable iron boss, the locking arrangement consisting of a screwed ring drawn towards the loose flange by two studs tapped into it.

Bolted to the front end of the cylinder head is a gun-metal water outlet connection which contains a thermostat bellows coupled direct to a double-acting valve controlling the passage of the water to the radiator. From the top of the valve box a $\frac{3}{4}$in. copper tube returns to a water jacket surrounding the greater part of the induction manifold, another pipe from this going to the suction side of the pump. Thus, when the thermostatic valve is closed the water can still circulate back through the induction pipe jacket, rapidly bringing the whole engine to a uniform working temperature without leaving the water stagnant in the cylinder jackets, as is the case when a thermostatic control is not fitted with a by-pass.

Additional heat is furnished to the "T" junction of the inlet manifold by two passages cored in the cylinder head and communicating with the exhaust valve ports of the two middle cylinders. These passages continue into the manifold casting, a parallel plug, milled away at its centre to leave a thin web, being fitted in the wall of metal which divides them. By rotating this plug the two passages are brought into direct communication, so that the hot gases take the shorter path and do not warm the induction pipe to the same extent, so that allowance for tropical weather conditions can be made.



Front view of engine.

Bolted direct to the inlet manifold, the 42 mm. Zenith carburetter is of the triple diffuser type, the mixture control lever being operated from the intrument board. There is in addition an extra air valve screwed into the middle of the inlet manifold, and controlled by a lever on the steering wheel.

An interesting feature of the exhaust manifold is that of coupling together the passages from the two middle cylinders into a nozzle which discharges into the annular space connected to the first and last cylinders, the object being to obtain some measure of "ejector" effect and prevent blowback from one cylinder into another. While it is understood that the arrangement does not increase appreciably the power developed, it would appear beneficial to the regularity of firing when "idling" at very slow speeds, the new engine being very good in this respect, in spite of the fact that it has the same amount of valve overlap as the original side-valve model.

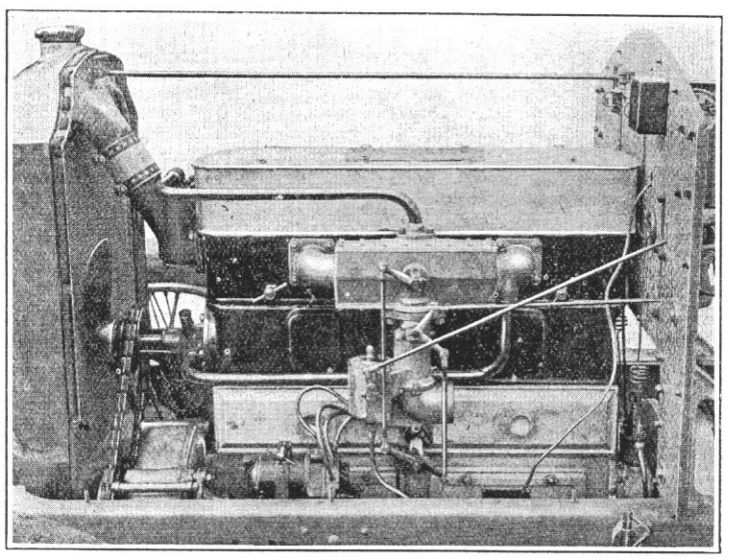
Operated by a ball-bearing crank pin screwed to the rear end of the camshaft, the plunger lubricating pump is remarkable in that while it has a suction valve at the bottom of the barrel there is no delivery valve; the inertia of the oil in the delivery pipe and the resistance offered by the fairly small holes in the pump plunger being relied on to draw the oil through the suction valve.

The main oil supply is by a copper tube cast in place in the crank case and having vertical holes drilled into it at each cross-web, from which the lubricant is taken by tubes to each main bearing cap. The crankshaft is drilled to supply the big-end bearings, an interesting point being that there is no continuous connection through the shaft, each big-end being connected only to the main bearing immediately behind it.

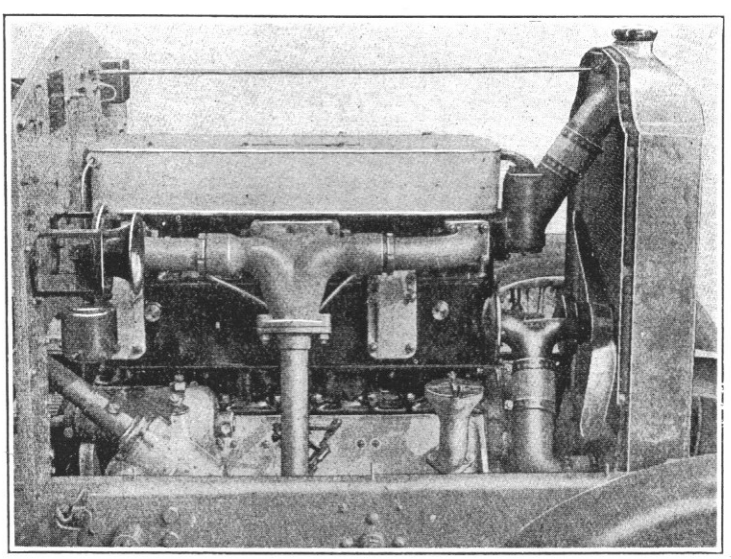
A flat strainer in the sump, which has always been a Vauxhall feature, is still retained, but, owing to the fact that the drums of the Lanchester harmonic balancer project through it, it cannot be withdrawn from the front without dropping the sump. In order to prevent excessive oil-splashing, a copper box is fitted round the balance drums, which are thus separated from the general body of lubricant in the sump.

Electrical equipment.

Mounted on a bracket on the near side underframe rail the Vandervell dynamo is belt-driven from a pulley ring attached by



Near side of engine



Off side of engine.

screws to the rear of the clutch casing. The starter is strapped to a saddle on the off side of the crank case and its Bendix pinion meshes with teeth cut in the stamped steel flywheel.

Fuel supply.

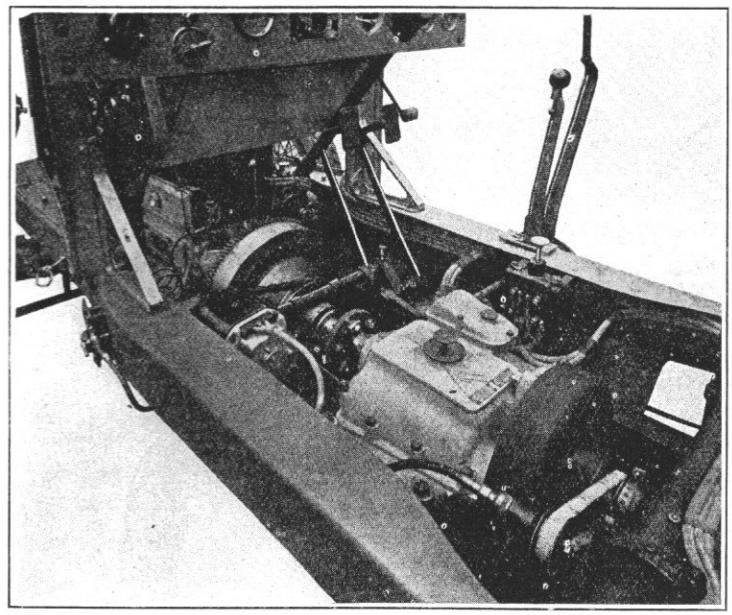
Linked to the eccentric which works the oil pump is the plunger of an air pump which supplies the pressure to the petrol tank at the rear of the chassis, a tubular cotton cloth filter being fitted on the delivery pipe inside the tank and being removable for cleaning through an opening in the bottom of the tank closed by a screw plug. There is little doubt that the retention of the pressure feed is advisable, as the carburetter is placed high up and is of the triple Venturi type, working with a fairly low induction pipe depression at full throttle. Under these circumstances an Autovac mechanism cannot be relied upon to supply fuel when on a steep gradient.

Clutch.

Bolted to the stamped steel flywheel is a large malleable iron casing enclosing the multiple-disc clutch, the outer plates of which engage with tongues cast integrally with the casing. There are 25 plates in all, the mean diameter being 8in., they are made of cold-rolled steel and run without any lubricant other than a little powdered graphite introduced through a plug. The clutch centre is a stamping of 0·40% carbon steel, not specially hardened on the driving tongues, and is held by a cone and nut on to a fairly long shaft connected by a single fabric disc coupling to the gear box driving shaft. At the front end the shaft is carried by a ball race housed in the flywheel, selected distance pieces inserted between this race and the rear face of the crankshaft flange limiting the forward travel. Rearward movement of the clutch-shaft is prevented by a distance-rod butting on the end of the gearshaft and carried by the fabric disc of the coupling.

Although the practice of fitting only a single universal joint between the clutch and the gear box is not one to be commended as a general rule, in this particular instance the underframe which carries the engine and gear box is of such exceptional stiffness that the original alignment, if carefully carried out, is not likely to be destroyed by the running of the car. It is, nevertheless, somewhat surprising that the clutch centre is not hardened, as it might be expected that even a very slight angular displacement of the shaft would cause wear on the driving tongues by the rubbing action of the inner plates of the clutch.

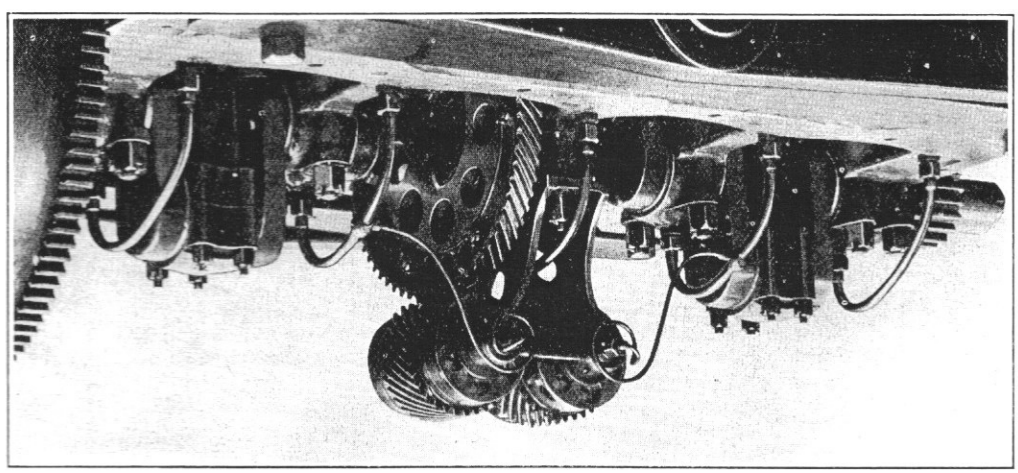
Bearing on a malleable iron pressure plate, a single helical spring forces the plates against a ring secured by countersunk screws to the clutch casing. The spring load does not, therefore, come on the flywheel face, the whole clutch being removable as a unit without releasing the pressure. No adjustment is provided for the spring, which is of generous proportions.



The Gear box and clutch.

Withdrawal is by a ball journal bearing, the inner race of which is clamped to the long sleeve formed integrally with the pressure plate. Housed in a gun-metal ring, the outer race is engaged by forks depending from the pedal shaft in the usual fashion, while the clutch stop takes the form of a disc screwed on to the boss of the coupling and bearing against the inwardly flanged nut which retains the withdrawal ball race.

The disc is faced with Ferodo and can be adjusted by screwing it along the boss of the coupling, and is locked by a ring nut fitting on a thread of larger diameter and opposite hand.



The Lanchester balancer.

Gear box.

Bolted to the underframe by four short arms, the gear box is an aluminium casting, split on the horizontal plane. The top half carries the fulcrum pin for the internally-expanding gearshaft brake, the operating spindle of which passes under the box to a lever in front coupled by a vertical rod to an arm on the pedal shaft.

Made of nickel case-hardened steel, the gears are of 6 D.P., the centres of the shafts being 4in. With a view to minimising hardening distortion, no attempt has been made to lighten the gear blanks by recessing, the first and second speed sliding pair being a particularly massive unit. The layshaft wheels are fitted with Woodruff keys on to a plain shaft while the driven shaft is splined for the sliding wheels.

All the bearings, with the single exception of the rear main bearing, are fitted direct into the aluminium, and it will be noticed that no thrust bearings are employed on either the layshaft or the driven shaft. The single journal bearing on the driven shaft would appear hardly adequate for its work when the strains imposed by the foot brake are taken into account.

Three selector rods, of rectangular section, work side by side in a recess end-milled in the lower half of the gear box, being retained by the lower face of the top half. While such an arrangement eliminates a number of bushes and bored holes, it would seem doubtful whether production costs are reduced thereby as it necessitates machining nearly all over the combined selector rods and forks to provide the necessary working faces and clearances.

Constrained by the usual spring-loaded plungers, the selector rods are provided with an additional positive lock which prevents two gears being engaged at once. The tails of the locking plungers are flattened on one side and work through D-shaped holes in a steel plate, over which another plate swings engaging a tongue on the boss of the selector lever. This plate is so shaped that only the tail of one plunger is free to rise at any time, the lateral movement of the selector lever "across the gate" uncovering the plunger of the rod it is desired to operate.

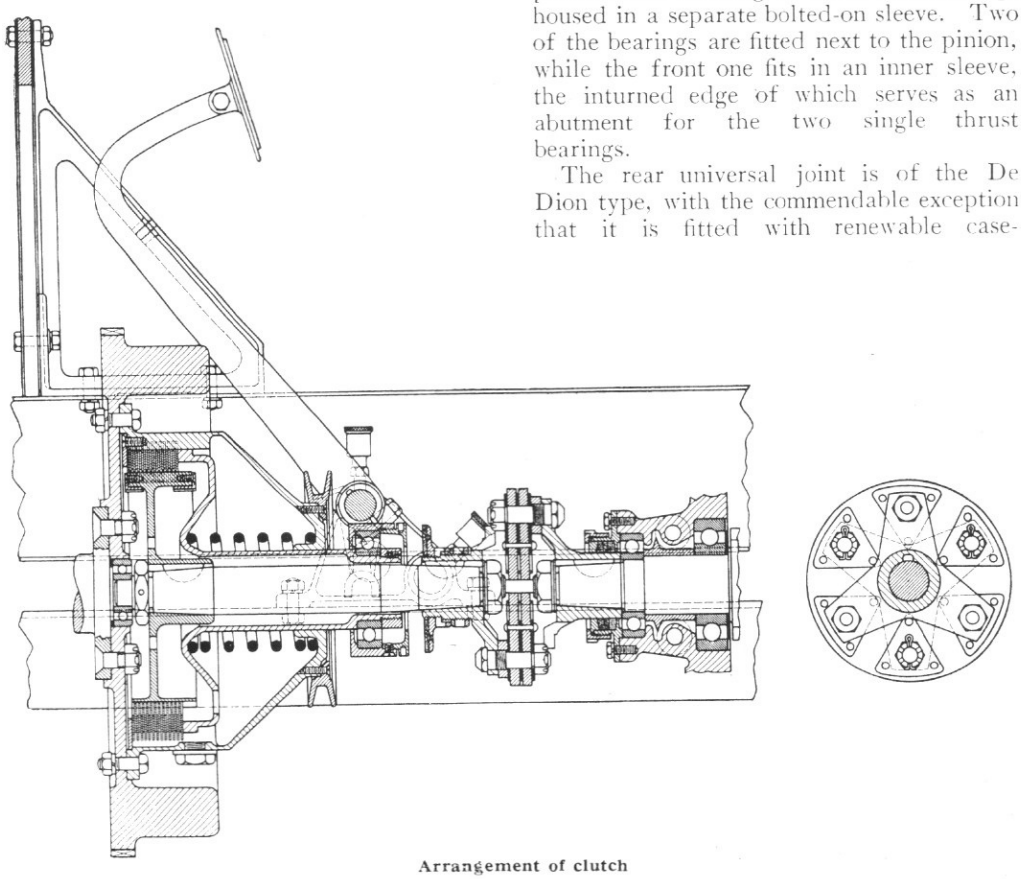
The selector shaft turns and slides in a sleeve carried in spherical bearings in the gear box and in a small bracket bolted to the lower flange of the frame side member. The change-speed lever itself works through a hole cut in the top flange of the frame, the gate taking the form of a flat steel plate attached to the flange by screws. Since there is ample width at this point the stability of the chassis is not endangered by this particularly ingenious method of modifying the lever position to suit the requirements of enclosed bodywork of limited width.

Of the internal-expanding type, the foot brake is lined with Ferodo and works in a malleable drum of considerable thick-

ness which is in addition provided with a thin cast-iron liner. Being bolted to the outer face of the universal joint casing, the drum can be removed without taking down the propeller shaft to permit access to the shoes.

Leakage of oil on to the braking surfaces is prevented by a felt washer housed in a gland which enables the packing to be compressed on assembly, though there is no provision for further adjustment to compensate for wear or hardening of the felt.

A similar stuffing-box is provided at the front end of the gear box, and in this case the local conditions permit the insertion of fresh packing without dismantling any parts.



Arrangement of clutch

Rear axle.

Split in the vertical plane, the malleable iron rear axle casing carries the journal bearings from the differential cage, the pinion shaft running in three ball bearings housed in a separate bolted-on sleeve. Two of the bearings are fitted next to the pinion, while the front one fits in an inner sleeve, the inturned edge of which serves as an abutment for the two single thrust bearings.

The rear universal joint is of the De Dion type, with the commendable exception that it is fitted with renewable case-hardened wearing plates, obviating the necessity for hardening the main forks. Here again it will be noticed that a member is drawn up on a cone and also serves as an end-location for a ball bearing, and in this instance is the front abutment of the thrust bearings. Unless the greatest care be taken in checking the fit of the conical surfaces before selecting the distance piece there would seem a distinct danger of accidentally overloading the thrust washers when tightening the nut securing the universal joint to the pinion shaft.

Between the flange of the thrust-bearing sleeve and the front flange of the pinion-shaft housing is a selected distance piece for the axial adjustment of the pinion, the differential box taking its side location from the inner ends of the axle tubes which bear on the ball thrust washers on each side.

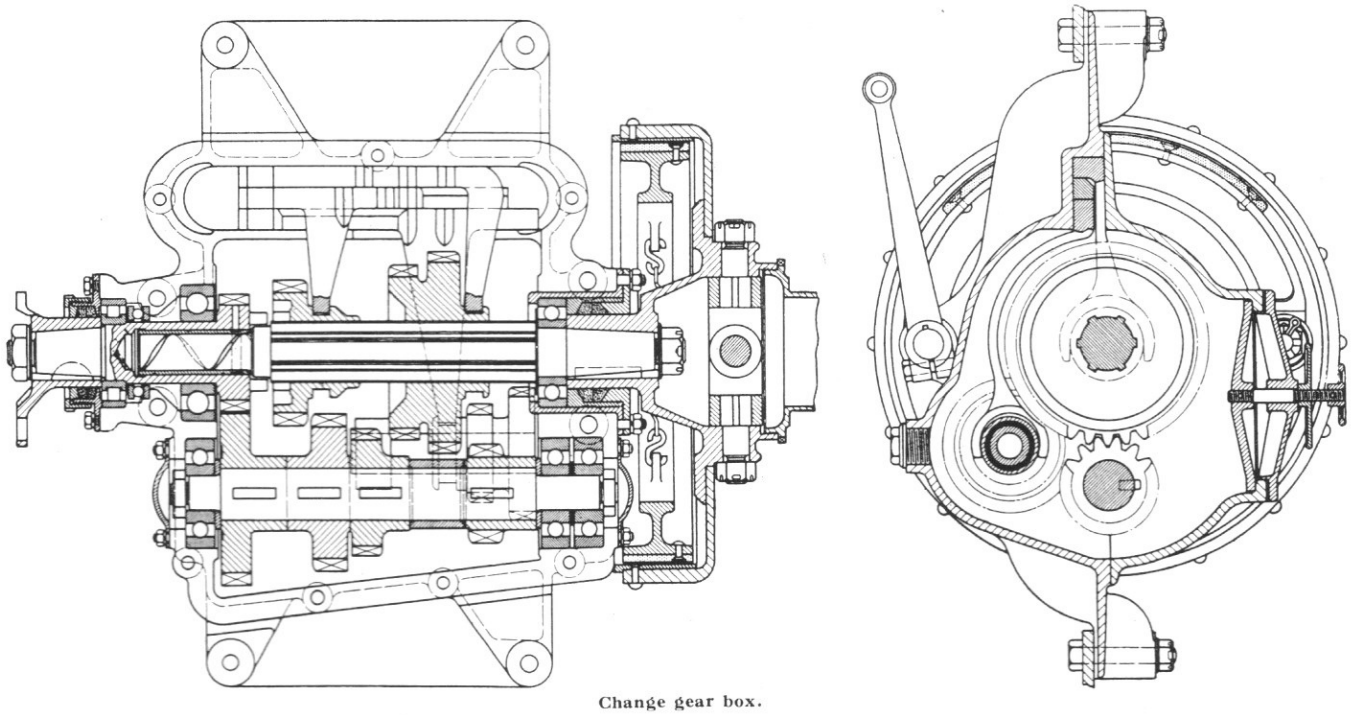
Adjustment in this case is secured by moving the axle tubes in the casing, for which purpose they are a tight push fit in the long bosses, and are finally secured by two large clamping bolts.

Of the parallel-pinion type, the differential gear is of robust proportions. The axle shaft pinions are secured to the driving shafts by cones and flat keys.

Fastened to the cage by throughgoing bolts, the crown wheel is considerably dished in cross-section, a shape hardly conducive to the elimination of distortion due to hardening. Spiral bevel gears are employed, these being cut in the Vauxhall works, and finished with separate cuts for the two sides of each tooth, a method which gives a more accurate tooth form than that often adopted in America of finishing both sides at once with the same cutter.

Carried on one ball journal bearing at the inner end and two at the outer end, the malleable-iron hubs are arranged to take Rudge-Whitworth detachable wire wheels. It will be noticed that all the bearings are free on the axle tube, outward thrust being taken entirely by the axle shaft, which has parallel splines in the hub and is drawn up by a castellated nut. Inward pressure is taken on a single ball trust washer fitted in a recess formed in the combined brake bracket and spring seat casting, the running race of the washer fitting into an extension of the screwed cover which retains the outer races of the hub bearings.

Riveted to the hub, the large brake drum contains a pair of Ferodo-lined shoes operated by cams of different radii, arranged to give equal travel to each shoe and compensate for the fact that the contact-point of one cam-face is nearer the shoe fulcrum than that of the other. Carried in a white-metal bush at the inner end, the cam-spindle is allowed about $\frac{1}{16}$th of an inch play at its working end, the makers having intelligently anticipated the



Change gear box.

wear that soon occurs at this point by leaving the spindle free to float until both shoes come to an equal bearing when the brake is applied.

From the upwardly-projecting levers on the cam spindles, rods passing inside the frame connect to hanging levers on a cross-shaft, adjustment being made by turnbuckles on each rod close to these levers and reached by lifting the floor-boards. No compensating gear is fitted, but the lever by which the cross-shaft is operated is secured to a sleeve outside it, attached to it at the centre of its length, thus equalising the torsional "spring."

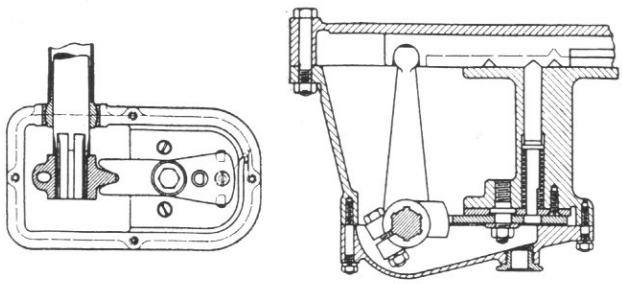
Secured by substantial clip-boxes and also registered by a centre-bolt, the rear springs take both the driving thrust and the torque due to the hub brakes, but the torque-reaction of the bevel gear is absorbed by a pressed-steel arm. This is attached to the frame at its front end by a ball-jointed link having adjustment for wear but without any springs to take up play, the makers having found them unnecessary, and, in fact, undesirable.

On the older models of the 25 h.p. Vauxhall the torque-arm was secured direct to the axle casing by a number of studs; this fixing having given trouble due to the lateral displacements from which the arm inevitably suffers, is now replaced by trunnions formed integrally with a ring fastened by the studs which previously held the arm-pressing. These trunnions work in bosses welded into two horns formed on the torque-arm, the ring being sawn through on the horizontal centre line, allowing the trunnions to be inserted into the bosses separately before bolting the whole assembly to the axle casing.

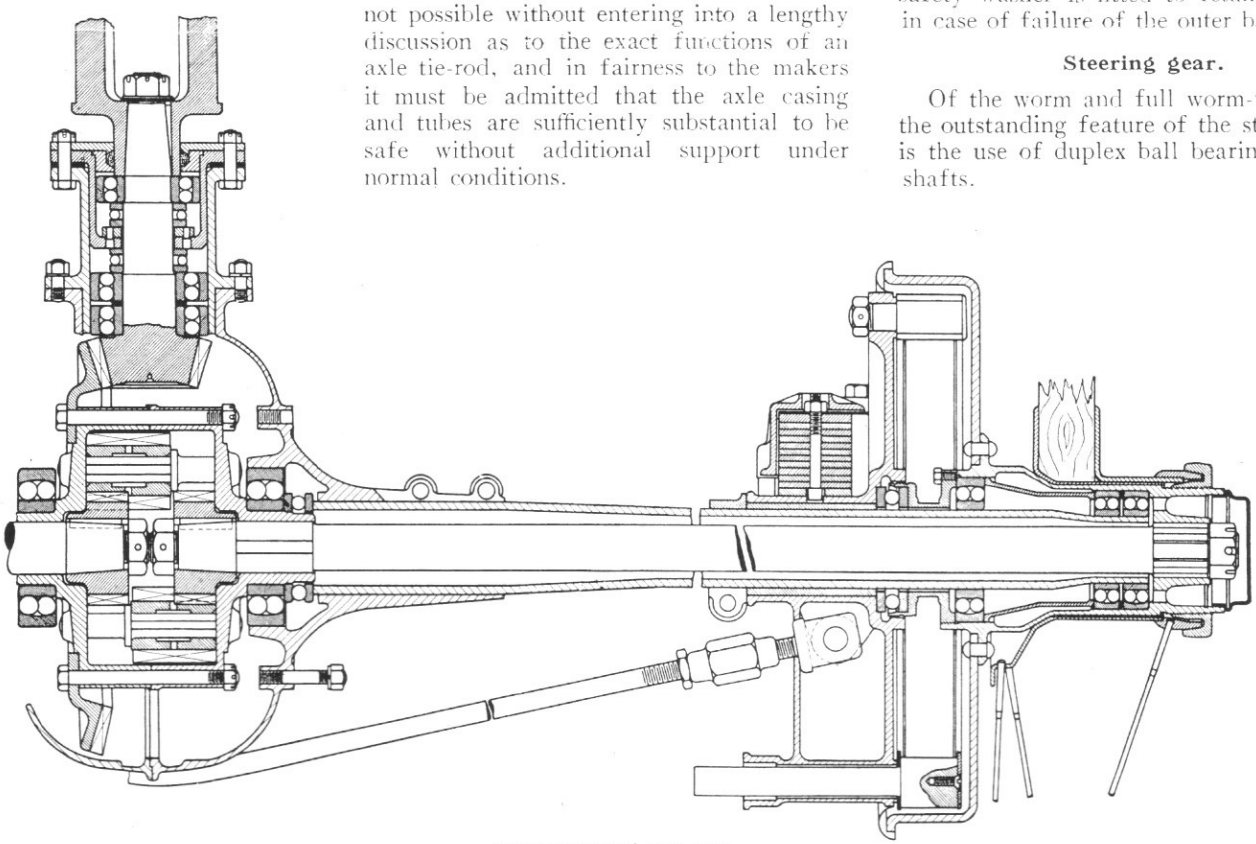
Following the practice usual where pressed-steel torque-arms are employed, a wood filling is used, which has been found to have a marked effect on the silence of the transmission.

The combined brake-shoe brackets and spring-seats turn on bronze bushes which are made a force fit on the axle tubes, taking their end-location from split collars clamped in position by bolts. These collars also take the pressure due to the axle tie-rod, the ends of which are attached to lugs on the brake-shoe brackets. This arrangement appears to invite mild criticism, in the first place the wear on the faces of the collars must be considerable if the tie-rod is drawn up tight, and, secondly, the ends of the tie-rod are being continually twisted in relation to the centre portion when the car is travelling over a rough road. That such twisting action was clearly foreseen by the makers is evidenced by the provision of only one locknut on the tie-rod turnbuckle, the intention being presumably that one thread should be free to turn.

Further consideration of the matter is not possible without entering into a lengthy discussion as to the exact functions of an axle tie-rod, and in fairness to the makers it must be admitted that the axle casing and tubes are sufficiently substantial to be safe without additional support under normal conditions.



Gear interlocking device.



Arrangement of rear axle

Front axle.

Of the reversed Elliot type, the front axle is provided with ball thrust washers at the top of the swivel pins, which fit in the axle bosses on a long taper, being additionally secured by cotters bearing on flats machined across the pins. The jaws on the swivel are more widely spaced than is usual in this type of axle, thereby reducing the intensity of pressure on the bushes and the frictional resistance to steering. Inclined at an agle of 4 degrees, the axis of the pivot produced meets the road at a point about 2½in. inside the tyre contact centre, and wedges are placed under the springs to attain a slight rearward inclination, the angle of the wedges being considerable on account of the rear end of the spring being half an inch higher than the front.

As is so often the case on fast cars, no springs are inserted in the ball joints of the steering rods, while an interesting feature is that of carrying the levers right through the balls, which are drawn up on a taper by a castellated nut. Avoiding as it does the imposition of a bending strain on a case-hardened part, much may be said in favour of this construction, where the ball is merely a spherical sleeve on the lever-end, which can be given heat-treatment appropriate to the shocks and vibrations which it has to withstand.

The front hubs are carried on two ball journal bearings, the outer races of which are not clamped in the hub shell in any way.

Drawn up on a spindle to nip a taper distance tube, the inner race takes inward pressure while the other one takes any outward thrust. This arrangement necessitates carefully checking the distance tube for length, as, should this be too short, enormous loads may be imposed when tightening up the spindle nut. It is somewhat surprising, moreover, to find that no safety washer is fitted to retain the wheel in case of failure of the outer ball race.

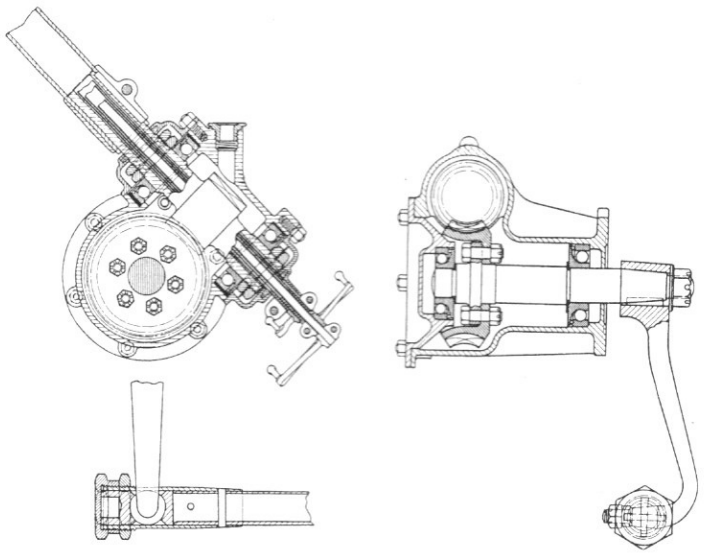
Steering gear.

Of the worm and full worm-wheel type, the outstanding feature of the steering gear is the use of duplex ball bearings for both shafts.

The worm wheel is fastened to a flange by six bolts, while the worm is made solid with a short spindle which is screwed to receive lock-nuts by which the ball bearings are drawn together against shoulders in the box to take up end play.

Adjustment for the correct mesh of the worm can be made by eccentric liners housing the worm bearings, but this we imagine is only intended as a workshop setting

Clamped and keyed to the wormshaft, the steering column is supported by a Skefko bearing carried in a bracket bolted to the dashboard.



Arrangement of steering box.

A liberal use of antifriction bearings, coupled with a fairly steep worm thread, should result in a steering that is remarkably free, and, as a consequence requires rather more holding on a rough road than a steering gear of a lower "transmission efficiency."

Above the steering wheel are mounted levers for the ignition, throttle and extra air control, these being attached to the usual nest of tubes having at their lower ends ball-jointed levers coupling up to another nest of tubes passing through the crank case to the carburetter and magneto.

Frame.

Of pressed steel $\frac{1}{8}$in. thick, the frame side members taper inwards in the region of the dashboard. The inner edges of the flanges, however, continue back in a straight line for about 2ft. providing ample strength and stiffness and enabling the change-gear lever to be brought through a hole in the top flange while leaving plenty of metal for stability.

The front cross-member, also of pressed steel, dips below the radiator and is securely riveted to the side members, which have their flanges widened at this point in a manner which provides a stiff lateral fixing for the front dumb-irons.

The second cross-member is fitted well behind the centre of the chassis, and is a tube of large diameter with brazed-on flanges riveted to the webs of the frame, a doubling plate being provided at this point. This tubular member supports the rear end of the underframe, which consists of two angle pieces, $2\frac{1}{2}$in. wide by 4in. deep, their vertical webs being swept outwards and upwards at the front, forming wide flaps which rest on and are riveted to the bottom flange of the front cross-member.

Close behind the rear axle is fitted a pressed steel member serving as the front support of the petrol tank, while the rear dumb-irons are tied together by a small tube.

In view of the fact that the rear springs take both the driving and braking thrusts, the attachment of the front spring brackets by only three rivets without an internal doubling plate is perhaps open to criticism, in view of the fairly light substance of the frame side-members. The general design of the frame, however, is excellent, and has stood up very well to the severe conditions imposed on the many Vauxhall Staff cars used in the war.

It is worth noting that all the spring eyes are fitted with flanged bushes, giving adequate surface to resist lateral pressure; the spring-pins being provided with spring-loaded ball valves which close to give a practically flush surface and are not therefore provided with caps; an oil-gun is supplied for charging the bearings.

General.

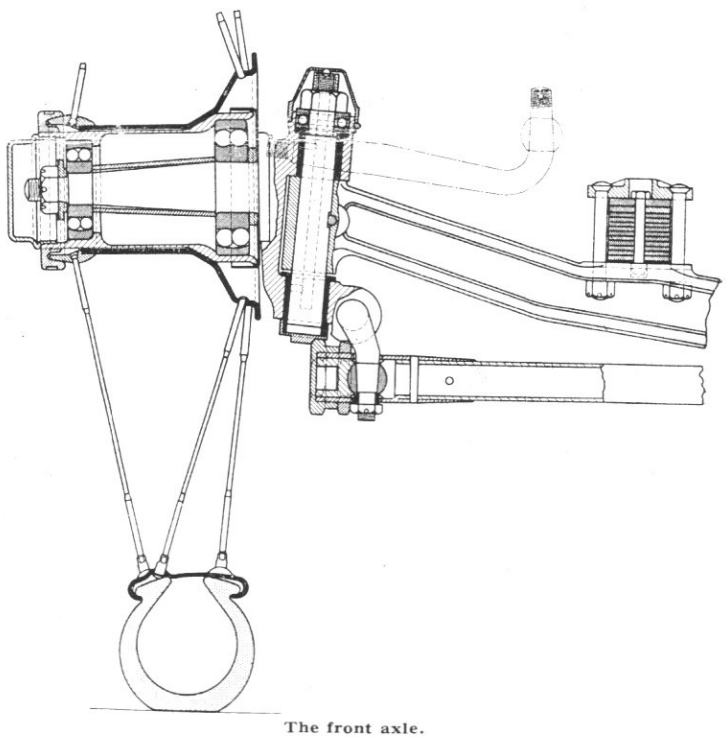
The chassis creates the impression of a sound and straightforward job, having an ample margin of safety and without the complexities of detail which are a sign of misplaced ingenuity on the designer's part. As might be expected in the product of a firm who have always built models in which high speed has been a characteristic, such vital parts as the steering and the brake details have been thoroughly well carried out.

While the transmission gear is in general of ample proportions, a few details are open to criticism, particularly the fitting of the gear box ball races direct into the split aluminium casing, and the use of parts drawn up on cones which also serve as end location for bearings. It must, however, be admitted that in all cases where the latter practice is employed the shafts are case-hardened and ground, so that there is little risk of the inner race of the bearing becoming loose on the shaft, even if it were not tightly nipped endways.

Of particular interest is the performance of the engine, in view of the fact that the new cylinders with overhead valves and rockers have been fitted to the old crank case, and are operated by an identical camshaft. The additional inertia of the valve gear parts appears to have been fully taken care of by the return springs now fitted to the valve tappets, while the eccentric cam base circle, which has always been a Vauxhall feature, gives excellent results as regards silence on the new engine.

The road performance of this car is excellent, an outstanding characteristic being the silence of the valves and valve actuation. The engine is smooth and vibrationless, and pulls well over a wide speed range. Assisted by the fact that there are four speeds, silent changes of gear are easily affected, and the steering is light and easy, while giving the required feeling of security.

The brakes are good, and altogether the chassis, judged from the model upon which the trial was made, is entirely free from those minor defects that it is sometimes possible to criticise. There is a happy combination of the characteristics of a high efficiency engine, giving good acceleration and speed, with quietness and manageability of the ordinary touring vehicle. The suspension is good, and the car holds the road well.



The front axle.

Electric Hardening.

In this process the pieces to be treated are placed in a salt bath of barium chloride, with or without a little potassium chloride, through which a strong current flows. A great advantage arises from the fact that the bath heats equally throughout, as does also, in consequence, the material under treatment. Moreover, the desired temperature can be quickly reached and easily maintained within very close limits.

If alternating current is available, the hardening plant can simply be connected to the supply, but direct current must be transformed, otherwise electrolytic decomposition of the bath would result.

Temperature is controlled by an electric pyrometer connected with a galvanometer, showing degrees Celsius. The electric furnace only takes, for hardening, a quarter of the time required by the muffle furnace, and may further be used for annealing, tempering, or other heat treatment.

It has been found economical to employ two furnaces, a larger one for carbon steels and a smaller one for high-speed steel.—Extract from *Technische Blätter*.