THE 8 H.P. ROVER DESIGN.

A detailed consideration of the construction of a commercially successful small car of moderate cost.

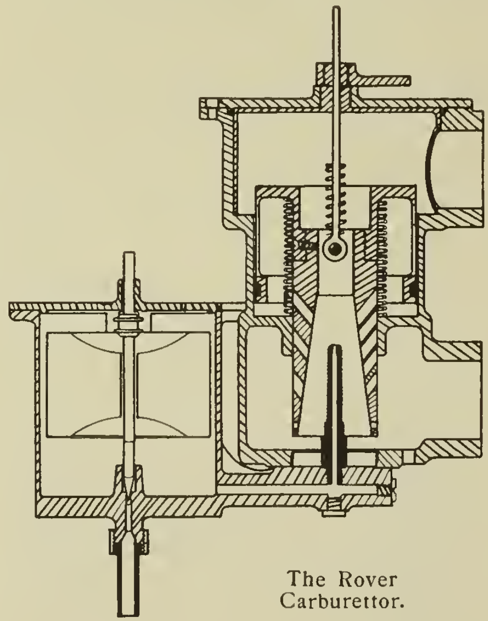
ALTHOUGH the 8 h.p. Rover is in many respects a peculiar car, and although a large number of the same type have been made and sold during the last few years, yet the design has been copied by other manufacturers to a remarkably small extent. In these days, when the sincerest form of flattery is so rampant in automobile design it is rather difficult to see why this is so, epecially as there is nothing in the whole car that is not cheap and easy to handle in both the foundry and the machine shop.

Possibly the explanation lies in the fact that the low compression slow speed engine with a single cylinder, 114mm. bore by 130mm. stroke does not appeal to the imagination of the modern school of voiturette designers whose efforts have lately been concentrated on the production of small four cylinder types.

The main characteristics of the chassis are the slow speed engine, the unit construction of the crank-case, clutch case, and gear box, and the suspension, which is three point, a transverse front spring being used. The frame is ash $1\frac{3}{4}$in. deep by $1\frac{5}{8}$in. wide, and the side members are strengthened by flitch plates mounted inside the ash. From the dashboard to the rear end these plates are $2\frac{1}{2}$in. deep, but the front ends are narrowed to $1\frac{3}{4}$in. or equal to the depth of the ash. The rear end of the frame is also ash of similar section to the sides and strengthened with a flitch plate $1\frac{3}{4}$in deep. The plates being all of the same thickness, namely 3-16in.

There are no cross members in the accepted sense of the word, except the back one, because from the point of attachment of the front end rear spring hangers the stresses usually resisted by a frame are borne instead by the aluminium engine and gear unit. This unit is bolted to a cast aluminium bridge of channel section of which the ends are attached to the side members of the frame alongside the spring hangers, and also to the end of the gear box.

The front end of the aluminium unit is bolted to a malleable iron channel section piece, called by the makers the nose piece, and shown in half sectional side elevation in the general arrangement of the unit. This nose piece carries a single large bolt, shown in the same view, and on this bolt it is possible for the pad of the transverse front spring to rock. Thus the engine and gear are directly supported at the centre of the front spring and at the forward ends of the rear springs.



The Rover Carburettor.

The front part of the ash frame has, therefore, merely to support the body, the wings. and like fittings, and plays no part in sustaining the weight of either engine or transmission.

Such a form of construction would certainly be far from good for a heavy car, but in this instance it has stood the test of several years' use and its continuance is sufficient proof of the fact that the makers have had no trouble from it. It should be noticed that there are a couple of tie rods disposed close to the bottom of the clutch case, joining the crank case to the gear box (only one of these rods is seen in the elevation). We are informed that these rods were added because it was found that without them tnere was a tendency for the flange joints at each end of the clutch case to open, after a car had been in use for a few months, and that their addition entirely removed this trouble.

The way in which the bracket which supports the rear end of the unit forms an integral part of the gear box is made clear by the same figure, and the satisfactory nature of aluminium for the purpose is proved by the fact that in practice no trouble arises from it. This is no doubt due to the ample section of the arms, and to the continuation of the channel right across the casting, the gear-shaft coming through the centre of the channel at the point where it is deepest, namely, 116mm. outside measurement.

In addition to the rear brackets and the nose piece, the unit is also attached to the frame sides by a steel plate, the full frame width, about 114mm. wide, and about 6mm. thick, but this plate carries the dashboard, and owing to the light section of the frame, forward of this fitting, the plate cannot support much of the weight of the unit by the transference of stress to the side members.

The attachment of the rear springs to the frame is accomplished in the customary manner, the after ends being shackled and the forward ends secured in malleable brackets. Dumb irons carry the rear end shackles, the former being bolted to the frame by three bolts apiece. The corners of the frame being strengthened by corner plates it is not considered necessary to attach the irons to the back cross member, as well as to the side members, and as the overhang of the springs is only about 20mm. the twist on the sides of the frame is not particularly severe and the corner plates should be quite capable of resisting it.

The rear springs are about 900mm. in length, 45mm. in width, and there are five plates in each, the average thickness of the individual plates being between 6mm. and 7mm.

Details of the front spring are shown in the view of the front axle arrangements, and we need therefore say no more about it here, except to add that the width of the spring is about 45mm.

The front axle has an interesting and distinctly bold type of steering swivel, which appears in section in the view of the end of the axle. The whole of the load is supported and the side stresses are also resisted by the steel balls, which are half an inch in diameter. It will be noticed that each ball lies between two conical cups, each cup having annular contact with the ball. The surfaces of the cups are all case-hardened to a good depth, and adjustment of the bearing can be made by rotation of the upper cap, the top end of the swivel fork being split and provided with a clamping screw for locking the cap.

It will also be seen that the stub axles and the swivel pins are separate pieces instead of being a single stamping, as is frequent, and this is a design which has a good deal to recommend it. In the first place there is no difficulty attendant on the use of very tough steel for the stub axle, which is a part that requires the maximum of strength. Then the swivel pin is simple and cheap to make, while (of importance in this particular instance) the ends of the pin can easily be hardened to receive the ball without any risk of affecting the properties of the stub axle steel. Finally, the steering arms also being separate, can, owing to their simple form, be made of a material having somewhat greater strength than usual. It might be urged that the built-up construction is less advantageous practice than the solid one, because of the ever present possibility of built-up structures coming apart, but against this must be set the manufacturing advantages of the three-piece design, and the liability to breakage of the latter would be slightly smaller than that of the single piece, other things being equal, because the material is subjected to less trying manufacturing conditions.

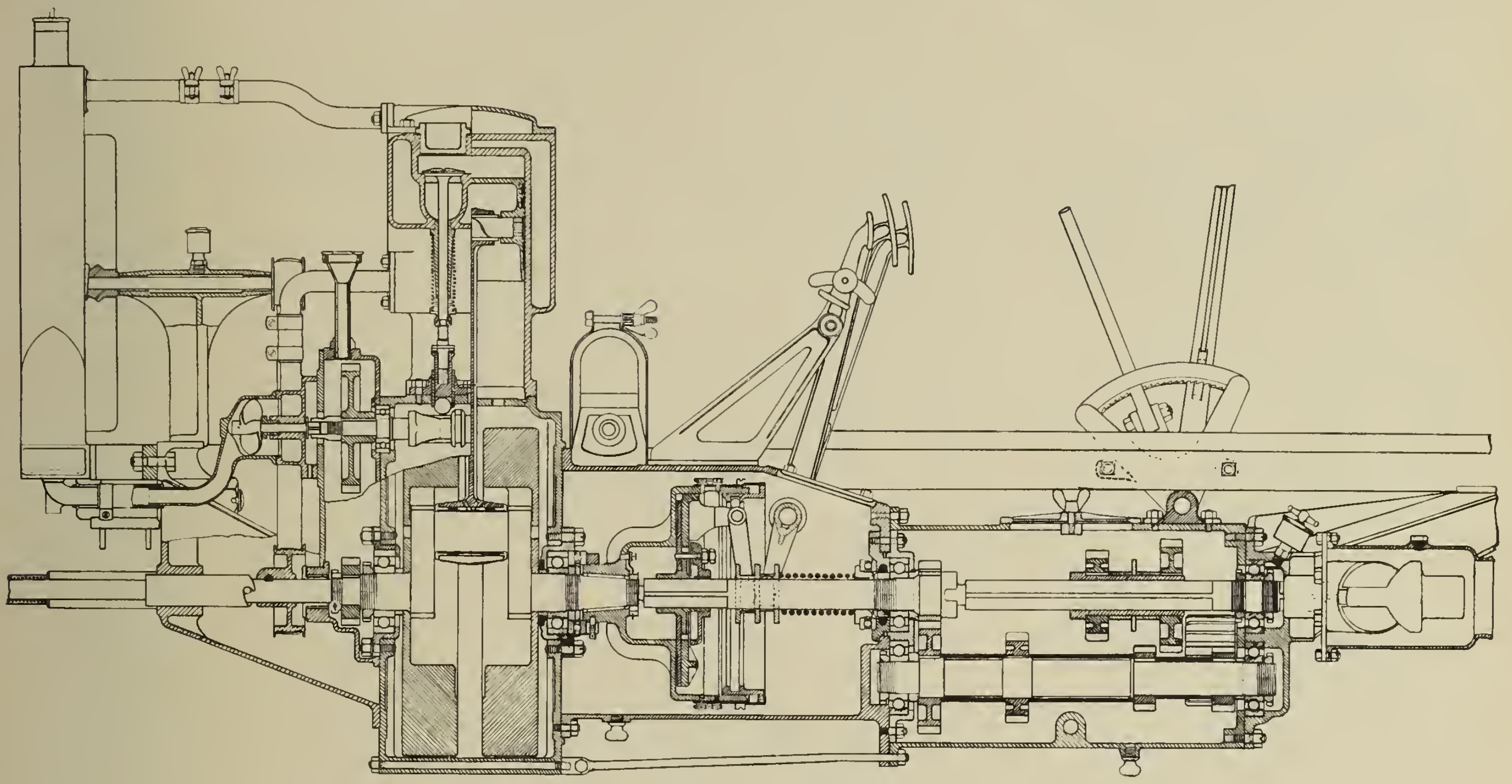
On the tubular front axle two collars are shown, spaced 700mm. apart, and at equal distance from the centre. These collars are brazed in position, and each carries the half of a pin joint. The other halves are the ends of a pair of tubes 16mm. in diameter, which converge and terminate in ball joints mounted on opposite sides of the clutch case. The purpose of these rods is, of course, to radius the ends of the front axle, which is necessary owing to the transverse spring. The behaviour of this spring when stressed from only one end can be seen easily if it is remembered that the pad is quite free to rock on the big supporting bolt, so that the whole length of the spring is available for the absorption of a one-sided shock, as well as for a shock affecting both wheels equally. This rocking motion is constantly taking place, and for lubrication a small brass casing is used to carry a screw-down grease cap in a convenient position just beneath the radiator.

The radiator is supported by the forward ends of the side-members of the frame, and the fan-carrying bracket is mounted on top of the front end of the nose piece. The fan itself is an aluminium casting, the insertion of copper rivets in one blade serving to secure balance.

Having thus described the disposition of the frame and springing we can proceed to consider in detail the engine and gear unit, which is, perhaps, the most interesting part of the chassis. There is nothing of particular or peculiar interest regarding any detail, but the unit as a whole is instructive, because it is almost entirely dependent on a 98% aluminium alloy for its strength, and yet is certainly satisfactory in use, though, at first glance it would not appear to be well calculated to withstand the bending stresses which it is required to resist, and which must be fairly severe.

The splitting up of the case into three separate compartments probably has no bearing on the strength, and, while it increases the number of machine-shop operations necessary, it also makes for simplicity in machining, as there is no part that cannot be faced by the simplest of tools; besides, each part being small, there is a slightly smaller chance of bad castings occurring, and there is not the same temptation to pass a casting that is neither wholly bad nor wholly good.

Two thoroughly good points are the way in which the ball races are carried in housings of malleable iron, and the careful manner in which the inner races are secured to the shafts. It seems a pity that the iron housings were omitted in the case of the bearings at the end of the gearbox, though, of course, there is not the same need for them as these races are almost free from shock.

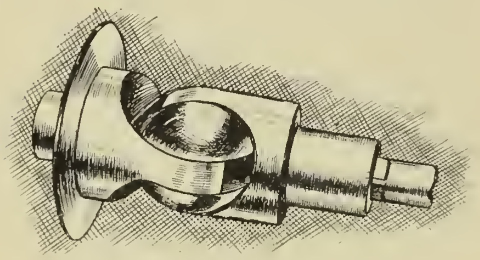


Engine Clutch and Gear Unit.

The engine itself is admittedly modelled on the old eight horse power De Dion Bouton. It has a stroke of 130mm. and a bore of 114mm. and is rated at a nominal 8 H.P. The compression is designed to be about 66 lbs. to the square inch, at its maximum, so it is easy to obtain slow running and the maximum speed is not very high. The normal speed is given as being 900 r.p.m., and the maximum as 1,600 r.p.m., while the minimum speed obtainable with the usual carburetter and ignition, is under 150 r.p.m., a very desirable feature in a car with so large a single cylinder.

The cylinder is held down in the usual way by studs, and calls for no special comment, except that it should be capable of improvement by enlargement of the water intake and exit. The area of valve opening is just under a thousand square cms., when at its maximum, and, as this represents close on one-tenth of the area of the piston, it is in a proportion in keeping with first-class practice. The valve operation is one of the features of the car.

and is easily followed by reference to the general arrangement. The exhaust cam proper and the inlet cam are of the same dimensions as regards total lift, but the cams can be slid by depressing a pedal, and when longitudinal movement takes place the inlet valve is allowed to remain shut continuously while the exhaust valve engages with a secondary cam, causing it to open at the top of every piston stroke, to remain open during the down stroke, and to close at the bottom. This action converts the engine into an air compressor and a smooth, but powerful braking action is the result. Needless to say, the sleeve and cams are one solid piece, and



Unique pattern of universal joint.

we consider that it is much better to arrange the parts in this manner rather than to use the alternative method of sliding the whole camshaft.

The construction of the tappets should be noticed, as it illustrates an excellent way of introducing a fibre pad for deadening noise. The small spring in the centre of the tappet keeps the top piece in perpetual contact with the valve, and this top piece is separated from the lower half by a fibre ring through which the pressure applied to the ball end is transmitted. The ball is ⅜ in. in diameter, and its use is doubtless due to the presence of sideway slide. The extremely narrow area of its contact with the cams is not exactly good, but if the latter are sufficiently hard there is no reason why the durability should not be satisfactory.

There are only a few other points with regard to the engine which require further elucidation than is made obvious in the drawing. The attachment of the cast-iron flywheels to the crankshaft should be noticed, and we may add that the crank, connecting rod and piston are balanced by the simple expedient of drilling out the opposite rim of the wheels.

The piston is peculiar on account of the ring arrangement, there being two rings in each groove. This is a practice which the Rover Company inform us has been found satisfactory, and has been in use for some time. If the fittings of the rings is carried out with care there is no obvious reason why they should not behave as well as when separated, but on the other hand, there is no particular object in the design, especially as it has been demonstrated conclusively that there is no necessity for more rings than three, the fourth merely causing extra friction.

The gudgeon pin fixing is good and easy to follow from the drawing. The bush and pin being both steel, while the big end bush is gun-metal lined with babbitt.

It should be noticed that oil excluding or separating washers are used to prevent the entrance of oil from the clutch case to the crank chamber, and that there is a gland round the shaft where it emerges from the distribution gear case. There is, however, a free way for oil through the front main bearing for feeding the gears.

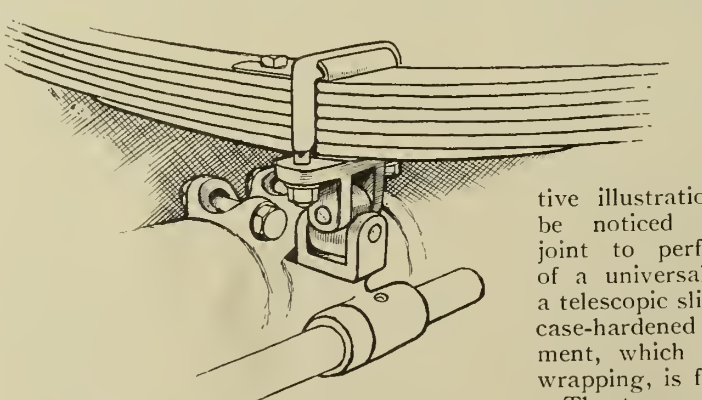
One small point which calls for adverse criticism is the position of the pump gland. The pump is a simple two-bladed propeller and is enclosed by an aluminium cap held in place by a dog mounted on two long studs projecting from the front of the distribution gear box. In order to tighten the gland it is necessary to remove this cap, which means letting out all the water from the cooling system, and although any leakage along the shaft is trapped in a chamber before it reaches the crankcase, the placing of the gland adjustment in a more accessible position would be a valuable improvement to the car as a whole.

Another small criticism which might be made regarding not only the engine, but the whole unit, is that there is a free use of studs depending for their security upon a comparatively short thread in the aluminium. Failures on this account are no doubt rare, but it is a form of construction better avoided whenever possible, and usually easy to avoid.

The clutch is a pattern which has been used for Rover cars for some years, and it is satisfactory in action when the plate separating device is set so as to clear the surfaces beyond the point where oil can cause them to stick together. The main body is, of course, cast iron, and the inner part of the clutch is made of the same material, while the central plate is steel. The action of the engaging levers is fully explained by the drawings and we need only add that adjustment is performed by turning the ring, the groove in which forms the fulcrum for the levers, of which there are three. The advantages of this clutch are that it is not costly to make, and it is durable as well as being sweet in action. Its disadvantages, that it is a little difficult to handle if the oil is of too stiff a consistency and, that when worn it is not so easy to repair as are clutches where the main body itself is not used for a working surface. Also the striking gear is liable to develop a good deal of slack. However, as the normal life is so long, the advantages should more than counterbalance the drawbacks.

The casing of the clutch is neat, and the large inspection door allows all adjustments to be made without dismantling, though to break the unit is easy when the latter is detached from the car.

The gears also present no special point for comment, being of the simple straight through type, controlled by a lever working in a quadrant with deep engaging slots in the side of the arc. The lever

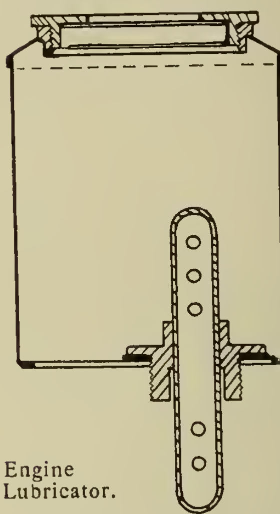


Swivel mounting of rear springs.

rocks on a pivot carried on the outer end of the shaft, and it is forced against the quadrant by a spring which is compressed in a socket as the lever is pressed outwards.

The cross tube (which turns on the brake shaft as usual) carries a lever connected by a link to another fixed to a shaft running across the bottom of the box. This shaft carries an internal arm and fork, by means of which the slide is operated.

The method of securing the gear wheels to the sliding sleeve and secondary shaft is shown in the drawing, and both sleeve and shaft are, of course, circular. It will be seen that the assembling is simple, and the necessary fitting equally so, while the replacement of secondary shaft gears is a simple job.



Engine Lubricator.

The first drive between the primary and secondary shafts gives a ratio of 1.8 to 1, the second speed wheels are of equal size, and the first speed wheels are verse train has the same ratio as the permanent drive only, of course, in inverse ratio, namely, 1 to 1.8.

The bevels in the axle have a ratio of 4.125 to 1.

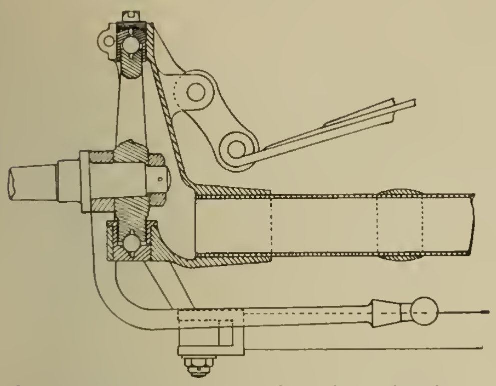
Notice should be taken of the grease chamber and screw-down cap behind the rear end bearing of the upper gear shaft. This is considered necessary, because if the oil level drops in the box there is a small chance of the bearing running dry, though the corresponding race at the front end is fed with oil thrown up by the permanent gears. This arrangement is a refinement which is probably not essential, and might be omitted without much danger of injury to the bearing.

There are no other details of the unit which require explanation, except that the side of the gear box not shown is a thin steel plate, secured by studs and nuts. This enables the box to be cleaned out thoroughly, and is cheaper than an aluminium plate would be, while being equally effective.

The drain plugs in the bottom of the clutch, gear, and crank cases might, with advantage, be a little larger, and the last-named, though not shown, is situated in the same relative position as the former pair.

The next point for consideration is the universal joint, which is a unique design, said to be very satisfactory in use. We show a special perspective illustration of this, and it should be noticed that not only has this joint to perform the usual functions of a universal coupling, but it is also a telescopic slide. All the parts are steel, case-hardened and ground, and the encasement, which is completed by a leather wrapping, is fairly complete.

The torque of the drive is resisted by the universal joint, the stress being transmitted by the casing of the propellor shaft (which is in one piece with the back axle) to the shaft itself, through the front end bearing. The spring pads are mounted



Front axle end and steering pivot showing built up stub axle and front spring shackle.

on the aluminium axle casing, and are secured by clamping screws, but the torque is not thus transmitted to the springs, because of the peculiar mounting of the latter on the pads. In order to relieve the springs of all twisting stresses due to the elevation of one road wheel at a time, the pads and axle are linked together by small Horkes couplings. This gives a sufficiently secure attachment and also permits universal movement. It is a refinement which is probably not necessary, but it must assist the springs to act in the freest possible manner, and should afford an interesting and worthy source of experiment for other designers.

The axle itself, together with the propellor shaft casing, is cast aluminium, of an almost pure quality. Aluminium has been used by the Rover Company for axle work for some years, and as there is no immediate prospect of its employment being discontinued, we assume that it has not given trouble. It is comparatively cheap, and it is light, but even if strong enough for the small cars made by the Rover Company we should prefer steel, and consider that steel can be made stronger, weight for weight, and just as cheaply.

No doubt the machining of the Rover axle is not an expensive performance, and the possibility of the ductility of the metal affecting the security of the housing of the bearings is overcome by the ample size of the ball races. In regard to the latter the way in which the inner races are secured is commendable. It will be noticed that the weight of the chassis is supported by the driving shafts, but we do not think there is any objection to this in so small a car. The arrangement of the brakes is open to criticism on two points, firstly, that the shoes are not as wide as they might be, considering the width of the drum; and secondly, that the socketing of the operating shafts into the aluminium of the differential case must result in wear and finally in rattle. It would be easy to bush these bearings, and not at all costly.

The internal expanding shoes are separated by means of pins set eccentrically on the end of the operating shaft instead of by means of the usual cam, and this is a good point, in that it gives a positive motion in both directions. The advantage of this is negatived in this instance by the use of wire ropes to actuate the brake shafts, but with a positive form of rod control the need for springs would be removed. The external contracting brake is controlled in a manner similar to that of the internal one, and is cleared from the drum by external springs, which draw the upper half out of engagement, too vigorous an action being guarded against by a stop, preventing the movement of the band to an extent more than sufficient than to just clear.

We have now described to a sufficient extent the main portions of the chassis, and have only to consider such parts as the carburettor, silencer, lubrication system, etc.

The carburettor is the standard Rover pattern, which is already well known. Its action is made clear by the drawing, and we need only add that the holes in the rising and falling cone and the strength of the spring are, by means of experiment, determined for each particular power of engine, once and for all, and that subsequently each car is tuned up by means of enlarging the size of the jet. Test drivers are provided with a small reamer, and each car is tested on a particular hill, the jet having to be enlarged till the car will climb the hill on the direct drive under normal road conditions.

The inlet and exhaust pipes are both copper, but the latter is connected to a steel expansion box, and subsequent connections are all steel. There are two expansion chambers joined by a short length of pipe, and the final exhaust is not unduly noisy, though, of course, it is next to impossible to completely silence a single cylinder engine, without great loss of power.

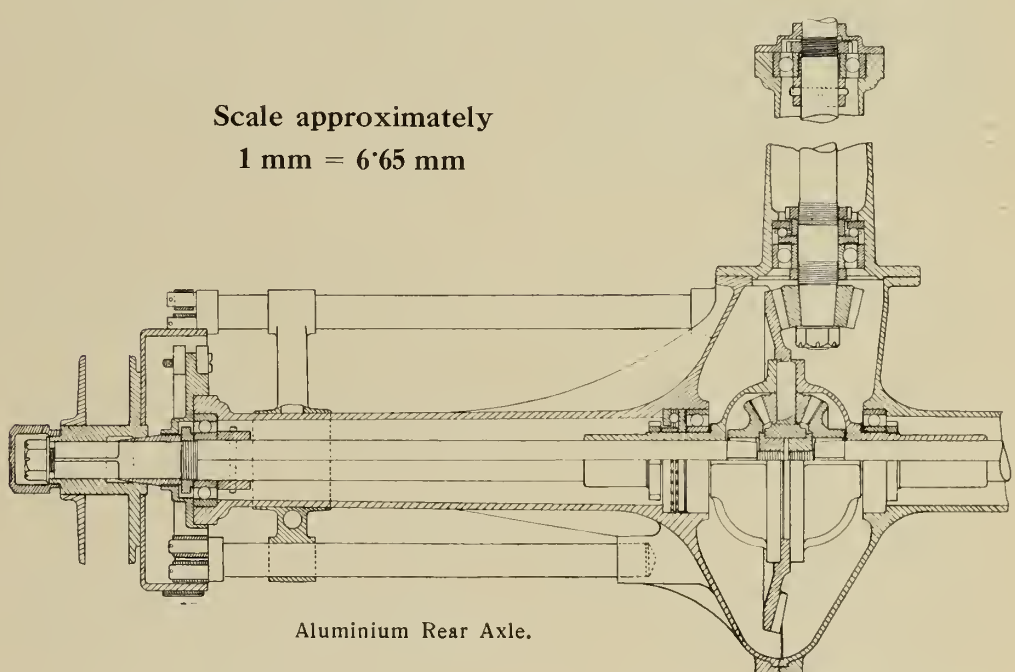
Lubrication has been reduced to the simplest possible system for the engine, by the use of the brass pot, mounted on the top of the crank case, and designed to contain just sufficient oil for a definite number of miles of running. This pot has to be filled with oil, which runs slowly into the crank chamber, taking several minutes to do so, and when empty the pot also acts as an air vent for the crank case. The clutch and gear box require to be filled up in the usual way as does the back axle. Practically all other points where ball bearings are present are provided with a grease feed, and the spring shackles and brake connections have, most of them, small cycle pattern oil cups, which are mostly arranged in accessible positions.

In general, while the design is peculiar in many parts, and is open to severe criticism on various theoretical grounds, it has proved to perform satisfactorily on the road, as is evidenced by the ability of the makers to obtain a fair price for the car for several years in succession. The principal part of the design with which we feel inclined to find fault is the considerable difficulty of getting at any part of the engine, clutch, and gear unit without dismantling the whole. Thus while it is possible to adjust the clutch from above, no part of it can be withdrawn without breaking the unit. Similarly, a new part in the gear box could not be fitted without several hours of work, and again, to take up the big end not only means opening the unit, but necessitates the complete removal of the crankshaft and detachment of one of the flywheels.

In detail matters, the car is well-thought out, and except in regard to dismantling, the parts are as accessible as they are in most designs. The lubrication of the engine puts rather too high a premium upon the memory and intelligence of the driver, and we think an automatic system would be an improvement, though the pot, which has to be filled at regular intervals, is no doubt less trouble than a gravity drip feed, and less likely to be abused.

Water pipes and waterways generally are all small, except the actual cylinder jacket, and the pump would have less work to do were they larger. Similarly, the altitude of the radiator should be increased, so as to allow natural flow to assist the pump.

However, it must not be forgotten that this car has been very successful commercially, and possesses a reputation for extreme reliability. The eliminating process of trial and error has been largely responsible for many parts of the design, and if these parts are satisfactory in use, their theoretical shortcomings are not of vital importance.



Aluminium Rear Axle.