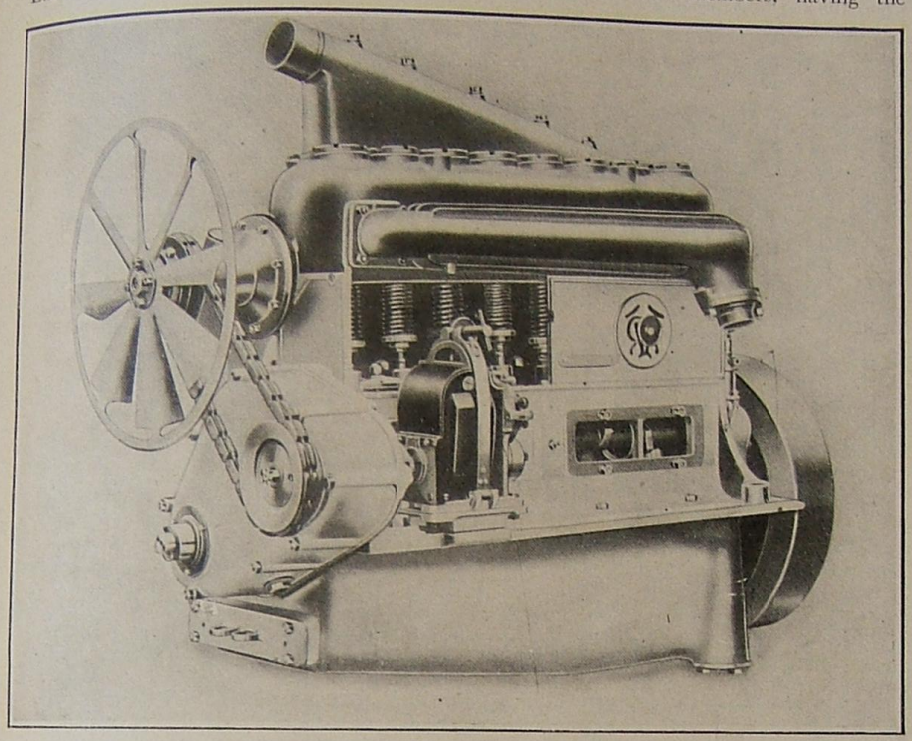
TOURING CARS ON WAR SERVICE.

Notes on the Performance of the Lighter Transport Chassis. Part I.

THE VAUXHALL D TYPE 25 H.P. CHASSIS.

THE Vauxhall car forming the subject of the following notes is the standard 25 h.p. model manufactured by Messrs. Vauxhall Motors, Limited, of Luton, and supplied by them in large numbers to the War Department. During lengthy service on the Western Front as a Staff car, it was subjected to the rough treatment that such vehicles usually receive, and was eventually sent to a Base repair shop, where the writer had the opportunity of examining its condition whilst undergoing a complete overhaul, during which it was possible to ascertain with accuracy the actual wear on each component part.



Side view of engine.

Frame.

The general design of the frame is interesting, being made up of a combination of members made from pressed steel, rolled steel, and drawn tube. Steel pressings of channel section, 5in. deep, are used for the side members, having the flanges widened to 4½in., where the greatest stresses are imposed. The plan of the chassis (fig. 1) shows the extra width of these members at the dumb iron extensions, and from the inswept portion of the frame to a point immediately behind the gear box.

Three cross members provide lateral bracing; a sub-frame, formed by two pieces of angle steel measuring 4½in. × 2in., supporting the engine and gear box. The first cross member is situated beneath the radiator, being shaped to clear its lower tank. A large steel tube, attached to the side members by brackets, forms the second cross member, and between these two are suspended the longitudinal members of the sub-frame. The third cross member is located behind the back axle, and at the extreme end of the frame the two side members are tied by a cross bar fitted between brackets which carry the rear springs.

After making due allowances for the abnormal conditions to which the chassis had been subjected, one or two points connected with the design of the frame appeared to be on the weak side, the most noticeable detail being the method adopted for attaching the sub-frame members to the front cross member. At the forward end the vertical portion of each sub-frame angle is cut away, the horizontal part being bent round to fit inside the front cross member channel, where it is secured by rivets. In the chassis under examination the sub-frame had broken right through where it is weakened by cutting away the vertical portion, the same defect occurring on other chassis being repaired at the same time.

Substantial hanger brackets are used to attach the rear end of the sub-frame to the tubular cross member; they also take the upward thrust imposed by the torque member.

A slight crack was detected in one of the side members where the rear spring is anchored, this being repaired by a reinforcing plate. The number of rivets renewed was comparatively small, and on being lined up none of the members showed any permanent deflection or sag. The overall width of the frame is 35in., and the wheelbase measures 10ft. 10in.

Front Axle, Wheels, and Suspension.

The front axle is a solid forging made from 40 tons per square inch axle steel, having a downward curve between the springs and a slight upward set at its extremities. The design being what is known as the reversed Elliott type, the axle is provided at each end with bosses to receive the stub axle swivel pins, which are secured rigidly to it. One characteristic of the design is the forward set at the

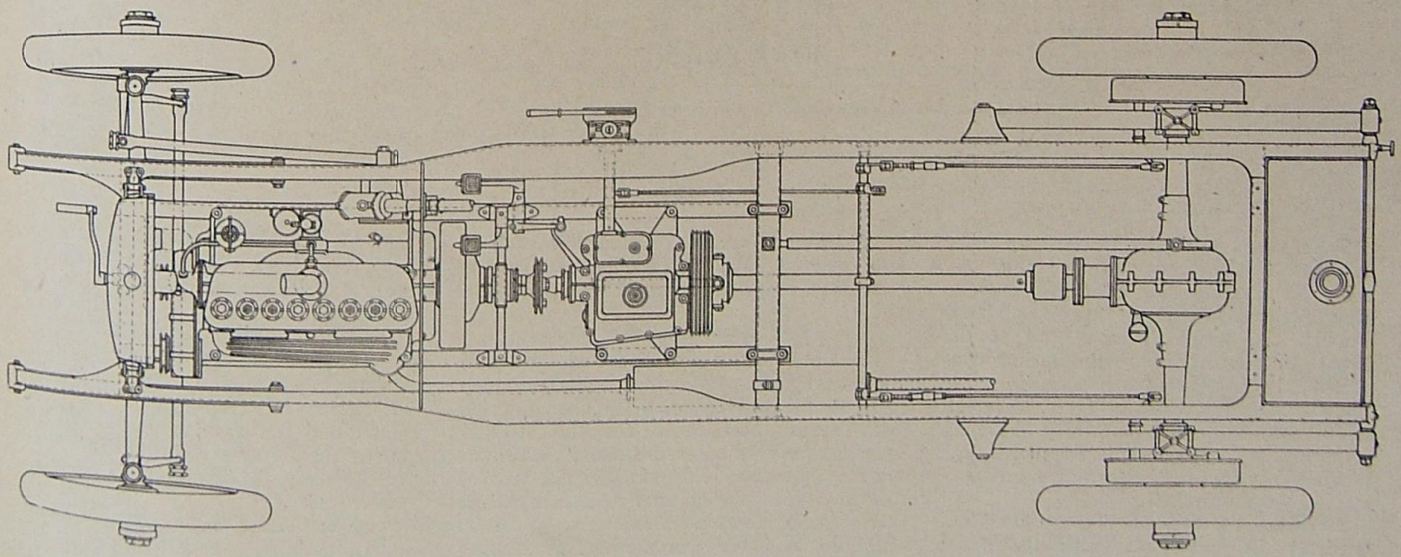


Fig. 1.

sary to replace the ball race carrying the inner drum, and the clutchshaft itself was renewed on account of wear on the splines at the rear end.

Mounted at the rear end of the clutchshaft is a spider similar in principle to those used for leather disc couplings, but the drive is transmitted through spring steel discs instead of through leather or fabric. The clutch is particularly light in action, and, with a normal amount of attention to its lubrication, wears remarkably well.

Gear Box.

The aluminium gear box is mounted by four-point suspension on the sub-frame, and provides four speeds forward and one reverse. With the engine running at 1,000 revs. per minute, the gear ratios provide the following speeds in miles per hour: First speed, 7.5; second speed, 12; third speed, 19; and fourth speed, 28.5. It is unnecessary to add that the range of speeds provided by the engine gives a maximum car speed well above the ordinary requirements of a touring car user, and officers at the Front were very keen to secure Vauxhall cars for Staff work on this account.

Case-hardened steel, with an ultimate stress of 46 tons per square inch, and passing a scleroscope test at 95-100, is used for the gear wheels. Reference to fig. 6 will show that the shafts and gears are well proportioned, which was borne out by an examination of the box for wear. Except in the case of the bearing at the rear end of the third motion-shaft, the ball races are fitted directly into the aluminium gear box. The absence of separate steel housings for these races was noticeable on the aluminium, the outer rings of the races having chattered slightly in their housings at the front and rear end of the second motion-shaft. Considering the slight extra cost of fitting these separate housings and the advantage obtained by their use when overhaul work is in progress, it is surprising that they are not used universally.

In this particular case the gear box had to be reassembled with the races slightly loose in their housings, which could have been avoided had renewable housings been embodied in the original design. None of the gears had worn to an extent endangering the case-hardened surfaces, and only a very slight amount of backlash existed between the sliding gears and the splined shaft.

FOOTBRAKE.—An internal expanding footbrake is located behind the gear box—a practice which, though widely adopted, involves a considerable amount of labour and loss of time when the shoes have to be renewed. The drum is mounted on a flange forming part of the universal joint coupling, and is provided with cooling ribs. The braking surface is of generous proportions, and a smooth action is ensured by the use of Ferodo lining.

Back Axle.

The bevel-driven back axle, shown in fig. 7, is of the full floating variety, constructed on orthodox lines. The casing consists of a vertically divided central portion, a separate housing for the driving pinion shaft, and two solid drawn steel tubes, upon which the road wheels and springs are mounted. A pressed steel torque member anchored at its front end to a ball

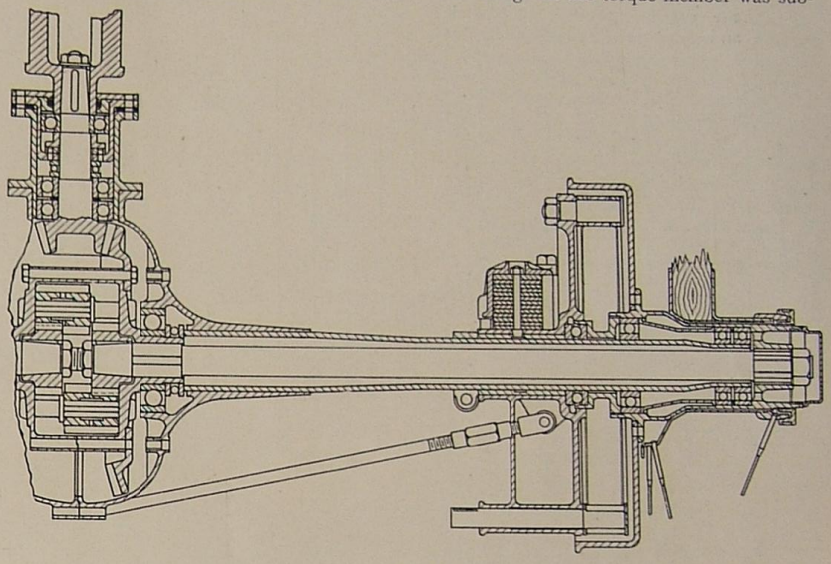


Fig. 7.

joint link resists the tendency of the axle to kick when taking up the drive, whilst the springs act as radius rods.

The cardan-shaft transmitting the drive from the gear box to the driving pinion has a yoke and die block coupling at the front and rear end respectively, the wear being taken up by renewing the bushes and die blocks.

Spirally cut teeth are adopted for the final drive gears, and, as these gears have a negative thrust, additional thrusts have to be provided to prevent them working too far into mesh on their own account. Straight toothed pinions are used for the differential gear, the pinions being mounted on pins of ample dimensions firmly secured in the differential cage. No repairs or replacements were required as far as the actual gears were concerned, nor had any weakness developed in any part of the casing. It was found desirable, however, to skim up those portions of the axle sleeves that accommodate the spring seats, chiefly on account of neglected lubrication at this point.

As is frequently the case where bolted on torque members are employed, there was some difficulty in maintaining a rigid connection between the rear end and the axle casing. This minor defect was corrected by fitting larger studs and issuing instructions pointing out the necessity for special attention to the nuts at this point. The design of the torque member was subsequently modified, providing a swivelling attachment at the rear end, thus overcoming the trouble.

A thrust race is fitted on each axle sleeve to relieve the rear wheels of side stresses. On examining these races, it appeared that their surfaces were not sufficiently well protected from mud and water, which works in at the edges of the side brake drums. The only other wear found on the back axle was on the splines at the outer end of the axleshafts, but by replacing the driving dogs most of this was taken up.

Before being returned for further duties on Staff work, the chassis was submitted to a long and complete road test, the results of which were satisfactory in every respect.

WE have received from Messrs. Clayton and Shuttleworth, Ltd., Lincoln, a copy of a booklet dealing with the firm's work and their various standard productions in threshing machines, steam traction engines, oil engines, railway rolling stock, etc.

The firm of Messrs. J. Lord, Ltd., Stockport, has now been reconstructed, and this company will be known in future as Messrs. J. Lord (Manchester), Ltd., Lord's Chambers, Corporation Street, Manchester. The new company forward us a booklet of their furnaces for various purposes. These include furnaces for annealing, case hardening, forging, etc., etc., practically every type of gas or oil-fired furnace being marketed by the company.

We have received from the publishers, Messrs. Iliffe and Sons Ltd., 20, Tudor Street, E.C.4, a copy of a recently published book entitled "Magnetos," by A. P. Young, A.M.I.E.E. Mr. Young will doubtless be recollected as being the author of papers presented to the Institution of Automobile Engineers, and published in *The Automobile Engineer*, and everyone will welcome a volume by so unquestioned an authority. Although a certain amount of technical and scientific matter is necessarily included, the primary purpose of the book is to explain the theory and practice of magneto ignition to those who have but a small store of electrical knowledge. The subject is diligently covered, and a thorough insight is given into the construction of the magneto, as well as to the theoretical considerations underlying its design. A valuable feature of the book is the section containing detailed descriptions and diagrams of the British-made magnetos. A very large number of half-tone and line illustrations are given, and the book should be of considerable interest to the decidedly technical reader as well as to the private car owner or driver. The price of the book is 4s. 10d. post free.

Notwithstanding the popularity of silent chain drives for camshafts and their adoption by manufacturers of high repute, it must be admitted that silence is only obtained when the chains and wheels are in an unworn condition. Considerable wear on the links of the chains affects the teeth of the timing wheels to a proportionate degree, resulting in frequent renewals to eliminate backlash and restore silence. The cost of such renewals compares unfavourably with those required for a spur gear-driven camshaft.

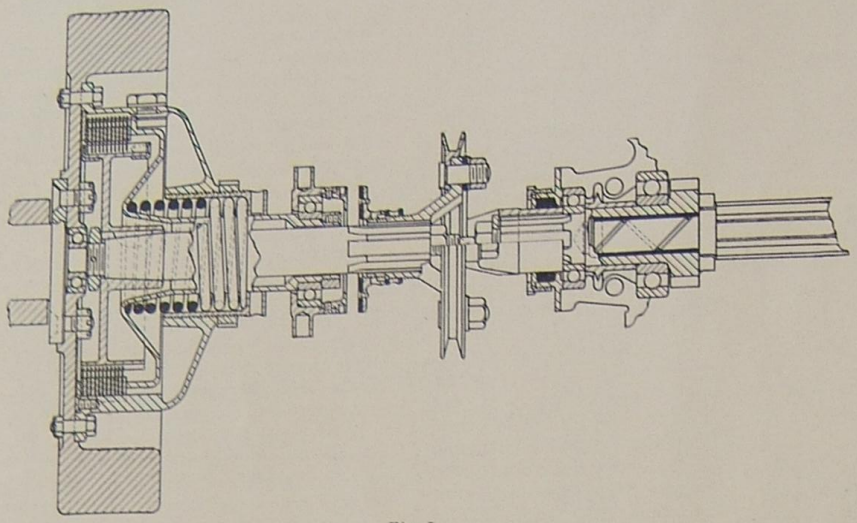


Fig. 5.

In the present example the chain had certainly been allowed to run far too long, a frequent occurrence, with the result that all the wheels, as well as the chain, had to be renewed.

The remainder of the valve mechanism was found in good order, except that a certain amount of trouble had been experienced with burnt exhaust valves, this being apparently due to setting the valve clearance so close that when the engine was warmed up the valves never closed properly.

CARBURETTER.—A standard White and Poppe carburetter has been used consistently on Vauxhall cars for the last ten years. In addition to the amount of air admitted to the mixing chamber through the throttle opening, an extra air inlet, worked by a lever above the steering wheel, allows the mixture to be varied by the driver, enabling him to choose between maximum power and maximum economy.

The petrol is delivered to the float chamber under pressure from a large tank at the rear of the frame, the pressure being maintained by a small piston pump actuated at the rear of the engine by an eccentric pin on the end of the camshaft. Mounted on the dashboard are the pressure gauge and the hand pump, by which the initial pressure for starting the engine is obtained.

OILING SYSTEM.—All the crankshaft bearings are lubricated under pressure, which is maintained by an oil pump actuated by the same eccentric that works the air pump. From the sump the oil is drawn into the piston pump and forced through pipes to each of the five main bearings. Holes drilled from the main journals to the crank pins allow the oil to pass to the connecting rod bearings, and surplus oil escaping from the latter is splashed up, thus lubricating the cylinder walls and gudgeon pins. Before returning to the sump, all the oil is strained by means of a gauze which covers the whole of the lower part of the base, so that the pump is fed continually with clean oil.

The arrangement of the strainer is particularly convenient, it being easily withdrawn for cleaning purposes by removing a plate at the front end of the casting. During the examination of the various parts connected with the oiling system, no traces of undue wear were noticed, and the condition of the engine showed that the supply of oil had been sufficient even under the abnormal conditions prevailing on active service.

COOLING SYSTEM.—The engine is cooled by forced circulation, the design of which includes many interesting features. In the first place, the size and arrangement of water pipes ensure adequate cooling by thermo-syphon action, should the fan belt be removed—a precaution sometimes necessary during the winter months. As may be seen in the sectional view of the engine (fig. 2), the fan is secured to the same spindle that operates the pump, and the latter is located in a pocket of the water jacket, the two components being thus driven by the same belt. This is of considerable advantage, if during frosty weather the pump freezes up, for any possible damage is prevented by the belt slipping on its pulleys when the engine is started. In order to allow for adjustment of the belt tension, the fan pulley is made with a variable flange, so that its diameter can be altered as required.

The only defect connected with the pump and fan gear was of a trivial nature, yet it was the cause of a lot of otherwise unnecessary repair work on the radiator. The fan hub is secured to its spindle by a plain key and taper cotter, but owing to defective fitting on some occasion the key had worked loose. This eventually caused the taper cotter to shear, allowing the fan to slide along the spindle and foul the radiator tubes, which in consequence sustained some damage.

The radiator, of the well-known Vauxhall pattern, is of substantial construction, being built up of vertical gilled tubes. Hinged supports are provided for its attachment to the frame, and, apart from the damage caused by the fan accident, no repairs were necessary.

IGNITION.—The high-tension magneto is mounted on the left-hand side of the engine, being driven from the adjustable spindle already mentioned, by means of a laminated steel plate coupling. The variable igniting point is controlled by a hand lever mounted above the steering wheel.

Clutch and Coupling Shaft.

Fig. 5 illustrates the mechanism transmitting the power from the engine to the gear box, comprising a multiple-disc clutch and a special type of laminated plate coupling, which permits of slight variations in frame alignment due to intermittent deflections of the frame members. Flat plates running in graphite form the frictional elements, designed to eliminate the common evil of "plate drag" so prevalent on multiple-disc clutches.

The wear on the surfaces engaging the inner and outer plate grooves was no more than might be expected, and after the slight serrations had been eased down, the original plates were refitted. It was neces-

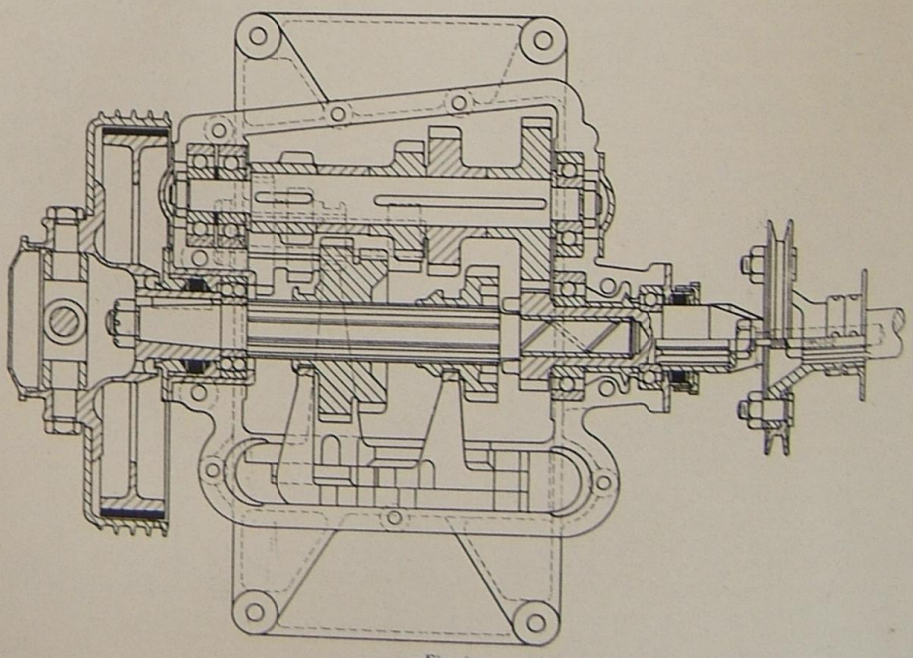


Fig. 6.

the crank case, the design being arranged to avoid the usual skew gearshaft for driving the magneto. As may be seen in the photograph of the engine, the crank case is of very substantial design, no trouble being experienced with fractured or distorted castings.

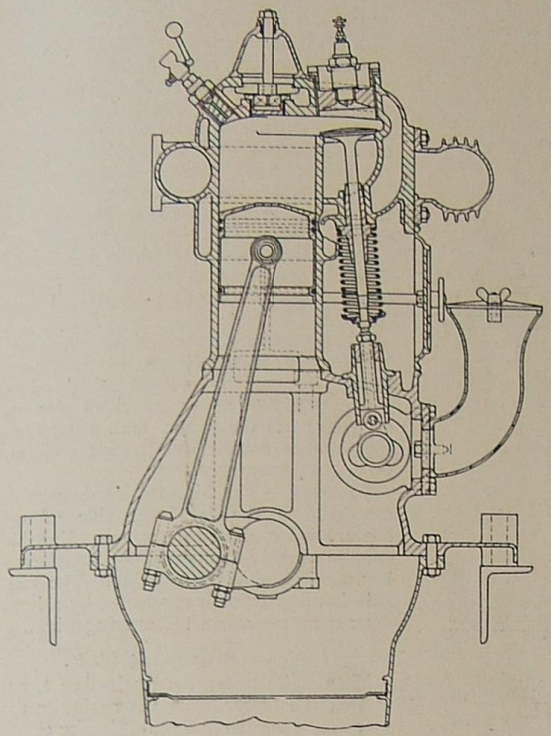


Fig. 3.

CRANKSHAFT.—Five main bearings are used for supporting the crankshaft, die castings being adopted for these as well as for the connecting rod bearings. All the main journals are 2in. in diameter, the length of the front and rear being 3in., while the second, third, and fourth journals are 2¼in. long. Nickel chrome steel, having an ultimate stress of 50 tons per square inch, is the material from which the crankshaft is forged.

When tested for alignment the journals were found to be very little out of truth, and the small amount of wear that had taken place rendered regrinding quite unnecessary. Slight ridges were noticed on the rear journal, but fortunately these had not assumed any serious proportions. Micrometer measurements taken on the connecting rod journals revealed an average oval wear of .004in., which was corrected by lapping.

The end thrust of the crankshaft is resisted by the flanges of the die cast bearings, but no excessive end float had developed, and as the condition of the latter was very good, they were not replaced.

By adopting large diameters for the connecting rod journals, wear on the bearings is kept very low. The length and diameter of the bearings are 2¼in. and 2in. respectively.

CYLINDERS.—A close-grained cast iron is used for the construction of the L headed cylinders, which, as already mentioned, are cast *en bloc*. A neat external appearance characterises the cylinder casting, due partly to the arrangement of the integral induction pipe and also to the compact valve chambers obtainable with inclined valves. At the front of the casting a large opening is provided to receive the water pump housing—an arrangement that greatly simplifies the general layout of the engine.

The bores showed very little sign of wear, either oval or taper, but when tested with water pressure a small but serious defect came to light, for which the casting was rejected. Two of the four exhaust valve seatings had developed radial cracks through which the water leaked when subjected to a pressure of 30 lb. per square inch, the position of the failure rendering any repair by acetylene welding very difficult, if not impossible.

Contrary to the increasingly common practice for high efficiency engines, the Vauxhall cylinders are not offset, as may be seen from the cross sectional view.

PISTONS AND CONNECTING RODS.—The pistons have cone tops, and are slightly longer than their diameter. Hollow gudgeon pins are held in the piston bosses by a single set screw in each case, the failure of this fixture having on more than one occasion been responsible for the scrapping of the cylinder casting. The recurrence of this trouble caused the Mechanical Transport authorities to issue special instruction to units in the field modifying the gudgeon pin locking arrangement. Three piston rings are fitted to each piston, two of these being located above the gudgeon pin, and the third, which acts as a scraper ring, being in the lower part of the skirt.

To rectify the slight amount of wear between the piston rings and their grooves, the latter were skimmed and fitted with oversized new rings. All four gudgeon pins were renewed, not because of wear on their working surfaces, but on account of slackness in the piston bosses. This trouble is always liable to recur until designers in this country recognise the advantages from the American practice of locking the gudgeon pin in the connecting rod and allowing all movement to take place in the piston.

The connecting rods, approximately 12in. long, are of the usual I section, the white metal for the big end bearings being cast in the rods, four bolts holding the bearings in place.

VALVE GEAR.—The valve mechanism is operated by a single camshaft cut from the solid with integral cams. As originally made, the camshaft had five bearings, but after the year 1914 the diameter of the shaft was increased and the centre journal enlarged, so that a three-bearing shaft could be adopted. This modification eliminated the use of split bushes for the camshaft journals.

Considering the fact that the camshaft is only supported for about one-sixth of its total length, the wear on the bearings was remarkably small, but, as might be expected, the shaft itself had sustained a slight amount of distortion under the action of the stiff valve springs. This matter was, however, rectified without difficulty.

A triangulated drive by silent chain actuates the camshaft and the magneto spindle. As shown in fig. 4, the design of the chain drive contains several features of interest, amongst which simplicity is not the least important. Keyed to the forward end of the camshaft is a flange, drilled with a series of holes, spaced relatively to a similar series of holes drilled in the timing wheel, enabling a fine variation of position to be obtained between the cams and the timing wheel teeth. Stretch or slackness on the chain can be taken up by means of an eccentric adjustment, also shown in the illustration. The only drawback to this form of adjustment is that the eccentric flanges at the front and rear of the timing case must be set very accurately with one another. Unless care is exercised in making the adjustment, the magneto shaft will be forced out of its correct alignment, resulting in undue wear on the timing chain. The skewing of the shaft will also throw abnormal strains on the magneto itself, and many instances have been reported where breakage of the magneto coupling has occurred.

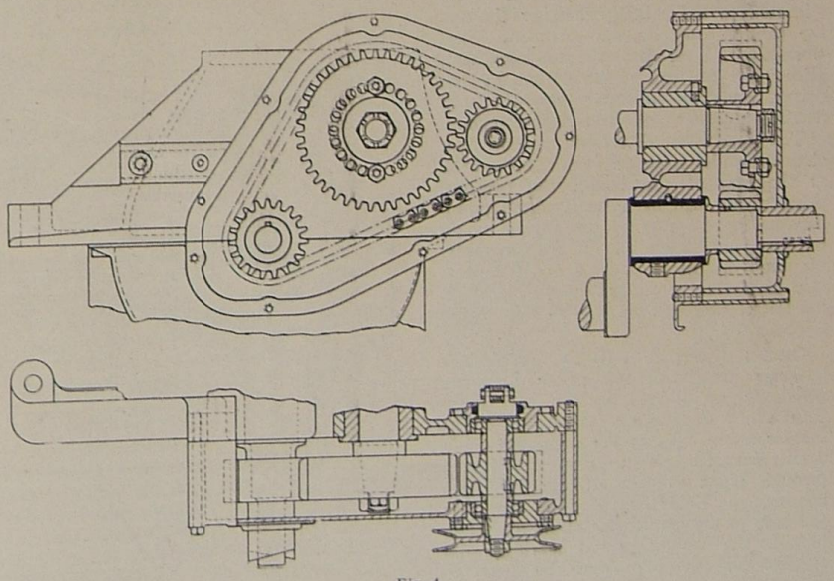


Fig. 4.

extremities in the horizontal plane, which may be noticed in fig. 1.

On being tested for distortion the front axle I beam was found to be quite satisfactory. The Rudge-Whitworth detachable wheels, fitted as standard, are provided with 880 mm. × 120 mm. tyres, the hubs being mounted on Skefko self-aligning ball races. In spite of the negligence of drivers, who rarely give the proper amount of attention to any form of wheel locking device, this pattern of wheel gave very good results.

enabling the driver to maintain control over the steering until the car comes to a standstill.

Another device employed with the same object was composed of two radius links made from spring steel and connected from a special tie bar, fitted between the dumb irons, to swivel connections on the front axle. In addition to the security thus afforded in the event of a spring fracture, the latter attachment appeared to be beneficial in steadying the front of the frame when the car was passing over bad roads.

Very little backlash was found in the steering gear, and in consequence the wear on the working parts of the mechanism was practically negligible. As far as manipulation is concerned, the steering gear is very light, so much so, in fact, that the wheel has to be held very firmly when the car is travelling over bad roads at high speed.

Engine.

The general layout of the engine is shown in the sectional drawings (figs. 2

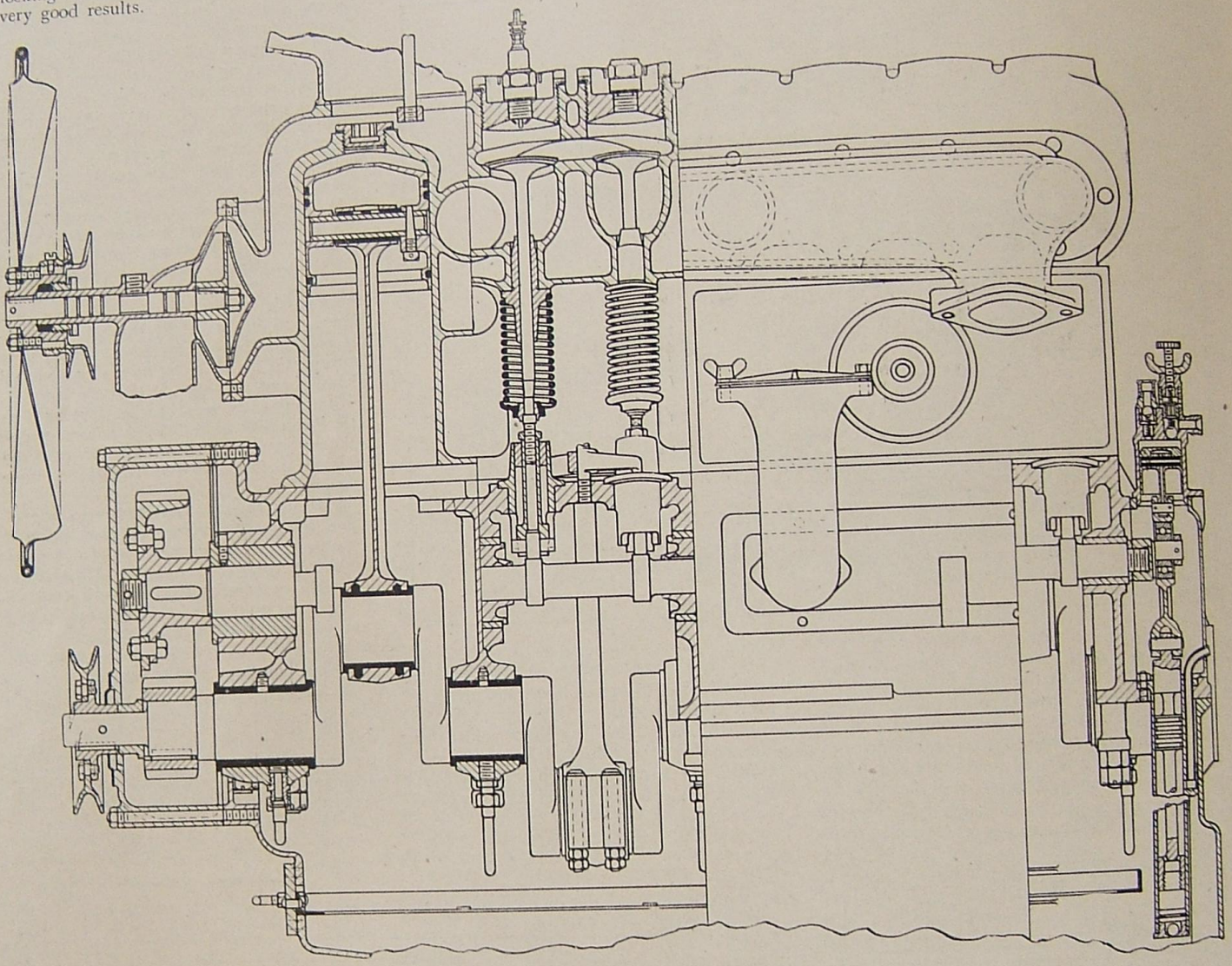


Fig. 2.

SUSPENSION.—Twelve leaves are used in each of the front springs; thus, by using a large number of thin leaves, a high resiliency-to-strength ratio is obtained. Though the Vauxhall cars used at the Front were most insatiable spring consumers, the fact does not necessarily prove that the suspension was at fault. Though other cars, with less carefully designed springing, used fewer replacements, it was because they lacked the turn of speed possessed by the Vauxhall.

Auxiliary safety devices were used extensively in connection with the front springs, the most convenient form consisting of a piece of Balata belting clamped between the spring and the axle at one end, the other end being bent over the spring and attached to the dumb iron. In the event of a spring snapping, the front axle is retained in position by the belting,

Thirteen leaves are employed in each of the rear springs, which gave no trouble whatever as far as breakages are concerned.

Steering Gear.

The steering gear is operated by a full worm wheel, ball bearings being provided for all the moving parts. The adoption of Duplex ball races for the steering mechanism eliminates the usual difficulties connected with side thrust, and also enables the design of the column to be simplified. The worm is made in one piece with its spindle, and the worm wheel is secured to the steering lever shaft by six bolts. The steering column is hollow, the control rods passing through the space thus provided. Ball and socket joints are used throughout the steering connections, suitable means for adjustment being furnished at all points.

and 3). The four cylinders are cast *en bloc*, and have a bore and stroke of 95 mm. and 140 mm. respectively, the nominal h.p. being 25 (22.4 h.p. R.A.C. formula).

Without sacrificing accessibility, the makers have succeeded in obtaining a distinctly clean design, thus avoiding any impression of complication. There is no doubt that the popularity of the Vauxhall car at the Front was in no small measure due to the reliability and efficiency of the power unit.

CRANK CASE.—The crank case is cast in 96% aluminium, being divided horizontally on the crankshaft centre line. The upper portion carries the five main bearings and the valve gear, as well as the feet by which the whole engine is supported on the subframe. A deep sump or oil reservoir forms the lower portion, and the timing gear is enclosed in a wide cover at the front of