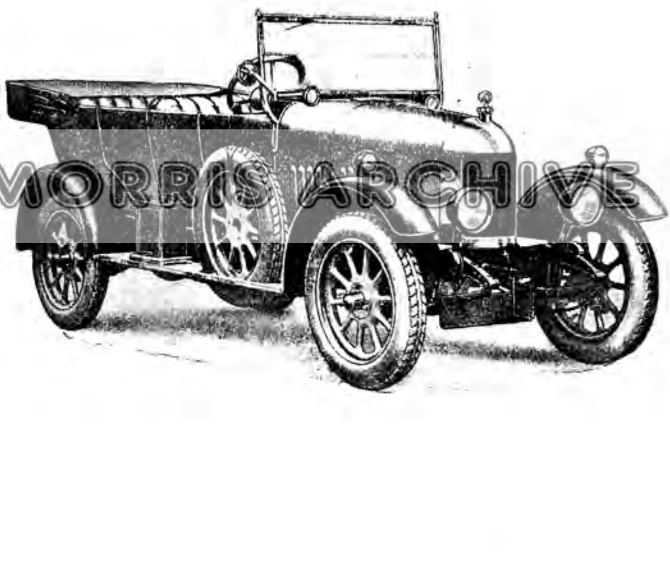
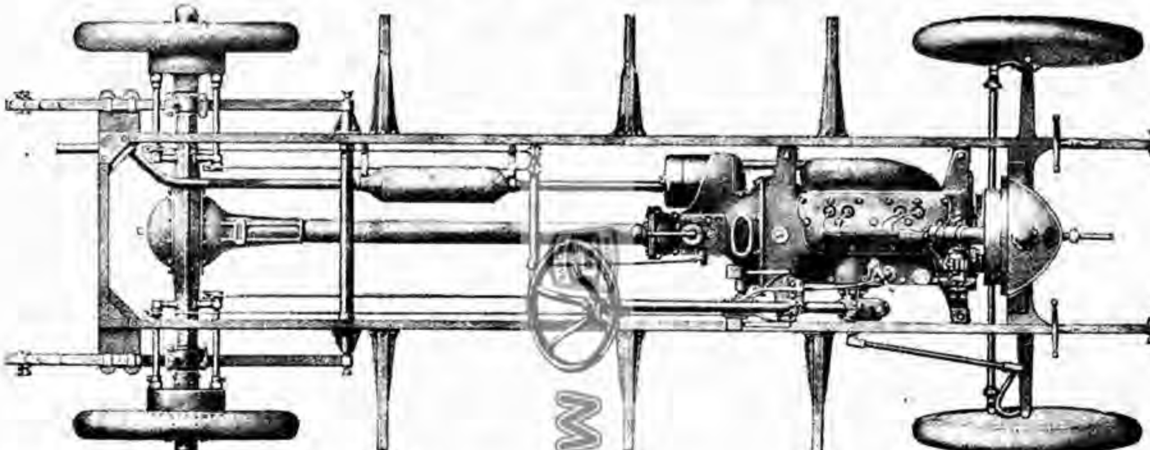
THE
HANDBOOK OF THE MORRIS CAR



PLAN VIEW OF THE MORRIS CHASSIS



Main features are a four-cylinder engine, in unit with a three-speed gear box and plate clutch, enclosed propeller shaft, spiral bevel driven rear axle, semi-elliptic springs in front and three-quarter elliptic rear springs, and worm and wheel steering.

The Handbook of the Morris Car

CARE AND MANAGEMENT OF
MORRIS CARS

ISSUED BY
The Autocar

This handbook was specially prepared for owners of Morris cars up to and including 1926 models. The major part of the text and illustrations are, however, applicable to the later type (four-cylinder) models.

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PREFACE.

SO extensive has the use of Morris cars become, due to their sound construction and economy of operation, that a complete handbook specially devoted to their care and upkeep is now a necessity. "The Autocar" handbook of the Morris car has been produced with the object of filling the want of many thousands of users. The arrangement of the letterpress has been so designed that even the veriest novice shall find the subject matter easy to read and understand. Diagrams and perspective drawings have been prepared with the object of conveying graphically to the inexperienced the construction of the car and the particular points requiring periodic attention. Naturally, technical terms cannot very well be entirely avoided in a work of this character, but, in order that their use shall in no way confuse the beginner, the opening chapter has been devoted to a simple, non-technical explanation of how an internal combustion engine is constructed, how it operates, and how the power developed is conveyed to the road wheels in order to propel the car.

Having absorbed this elementary knowledge, the reader is in a position to comprehend the details of construction of the Morris engine, its auxiliary units, transmission, and chassis details. A clear insight into the "why and wherefore" of the design of the various units helps the reader to appreciate the fact that every car requires a certain amount of regular attention—an important matter which is fully dealt with in a chapter devoted to care and maintenance.

Since it is realised that many Morris owners are driving a motor vehicle for the first time, much useful information has been embodied relating to the handling of the car on the road, and the necessary legal formalities which must be carried out before this may be done are also clearly set forth.

Thanks are tendered to Morris Motors, Ltd., Stewart & Ardern Ltd., Joseph Lucas, Ltd., S. Smith & Sons (M.A.), Ltd., and the Royal Automobile Club for their hearty and helpful co-operation in the compilation of this handbook.

MORRIS

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THE HANDBOOK OF THE MORRIS CAR

CHAPTER I.

ELEMENTARY PRINCIPLES.

How a Petrol Engine Works—With Simple Explanatory Diagrams—And How it Drives the Car.

"A BOX of mystery! I shall never understand how it works!" Such is a common exclamation when a proud owner peeps timorously under the opened bonnet of his first car, and anticipates with some anxiety a moment when the engine may refuse to run.

In sober fact, the operation of a petrol engine is extremely simple, and many people who have never been quite sure which way to turn a gas tap, or a screwdriver, have gradually become complete masters of their new hobby. This chapter will not do more than indicate in outline how an engine runs, and why its running propels the car. When its contents are grasped, a study of the succeeding chapters, dealing in detail with the construction of a car, followed by a comparatively brief experience on the road, will make the reader feel quite at home with the vehicle.

Effect of an Explosion.

The explosive force of various gases is harnessed by man to his service in a variety of ways, most of them destructive. In war an explosion of mighty force is induced inside the metal casing of a shell. There being no loophole through which the expanding gases can escape, the casing of the shell is violently riven into myriads of fragments, each of which becomes a death-dealing missile.

This same shell is hurled at the enemy by a different gas, employed in a different manner. The charge which propels a shell is exploded in a chamber shaped like a cocoa tin. With the exception of one end of the chamber, which may be likened to the lid of the cocoa tin, the walls of the chamber are fixed, mmovable, and strong enough to resist the bursting charge. But one end of the chamber is formed by the base of the shell, which lies a snug fit inside the breech or barrel of the gun. When the explosion occurs, something has to give; and the shell—as offering less resistance than the heavy steel breech—moves up the gun barrel at a great speed, whilst the twisting grooves (or "rifling") machined inside the barrel of the gun cause it to spin as it flies out.

So the gun takes a gas explosion and uses it to produce two forms of motion in the shell, viz., a forward movement through the air and a spinning movement round its own axis.

In a petrol engine a tiny charge of less violent character, threatening no possible danger to anybody, is used to produce a different sort of motion. In this case the breech of the gun is replaced by a cup-shaped chamber at the head of the cylinder. The explosion is too weak to burst this chamber under any conditions. Instead of the shell we have a piston, sliding freely in the lower part of the cylinder which is just like a large pipe. When an explosion occurs in the cylinder head, the piston slides down this pipe at considerable speed. As there is no rifling, it does not spin like a shell, but goes straight down without turning. Since the explosion is weak, the piston does not fly out of the bottom end of the cylinder, as a shell flies out of a gun, but the force of the explosion is spent by the time the piston has slid down a few inches. On this piston motion the working of every motor car is based.

Producing Rotational Movement.

We have still to see how this downstroke of a piston causes the wheels of the car to turn round. The piston is coupled by a "connecting rod," perhaps 8in. or 9in. long, pivoted to it, to a stout shaft beneath, to which it is also pivoted. If this stout shaft were straight, one of two things would happen; either the piston would be unable to move down at all, or else it would bend the connecting rod or the shaft underneath. But the stout shaft is not straight. It is "cranked"; in other words, immediately beneath the piston there is a turn in the shaft, shaped like the letter U upside down, and to this crank the connecting rod is pivoted, so that whenever an explosion drives the piston downwards, its connecting rod turns the crankshaft round, exactly as a domestic washerwoman turns a mangle. The gas acts as the washerwoman, and the crankshaft is the mangle.

It is now plain how an explosion propels a car. The gas has been utilised to set a shaft rotating, and there are a great variety of ways in which a rotating shaft at the front of a car can be made to rotate wheels at the back of the chassis. But it is first necessary to enter a little further into the details of the operation of the engine.

So far nothing more than the action of one solitary explosion has been considered. A single explosion is of no use to the motorist—at the best it could only jerk his wheels forward an inch or two. He requires a prolonged series of very mild explosions, all merging into a smooth even turning of his wheels. Moreover, he desires all the necessary actions to occur automatically. He wants to look at the scenery, to keep his eye on other traffic, to converse with his companions. He cannot be bothered to attend to the supply of gas, or to arrange for the explosions to occur in proper order at the right intervals. All this work must be done without worrying the owner. Let us consider what is necessary.

Sequence of Operations.

First, there must be a supply of gas, adequate for a long trip; this is attended to by the petrol tank and carburetter (dealt with later in Chapter III.). Secondly, the correct charge for a satisfactory explosion must be introduced into the cylinder at the proper moment and then ignited. If we shoot at a partridge the fumes from our shot gun hang in the air afterwards, and there will certainly be waste fumes in the cylinder of our engine after each explosion. These must be cleared out to make room for the next explosion. Finally, the next charge must be supplied to the cylinder.

These considerations prove that our cylinder cannot be hermetically sealed; it must have a kind of door, which will open to admit fresh gas, shut for the explosion, and open again to let the burnt fumes out. Actually, there are always at least two doors, to avoid crowding and hustling between the new gas on its way in and the burnt fumes on their way out. Usually there are two such doors, called "valves." They are shaped like mushrooms with small heads and long stems, and they fit down on to two round holes in the cylinder head, one communicating with the gas supply, and the other with the exhaust pipe. They are pushed up at the correct moment by the engine itself, and closed by springs which encircle the stems when the gas has passed through. They are both shut during the actual explosion, so that the gas explosion may concentrate all its force on the piston.

Now come five diagrams which will make the entire action of the engine perfectly clear. The great majority of car engines work on what is known as the four-stroke cycle, because an explosion, complete from start to finish, including the supply of fresh gas and the expulsion of the burnt fumes, requires four separate strokes of the piston, two downward strokes and two upward. The four strokes are called :—

1. **Induction** (the drawing in of a charge of gas as the piston moves downwards).
2. **Compression** (during which the charge of gas is compressed at the top of the cylinder as the piston moves upwards).
3. **Explosion** (during which power is developed as the piston again descends).
4. **Exhaust** (during which the burnt flames are expelled as the piston again ascends).

A word of explanation is here desirable regarding the compression stroke. It is a scientific fact—and a very useful one for the motorist—that the more the charge of gas is compressed the more power may be obtained from it when it is exploded.

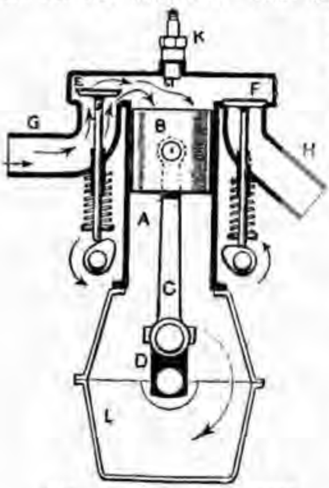


Fig. 1.—Commencement of the induction stroke. The inlet valve E is just opening, and gas will be drawn into the cylinder as the piston B descends.

In fig. 1 the letters indicate the various parts as follows :—

A. The cylinder, closed at the top, but open at the bottom to accommodate the piston.

B. The piston, sliding freely in the cylinder A.

C. The connecting rod by which the piston B imparts its up and down motion to

D. the cranked portion of the crankshaft.

E. The inlet valve, through which fresh gas enters the cylinder.

F. The exhaust valve, through which burnt fumes escape after each explosion.

G. The inlet pipe, communicating with the gas supply, which is called a "carburetter."

H. The exhaust pipe, along which the burnt fumes are led away.

K. The sparking plug, at which occurs the spark which fires the gas to produce the explosions.

L. The crank chamber, which covers in the lower part of the engine, supports the bearings of the crankshaft, and is used as a reservoir of lubricating oil.

A glance at fig. 1 will show that the inlet valve E is open, but the exhaust valve F is shut. An arrow round the crank shows that the piston is moving downwards. As the piston goes down, it acts like a pump, and draws in a charge of gas from the carburetter. Glance a moment at the lower end of the valve E. You will notice that a coiled spring normally keeps the valve

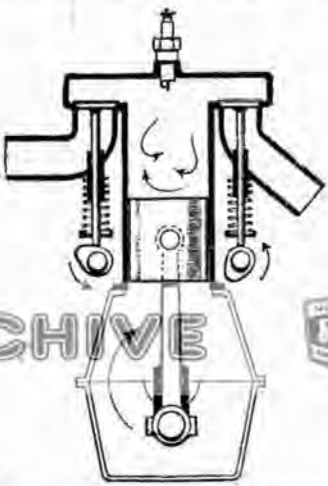


Fig. 2.—The induction stroke has just finished, the cylinder is full of gas, both valves are closed, and compression is about to take place.

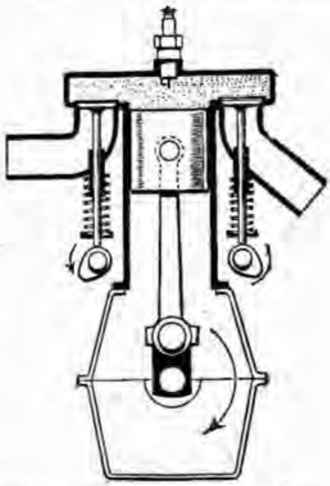


Fig. 3.—At the end of the compression stroke ; ignition is about to take place, and the piston will then be driven downwards on the power stroke.

down on its seat, *i.e.*, shut. But it is shown raised by an egg-shaped piece of steel, known as a cam. This cam runs at half the speed of the crankshaft, and it will not lift the valve E again until the piston has first made another complete down and up movement. Meanwhile the cylinder is being filled with gas.

Now turn to fig. 2. Notice that both valves are shut, the cylinder is full of gas, the piston has finished its downward stroke, the crank is coming round, and is on the point of driving the piston up the cylinder again. As the piston comes up, it compresses the lightly packed gases into a tighter and tighter mass at the head of the cylinder, for there is no outlet for the gas, and it must yield.

Fig. 3 shows the piston right at the top of this upward stroke. But there is a vast difference between this diagram and fig. 1. In the first picture the inlet valve was open, and the head of the cylinder was practically empty. In fig. 3 both valves are shut, and the head of the cylinder is tightly packed with compressed gas. Somewhere about this point an electric spark leaps the gap between the points of the sparking plug, and

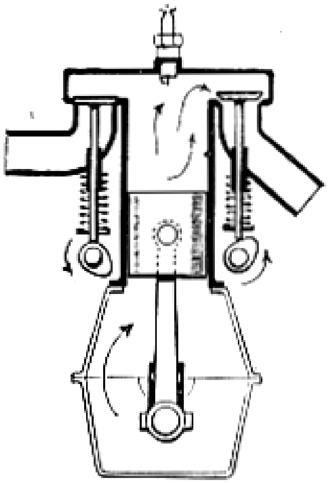


Fig. 4.—At the end of the power stroke the exhaust valve begins to open, and as the piston rises on the exhaust stroke the burnt gases are expelled.

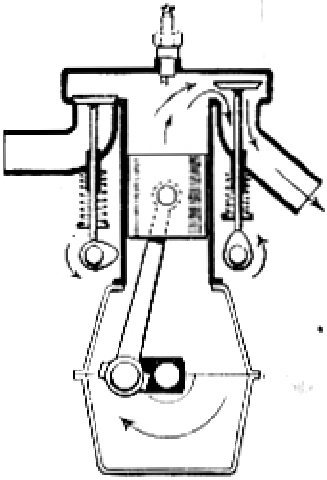


Fig. 5.—Half-way up the exhaust stroke; the exhaust valve is fully open and the gases are being expelled. At the end of the stroke the inlet valve will begin to open for the induction stroke.

ignites the compressed gas, which explodes, and expands, driving the piston down the cylinder and turning the crankshaft round.

Fig. 4 shows the end of this power or explosion stroke. The piston has reached the bottom, the expansion of the burning gas is complete, the cylinder is full of useless fumes, the exhaust valve F is just beginning to open to let these fumes out, and the crank is bringing the piston up again to drive the fumes out.

Fig. 5 shows the piston half way up on this exhaust stroke, with the exhaust valve wide open, and the waste gases escaping into the exhaust pipe. Similarly to the inlet valve, the exhaust valve will not be lifted again until the piston has made another complete up and down movement.

Observant readers will have noticed that in these four strokes of the piston—down, up, down, and up again—which compose the complete four-stroke cycle for one explosion, only one stroke, *i.e.*, the third piston movement, which is the second down stroke, imparts any push to the crank. This is quite true; the other three strokes absorb power, instead of producing power. Since the reader may wonder how the crank is kept moving through three idle strokes, it is time to add that a heavy flywheel is fixed to one end of the crankshaft. Flywheels possess the knack of storing energy, and parting with it gradually; a small boy wraps a bit of twine round the flywheel of a toy engine, and pulls it off; the flywheel stores the energy of the momentary pull, and parts with it slowly, causing the toy to move for a full minute or more. So the flywheel stores energy from the power stroke, and keeps the crank moving through the other strokes.

It is further interesting to watch the action of the cams, which work the valves E and F, through the series of diagrams.

It has already been explained that the inlet valve has only to open on the induction stroke, and similarly the exhaust valve on the exhaust stroke, and that this effect is obtained by rotating the cams at only half the speed of the crankshaft. That is, the cams only complete one revolution while the crankshaft makes two complete revolutions.

In our diagrammatic engine the cams and valves are shown at each side of the cylinder, for the sake of clearness. This is known as a T-headed engine and is a design not now often seen. The usual arrangement, and that adopted on the Morris engine, is to have the two valves side by side; the cams may then be arranged on one shaft, known as the camshaft. In some engines the valves are placed overhead in the combustion chamber, such an engine being known as an overhead valve engine.

Four Cylinders.

Twenty years ago many of the world's best cars had engines as simple as the imaginary unit depicted in the diagrams. They were very rough and jerky to drive. There came a bang, and then just as the engine threatened to die away there came another bang, rather like a boy driving a hoop along the pavement by hitting it with a stick every few yards. People complained of the vibration thus caused, and the next invention was an engine with two cylinders. The pair of cylinders might be coupled together so that the extra cylinder put in a power stroke midway between the power strokes of the first cylinder. This was a distinct improvement

The action of a single cylinder engine might be described as *bang*—nothing—nothing—nothing—*bang*—nothing, etc.

Then the action of the two-cylinder would be by comparison *bang*—nothing—*bang*—nothing—*bang*—nothing, etc.

Before long, engineers saw that if four cylinders were provided, one of them would always be busy on its power stroke, and a very smooth, even, turning motion could be imparted to the various rotating shafts. So the modern car engine generally has four cylinders. Some luxurious cars have six or even eight cylinders, in which the power strokes actually overlap each other, bestowing an even greater smoothness; but such engines are naturally more expensive to build, and take up more space, so that they are hardly suited to economy motoring, while the four-cylinder gives all that a reasonable man need demand.

Auxiliary Drives.

In a modern engine the crankshaft already described is by no means the only shaft which is rotated by the power stroke. When once the main shaft receives its rotating motion from the explosion it is a very simple matter to employ chains, gearing or belts by which other shafts can be caused to rotate at any desired speed. The shaft carrying the cams (known as the camshaft) required to work the eight valves of a four-cylinder engine is driven in this way; and in similar fashion ignition devices, electric dynamos, fans, and other accessories can be driven. With properly cut gears, suitable bearings, and adequate lubrication these auxiliary drives consume very little power and do not unduly raise the fuel consumption, or reduce the speed of the car as a whole.

Balance.

Tough-skinned persons may be inclined to consider a simpler form of engine, so it is well to note in passing that smooth, even application of power is by no means the only argument in favour of regarding four cylinders as the desirable minimum. It is a fundamental law of physics that every action has an equal and opposite reaction. This sounds very alarming, but any reader who will take the trouble to attach a weight to a piece of string about a yard long and then, grasping the free end of the string firmly, to whirl the weight round and round at increasing speed, will at once find that he has to exert a considerable pull on the string in order to neutralise the pull of the weight and prevent it flying off at a tangent.

Now, something very similar is happening in an engine, for the crankpin and the lower portion of the connecting rod are being whirled round by the crankshaft, so that there must be a pull or force on the shaft. When the engine has four cylinders, however, and accordingly four pistons, connecting rods and crankpins, the two end pistons are arranged to ascend while the two middle pistons descend. The crankpins are, in fact, arranged on opposite sides of the crank, and therefore the forces due to the rotating parts of the end cranks act in opposite directions to those set up by the middle cranks and thus balance each other. Similarly, forces due to the pistons going up and down also balance out, and on a good four-cylinder engine no vibration should be perceptible.

Lubrication.

Friction generates heat. A modern engine can be run at over 3,000 revolutions a minute, and an experiment with a file or drill at a tool bench will show the reader that good metal quickly gets very hot in continuous rubbing. Oil is our great standby for reducing friction, and it further conducts heat away from hot places if fed through or over them in a stream. So a constant stream of special oil is perpetually fed over, or between, all the moving parts in an engine, and serves the double purpose of reducing the friction to a minimum, and of conducting away any heat which may be generated by whatever friction remains.

To conserve the oil and exclude dust and dirt, all the moving parts are carefully protected by tightly fitting covers of various kinds, and a pump forces a perpetual stream of ever-changing oil to all the highly stressed parts, some of which is flung off in the form of a mist, and splashed freely over other parts which are subjected to lesser heat. Even in this simple introduction, the fact that the oil is the life of the engine cannot be too heavily emphasised. Any failure to maintain the oil supply will rapidly produce temperatures which even modern metals cannot long withstand. For example, a piston starved of oil will practically weld itself into the cylinder, a white metal bearing deprived of lubrication will "run," or melt, and so on. The crank case must be kept supplied with a recommended oil at the correct level; and this oil must be put in clean, as dirt may choke some of the fine passages along its course.

Cooling.

In a busy corner of a pheasant covert a shotgun will soon become too hot to hold; and similarly a car engine, subjected to the heat of perhaps 750 explosions a minute in each cylinder at quite a moderate rate of touring, must dispose of considerable heat. The petrol engine, it has been found, runs its best within a few degrees of boiling point, and some gallons of water are continuously circulated through the water jackets to carry away surplus heat and keep the temperature near the designed limit. The water spaces consist of hollow metal jackets surrounding the upper part of the cylinders, two rubber pipes connecting the latter to the radiator, and the radiator itself. The latter consists of tiny passages with very thin walls, strongly chilled by the wind created by the car's passage through the air assisted by a rapidly spinning fan. The natural tendency of hot water to rise induces a natural circulation of the water through these spaces. Thus the water in the cylinder jackets, which is heated by the explosions, is duly brought out to the radiator at the front of the car, cooled down, and returned to replace other water which has meanwhile been absorbing heat from the explosions.

The Carburetter.

A petrol engine will run quite nicely on town gas, and in some factories town gas is actually used in the preliminary tests of engines. In the war, petrol shortage compelled motorists to use town gas in clumsy containers fixed to the roofs of their cars, but by far the simplest method is to carry a liquid fuel which can be vaporised simply and readily, petrol being easily the best of these liquid fuels.

The simple example of a scent spray or a garden syringe reminds us that it is easy to vaporise comparatively sluggish liquids by forcing them through a tiny nozzle under pressure. This principle is adopted on the petrol engine. Instead of the force pump behind the liquid, as used in a rose syringe, the car engine takes advantage of the fact that its pistons and cylinders form an admirable suction pump. So piston suction is applied *via* the inlet valve and inlet pipe to one or more tiny nozzles in a device called the carburetter. Petrol is fed to these nozzles by the piping from the tank and an ingenious reservoir, in which a float traps a supply of petrol at a constant level. The petrol nozzle or "jet" is mounted inside a larger pipe forming an air nozzle, and the engine pumps at them both. So a constant stream of petrol vapour and air, intimately mingled in the correct proportions, is always available when the engine is turned round. A throttle valve, operated by the pedal generally known as an "accelerator," enables the driver to control the flow of gas, and thus to determine the power of the explosions, and decide the speed of the car at any moment.

Ignition.

We have already seen that the explosive charge is fired by a tiny spark, which leaps the gap between the points of a sparking plug at the correct moment, this plug being tightly screwed into the cylinder head so that only its points project into the explosion chamber. It is placed close to the inlet valve, so that the fresh, cool gas will prevent it from being overheated ; otherwise its points might grow white hot, and fire the charge at the wrong moment.

Fig. 3 depicts the piston at what is called "top dead centre," *i.e.*, exactly balanced between its up and down strokes, with a charge of gas fully compressed above it. This is approximately the time for the explosion to commence. If the explosion were timed later, the gas would be less tightly packed, and the piston would be part way down, and so receive a less forceful push. If, on the other hand, the spark occurred earlier, the thrust of the explosion might arrest the upward motion of the piston with a fearful jerk. Actually, the explosion spreads progressively through the charge, and at high engine speeds the spark should occur before the piston is at the top. But these details do not matter at this stage, so long as the reader comprehends that it may be well to vary the precise timing of the ignition within a short distance on either side of the top dead centre of this piston stroke. It is obvious that the spark must occur near this point, and not in the positions of the other diagrams, when either the piston will be hopelessly out of position, or there will be no charge of gas to fire.

Ignition Timing.

In broad outline the moment when the spark shall occur is fixed when the engine is put together. The gear wheels driving the magneto are so meshed that the spark must occur very close to the top dead centre of the compression stroke of each piston ; but to permit the driver to vary the spark within a few degrees on either side of this point, an ignition lever is provided on the steering column. This rocks the timing device of the magneto over a very short distance between two stops, and allows the driver to set the spark a little earlier when he is travelling fast and a little later when the engine is running slowly. It does not allow enough choice for the driver to do any harm ; but if he experiments until he can handle this lever skilfully, he will get a slight improvement in running.

The Magneto.

The wonderful engine, which already performs so many duties, automatically attends to the task of igniting its own charges of gas. If a coil of wire is rotated between the shoes of a magnet, an electric current is generated in it. The engine rotates this coil by means of special gearing. The current so produced is not capable of making a spark leap a gap amidst compressed gas, but a simple addition to the apparatus transforms it into the right sort of current. The shaft carries a fitting which breaks the circuit at the right moment, and causes a spark to jump; and a four-way distributor feeds the current to each of the four sparking plugs at the correct moment.

Clutch.

By this time the new owner should be conscious of a dawning comprehension of his power plant, and may be promoted to consider the method in which the engine drives the car. Unfortunately, a petrol engine produces no power worth speaking of until it is running fairly fast. For example, when an engine is ticking over outside its owner's front door, it is probably running at about 150 revolutions a minute. At this speed its power is negligible; and unless it were speeded up considerably it certainly could not propel the car up a hill; indeed, it would probably fail to start the car from rest on the flat.

So it is necessary to run the engine fast and the back wheels comparatively slowly. This is done by gearing down. Several different gears are desirable, and we must be able to change them while the car is running. Furthermore, we must be able to disconnect the power in order that the owner may leave his engine running with the car stationary. For both these purposes a "clutch" is used, permitting the engine to be connected or disconnected from the gears at the owner's will.

The simplest form of clutch consists of two shallow tapered cones, one solid and the other hollow, both of similar size and angle. One is mounted on the tail end of the crankshaft, the other on the forward end of a shaft which leads backwards to drive the car. When the two cones are pressed into each other by a powerful spring, they jamb, and the two shafts rotate just as if they were one solid piece of metal. The driver's cockpit contains a pedal, operating levers which can separate these two cones, in which case the engine is entirely disconnected from the driving mechanism.

The Morris car in reality employs a type of clutch of which the action is less obvious; for flat plates are utilised instead of cones, but their surfaces, area, and spring pressure are so designed that they grip as tightly as two jambing cones. In starting the car from rest, and to a less degree in gear changing, the driver operates his clutch pedal so that the plates of the clutch slip a trifle before they lock; and the engine is thus connected to the drive smoothly, without shock or jar to the car or its passengers.

The Gear Box.

When a cyclist reaches a hill, he slows down because of the resistance caused by the gradient. A car slows down in identical fashion. The cyclist can, if he likes, maintain his previous speed by harder pedalling; but if the hill is long or steep, he will soon find that he is digging as hard as he can, and yet his cycle is slowing because the resistance overpowers his strength. So too with a car. On reaching a hill, the driver may maintain his previous speed by opening his throttle and causing the engine to use its full power. But if the hill is long or steep, the resistance of the gradient will overpower the engine, and the car will slow.

Now is the moment at which the driver urgently requires more power. We have seen that the power of a petrol engine depends on its being run at a fast rate, but the hill is slowing the car; and when the car slows, the engine slows, for it is geared to the car. This is where the gear box comes to our aid. We disconnect the engine very rapidly, engage a lower gearing, and couple the engine to the back wheels once more. The gearing is now lower, the engine can run faster, and at this faster speed it develops more power. So the car accelerates up the hill on its lower gear.

In Chapter IV. the Morris gears are described in detail, but for the moment it is enough to say that there are three forward gears, and one reverse. The top forward gear is that normally used in ordinary running; it is the most silent, and entails the least consumption of petrol. The second gear will suffice for ordinary steep hills. The bottom gear is always used for starting from rest, and serves as an emergency climbing gear for exceptionally steep hills.

The Transmission.

The drive passes from the tail of the gear box to the rear axle and wheels by means of a long shaft known as the propeller shaft. In a factory the shafts which drive the machinery are supported by the rigid frame of the building, and their relative positions cannot vary. The shafts of a motor car, however, are perpetually varying their positions and angles in relation to each other as the four road springs at the corners of the chassis open and close, and as the tyres flatten on impact with the road. To prevent friction in the propeller shaft, therefore, it is equipped with a universal joint, which permits movement in any direction, so that the shaft runs with perfect freedom even when its alignment varies considerably in road work. This need not worry the owner, as it is automatically lubricated from the gear box. Incorporated with the universal joint, there is also a telescopic or sliding joint, which permits the propeller shaft to adjust its own length within moderate limits.

The propeller shaft runs inside a casing, which performs two less obvious functions. On the one hand, it transmits the thrust of the back wheels to the frame of the car, since it is attached by a ball joint to permit of its movement to the gear box; on the other hand, it prevents the pinion, or gear wheel, at the tail of the shaft from running round the larger pinion on the back axle, and enables this small pinion to rotate the driving axles.

We have now followed the drive as far back as the central bulge in the rear axle. Since the engine crankshaft runs lengthways of the car, and the rear axle runs across, there must plainly be a right angle in the drive at this point. Right-angled drives are common in engineering practice, and when properly made entail no special friction. On the Morris car this drive is of a type known as the spiral bevel, which is both silent and efficient. Running encased in an oil bath it will function for several years without attention.

It is worth noticing that these two pinions are not of the same size, but gear the drive down in the proportion of approximately 1 to 4. This is not a gear which can be changed in driving, but is a permanent gear reduction outside the driver's control, is always in action even on top gear, and is carefully chosen after experiment at the factory. It is provided on all cars for the reason stated earlier in this Chapter, that a petrol engine's power depends on its being allowed to run fast. In practice, even when the work is easy, as in driving a car on the level, the engine must be set to run about four times faster than the back wheels. This reduction is afforded by the different sizes of this bevel pinion and crown wheel in the final drive.

The Differential.

Inside the central bulge of the back axle there lies the most mysterious piece of mechanism on the entire car. It is known as a differential, and is described in detail later on in this volume. When a car is driven round a sharp corner, the outside back wheel has to travel over a much longer path than the inside back wheel. If both wheels were fixed to one and the same axle shaft, the inside wheel would be dragged or scraped round the corner. This somewhat brutal method of mounting the wheels is adopted for the sake of cheapness and simplicity on some cars, but all expensive cars have their rear wheels fixed to two separate half axles coupled by a balance gear at the centre, which is so ingenious that it allows one wheel to remain stationary whilst the other spins fast, though in practice each wheel normally takes its precise share of the drive. Smooth cornering and long tyre life are the result.

Other Items.

The Morris chassis embodies a number of other items, which are sufficiently familiar in their broad outline and general purpose to require no elementary introduction, and the reader may pass direct to the detailed account of them contained in later chapters. For example, such items as the steering, the engine starter, the brakes, and the lamp installation are self-explanatory in their main essence, and will therefore be omitted here.

CHAPTER II.

THE MORRIS ENGINE.

Component Parts and their Functions—Application of Elementary Principles.

HAVING gained from a careful perusal of the previous chapter an idea of the principal component parts and the cycle of operation of the internal combustion engine, we can proceed to apply our knowledge to considering the Morris engine.

Cylinder Block.

This engine is of the four-cylinder type, for the reasons given in Chapter I., and it has the four cylinders arranged vertically and in line with one another (fig. 1). Cast iron is the material employed for these cylinders, and a single casting incorporates the cylinders and valve ports, the water jackets surrounding the cylinders, and the upper part of the crank case. Four bearer arms, two on each side, support the engine in the frame of the car.

The cylinder heads are comprised in a separate casting, which also has waterways cast in it, and a suitable connection at the front end for allowing the cooling water to pass to the radiator. This is what is known as a detachable head (fig. 2), and the advantages of this type of construction are saving in the cost of manufacture and the rendering easy of the process of decarbonising after a considerable period of running, which is the removal of carbon deposit—a by-product of combustion—from the cylinder heads and tops of the pistons. To the owner-driver who will care for the car himself very largely this is an important matter, as otherwise it would be necessary about every 5,000 miles for the cylinder block to be lifted, *i.e.*, the engine partially dismantled, in order that the carbon might be removed.

The cylinder head is attached to the cylinder block by fifteen studs and nuts, and between the head and block there is inserted a thick washer made of thin sheet copper and asbestos. This is known as a gasket, and its purpose is to make a gas- and water-tight joint between the two castings, so that the pressure on the studs and nuts securing the head to the block is necessarily very high. The gasket is pierced with holes corresponding to the water passages in the block and head, as

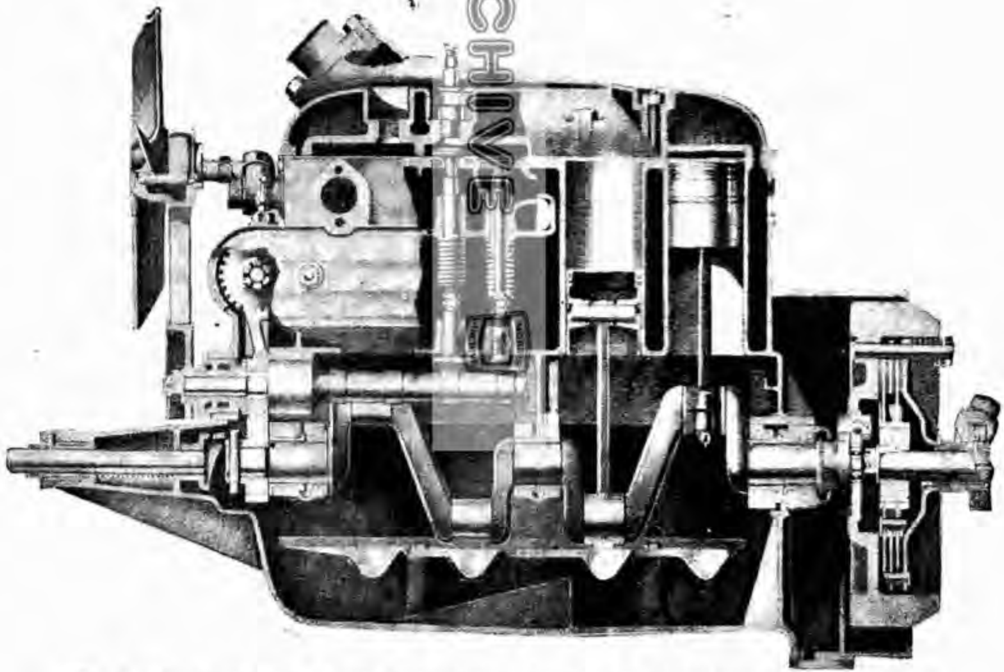


Fig. 1.—Sectional view of the Morris engine showing the three-bearing crankshaft and other component parts.

MORRIS

the cooling water must be able to circulate from the bottom of the radiator through the passages around the cylinders, then through the cylinder head and the water outlet pipe back to the top of the radiator.

In the case of the Morris-Cowley engine the bore of the cylinder, that is its diameter, is 69.5 mm., while the stroke, or the distance the piston travels from the top to the bottom of the cylinder, is 102 mm. In the case of the Morris-Oxford the bore

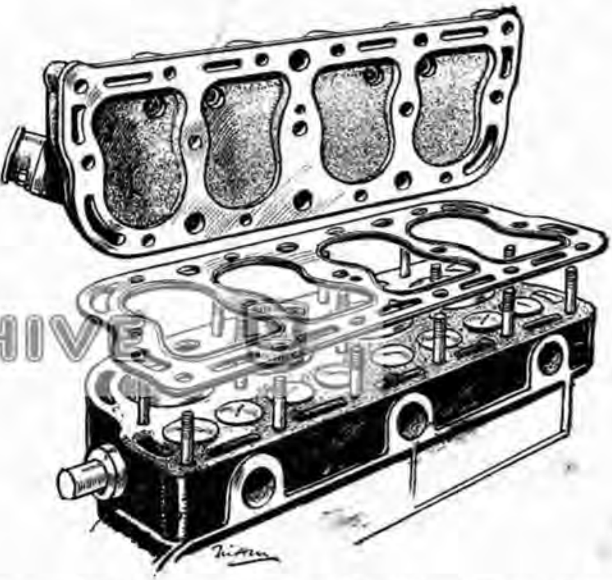


Fig. 2.—A detachable cylinder head is held down on the cylinder block by 15 studs and nuts, a copper-asbestos gasket being used to make a gas- and water-tight joint.

of the cylinder is 75 mm., but the stroke is the same, 102mm. The capacity of the two engines is, therefore, respectively, 1,548 cubic centimetres and 1,802 c.c.

Crankshaft.

As already explained the crankshaft (fig. 3) has four crank pins, and the end pins are on the opposite side to the middle pins. A stout steel forging is used for the crankshaft, and the four crank pins and the three main journals—the portions which revolve in the main bearings—are machined very accurately indeed to a high finish. On the front end of the crankshaft is mounted the small pinion of the timing gear, and at the back end the flywheel is fixed.

Main Bearings.

In the lower part of the casting, comprising the cylinders and crank case top half, there are formed three brackets for the purpose of receiving the main bearings which support the crankshaft. These brackets are strongly ribbed and reinforced, as their function is most important. On the rigidity of the crankshaft, and its good fit in the three main bearings, the smooth running of the engine largely depends, so that any lack of strength in this part of the engine would allow vibration

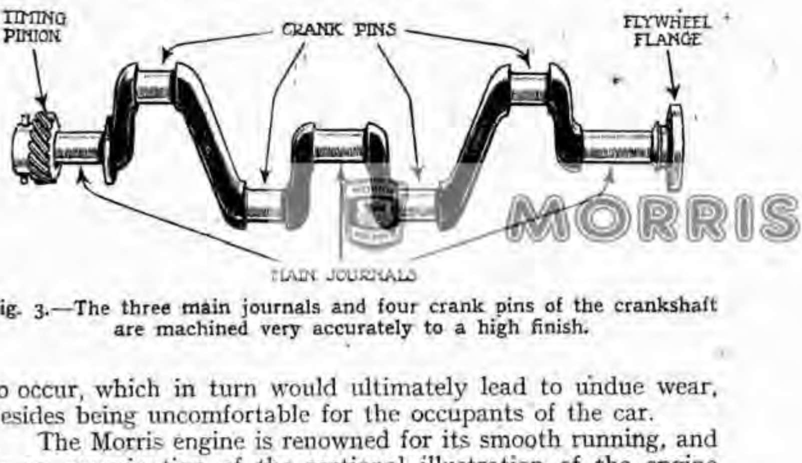


Fig. 3.—The three main journals and four crank pins of the crankshaft are machined very accurately to a high finish.

to occur, which in turn would ultimately lead to undue wear, besides being uncomfortable for the occupants of the car.

The Morris engine is renowned for its smooth running, and as an examination of the sectional illustration of the engine (fig. 1) will show, the main bearings are of generous dimensions, and the crank case is strongly ribbed at the bearing supports. In order that the crankshaft may be mounted in its bearings they have, of course, to be split, and the lower halves or caps are secured by substantial studs and nuts, while in the joint between the two halves of the bearings there are inserted thin brass plates, known as shims. These are provided as an easy means of taking up wear in the bearings, for when too much slack develops the caps of the bearings are removed and one or other of the shims removed, so allowing the two halves of the bearing to approach more closely together. These bearings consist of bronze shells lined with anti-friction metal, the purpose of which is, as its name implies, to reduce friction.

Pistons and Gudgeon Pins.

We have now to consider the pistons and connecting rods which, as we have seen in the first chapter, constitute the means whereby the power generated by the combustion of the petrol vapour is transmitted to the crankshaft.

The pistons of the pre-1925 Morris-Cowley engine are of cast iron, and they bear at their upper ends three piston rings. These also are of cast iron of rectangular cross section, and each has a diagonal slit across it and is so machined that the ring naturally has a considerable amount of spring. A rectangular groove is provided in the piston for each ring so that it is a good but easy fit therein. Normally, that is when not compressed, the diameter of the rings is larger than that of the pistons and cylinders, so that when the piston with its rings is inserted in its cylinder the natural springiness of the rings causes them to bear outwards against the cylinder wall, so making a gas-tight joint.

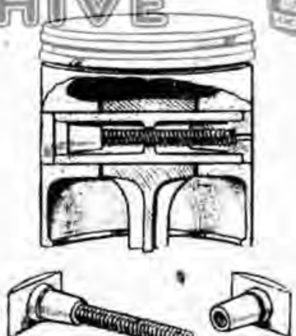


Fig. 4.—Aluminium pistons with two rings are used in 1925 models. The connecting rod little end is plain, and a clever safety device locates the floating gudgeon pin.

Fig. 5.—Connecting rod and gudgeon pin of the 1924 Cowley engine. Shims are fitted in the big-end bearings to provide an easy means of taking up wear.

In the pistons there are formed two bosses in which holes are bored to act as bearings for the gudgeon pins, which are hollow in order to reduce their weight.

In the 1925 Morris-Cowley engine, however, aluminium pistons (fig. 4) are used. These carry two piston rings, and have "floating" gudgeon pins, *i.e.*, the pins are free to rotate in the piston bosses and also in the little end of the connecting rod. To prevent damage to the cylinder wall a clever safety device is fitted, consisting of two soft brass segments joined by a spiral spring.

As regards the Oxford engines, 1925 models have aluminium pistons of similar design, but 1924 models have aluminium pistons with a split skirt, a spring ring being fitted within the skirt to expand it against the cylinder walls.

Connecting Rods.

Steel forgings are used for the Cowley connecting rods, which are of I section in order to give strength and rigidity coupled with light weight. The smaller end, known as the "little end," is split and fitted with a bolt, in the pre-1925 engines, to secure the gudgeon pin (fig. 5). A groove is formed in the surface of the gudgeon pin so that the bolt can actually engage with it, and, therefore, the gudgeon pin cannot move endwise and there is no danger of the ends of the pin coming in contact with the cylinder wall and causing damage.

In the 1925 engine the "little ends" of the rods are plain, as the gudgeon pin floats.

The other end of the connecting rod is known as the "big end," and has a split bearing similar to the main bearings, already described. The cap of this bearing is secured to the rod by two bolts and nuts, and bronze shells lined with anti-friction metal form the actual bearing surface. Shims are also interposed between the two halves of the bearing, and on the cap there is fitted a small scoop to pick up oil.

In the Morris-Oxford engines the connecting rods are of duralumin.

Timing Gear.

At the front of the engine there is formed a compartment which contains the gear wheels driving the camshaft and the magneto. Into this compartment the front end of the crankshaft projects, and it is on this end that the small pinion of the timing gear is fitted. This is of steel, with teeth cut helically in order to give silent running, and it is secured to the shaft by a key. With this pinion meshes a phosphor-bronze gear wheel of double the size, *i.e.*, having twice as many teeth, and this is mounted on the front end of the camshaft. By this means the latter is driven at exactly half the speed of the crankshaft.

At the top of this wheel, and at right angles to it, there is another steel gear wheel with the same number of teeth as that on the crankshaft. This is mounted on a short shaft, carried in suitable bearings, which runs across the front of the engine and acts as a drive for the magneto.

Camshaft.

Mounted in the crank case parallel with the crankshaft is the camshaft. Since there are four cylinders, each having two valves, there are eight cams on this shaft, and these are set at such angles that when the valves of any one cylinder are operated at the right moments the valves of the other cylinders will also be correctly "timed." This camshaft is supported in two bearings formed in the casting which comprises the cylinders and crankcase, and starting from the front of the engine the cams operate respectively, exhaust—inlet—inlet—exhaust—exhaust—inlet—inlet—exhaust.

Valves.

We have already seen that the valves are mushroom shaped pieces of metal, and these are mounted in the cylinder block so that the stems come immediately over their respective cams. The valve heads have an edge cut at an angle, and the rim of the port on to which they seat is cut at a similar angle. To support the valves in the correct position use is made of guides, and these are short tubular pieces which are a close but easy fit on the valve stems and are a tight fit in the holes in the cylinder block into which they are pressed. In the bottom of the valve stem a slot is cut through which a small flat piece of steel, called a cotter, passes in order to keep a specially shaped washer in position and to transfer the pressure of the coil spring to the valve stem. The valve springs surround the valve stems and are fitted between a flange on the valve guide and this washer or spring cup.

Valve Tappets.

Between the valve stems and the cams there are inserted valve tappets. These are cylindrical steel rods having at their lower ends flat round faces against which the cams act. The upper ends of the tappets are drilled and screwed to take a short bolt, which also carries a lock nut. By this means it is easy to adjust the length of the tappet by undoing the lock nut and screwing the bolt in or out of the tappet as may be required. In order to allow the valve head to make a gas-tight seating it is necessary to allow a little clearance between the top of the tappet and the bottom of the valve stem, and it is for this reason that the adjustment just described is provided.

Inlet and Exhaust Ports.

The ports cast in the cylinder block for conducting the fresh gas to the cylinders and the exhaust gases away from them are so arranged that the inlet ports combine into a single passage which ends in an opening on the off side of the cylinder block, *i.e.*, the right-hand side as seen by the person sitting in the car, while the exhaust ports lead into a pipe which is bolted to the near, or left-hand, side of the cylinder block. This pipe is known as the exhaust manifold, and from the rear end the gases are conducted to the silencer by the exhaust pipe. The carburetter is bolted directly to the single opening of the inlet passage on the off side.

Lubrication.

Most important is the lubrication system, and the essential feature of this is a small pump arranged within the crank case so that a continual supply of oil is distributed by it to all the moving parts. A general arrangement of the pump will be gathered from fig. 6. The pump is of the ordinary plunger type, and in many ways is similar in its action to an ordinary bicycle pump. It is arranged vertically immediately beneath the camshaft on the near side of the engine (fig. 7), and at its upper end the plunger is somewhat like a valve tappet, and is furnished with a spring which normally holds it up. A special cam on the camshaft forces the plunger down every time the camshaft revolves, and the spring lifts the plunger up again immediately the cam has passed. The lower end of the pump contains two small ball valves and projects into a gauze cylinder, or filter, which prevents any dirt or particles of carbon from passing into the pump and possibly causing damage. The filter is so fitted into the sump, which is the lower part of the crank case and serves to cover in the working parts of the engine and hold the supply of oil, that it can easily be withdrawn for cleaning by unscrewing a large plug in the bottom of the sump.

As the pump plunger travels up and down, oil is drawn in past one ball valve and delivered through the other ball valve and a system of pipes to the three main bearings of the crankshaft and to the timing gears at the front of the engine. Also carried in the sump is a sheet steel tray in which are four troughs, one beneath each big-end bearing. These troughs collect the oil which passes through the bearings, and they are so arranged that the dippers or oil scoops on the caps of the big-end bearings pick up a supply of oil from them on each revolution (fig. 7). Naturally, also, the passage of the dippers through the oil in the troughs splashes the oil in all directions and on to the cylinders, pistons, and little-end bearings. The fine mist of oil also finds its way on to the valve gear, so that all the moving parts will be liberally supplied with oil so long as the pump is working.

In order that the driver may know that the oil pump is duly carrying out its important duty, a pressure gauge is mounted on the instrument board. When the engine is started up

Fig. 6.—Part sectional view of the oil pump, showing ball valves and method of cam operation.

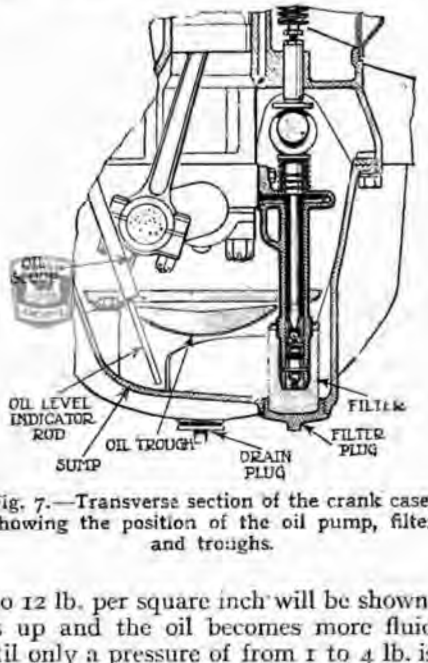


Fig. 7.—Transverse section of the crank case, showing the position of the oil pump, filter and troughs.

from cold a reading of 10 to 12 lb. per square inch will be shown, but as the engine warms up and the oil becomes more fluid this pressure will drop until only a pressure of from 1 to 4 lb. is indicated. Should the gauge fail to show any pressure at all it is of the utmost importance that the driver should at once find out why, otherwise excessive friction in the bearings will result in such heat being developed that the white metal bearing lining will melt.

On the off side of the engine there is a funnel-shaped opening, closed by a coned cap on the end of a rod which projects down into the sump. On withdrawing this rod (fig. 8) the level of oil can at once be seen, and if any oil is required it is poured into the sump through this orifice. When the oil level reaches the mark "full" on the indicator rod, the sump contains approximately one gallon, which should be sufficient for 250 miles, when the level should be inspected and again brought up to the "full" mark. The oil level should never be allowed to fall below the "half" mark. A drain plug in the bottom of the sump allows the oil to be run off when desired, and from time to time it is necessary to drain out the old oil and refill with fresh oil.

The oils recommended for use in the Morris engine are, in summer, Double Shell or Gargoyle Mobiloil A, and, in winter, Single Shell or Gargoyle Mobiloil Arctic.

Fig. 8.—Oil filler orifice on the crank case, and oil level indicator.

Fig. 9.—The Morris radiator.

Cooling System.

Reference has already been made in Chapter I. to the cooling system. Between the radiator (fig. 9), at the front of the car, and the cylinder jackets there are two connections by means of short pieces of rubber pipe—one arranged at the bottom of the radiator, and the other leading from the top of the cylinder block to the top of the radiator. As the water in the cylinder jackets is heated it rises and passes up the top water connection to the radiator, where it is cooled, and accordingly descends to the bottom of the radiator, and so back again into the cylinder jacket. This is known as the thermo-syphonic system. In order to assist this natural circulation system of cooling, an aluminium three-bladed fan is mounted on the front of the engine and driven by a belt passing over pulleys from the front end of the camshaft. The fan accordingly assists the draught of air through the radiator and helps to increase its cooling capacity. So that no more power shall be absorbed in driving the fan than is necessary, it is mounted on two ball bearings, and, in order to compensate for wear and stretch in the driving belt, the spindle of the fan is so mounted in its bracket that it may be moved slightly further away from the driving pulley on the camshaft.

Starting Handle.

At the very front of the engine is arranged a handle, the spindle of which is in line with the crankshaft and capable of being pushed into engagement with a projection on the shaft. By turning the handle the engine can therefore be turned in order to start it, although an electric starting motor (to be dealt with later) is also provided.

CHAPTER III

IGNITION AND CARBURATION.

Principle of the Magneto—The Lucas Magneto and the Attention it Requires—The Smith Carburetter and Necessary Adjustments.

IGNITION of the compressed charge of gas and air in the cylinders is effected by an electric spark. The current for this is generated by a self-contained highly specialised type of electrical generator known as a magneto. During recent years much has been done to solve the various problems which have presented themselves in the construction of the apparatus, and it may now be said that the magneto has reached a very high standard of performance and reliability.

Principle of the Magneto.

Although the attention required by the magneto from time to time is but little, it will be well to consider the principle upon which it works before dealing with the Lucas magneto, which is fitted to Morris cars, in detail. The magneto is, in reality, a form of dynamo, and in place of the usual field coils it has permanent magnets, while the armature also has, in addition to the winding which produces the low tension current, another winding which converts the low tension current to a high tension current. The reason for this is that the low tension current cannot jump the gap at the sparking plug points, whereas the high tension current is easily able to pass across this gap and so gives rise to the vital spark.

When a coil of wire is rotated in a magnetic field, such as exists between the poles of a magnet, a current of electricity is induced in the coil. This is the simple fact on which the design of the magneto is based, and the armature rotates between the pole shoes of the permanent magnet so that the current is set up in the primary winding. The inner end of this winding is connected to the armature core, which is of soft iron, and the outer end is connected to the fixed contact point of the contact breaker, the other contact being connected to the metal part of the magneto so that it is in connection with the inner end of the primary winding.

Contact Breakers.

The contact breaker consists of two platinum points, one of which is fixed on the contact breaker base and the other carried by a small pivoted lever which, as the contact breaker rotates comes in contact with two small cams so that the contact points are momentarily separated. This interruption of the primary circuit produces a current wave of high voltage in the secondary winding, which consists of a large number of turns of very fine wire wound directly over the primary winding. One end of this winding is connected to the primary winding and is earthed indirectly through it, *i.e.*, connected to the metal part of the magneto, while the other end goes to the collector ring or slip ring. On this ring there rubs a carbon brush held in contact with it by a small spring, and from this collector brush the high-tension current is conducted to the centre portion of the distributor.

Distributor.

The distributor has a centrally rotating arm driven by gearing from the armature shaft, so that it runs at half the speed of the armature shaft. As there are two cams to separate the points of the contact breaker on each revolution, four sparks will be generated for every revolution of the distributor. In the distributor casing, which is made of an insulating material, there are four connecting pieces, to which come the high-tension cables from the plugs and to each of which in turn the rotating arm distributes its current. The contact breaker and the distributor arm are so arranged that the arm is opposite one of these connections when the points are separated, so that the high-tension current is taken in turn to each of the four distributor connections and from these to the four sparking plugs in the cylinders.

Fig. 1.—The Lucas magneto fitted to Morris cars.

There is another important component, known as the condenser, and this is connected across the contact breaker points in order to prevent sparking occurring at these points and thus causing them to burn away.

The Lucas Magneto.

On the Morris cars the Lucas magneto is fitted (fig. 1). This is constructed on the lines already indicated, and it requires but little attention. When, therefore, ignition trouble is suspected it is well, before interfering with the magneto, to verify that the sparking plugs and the cables are in order. If one cylinder alone is missing this may be due to a faulty high tension cable, an examination of which will generally reveal the fault. If the firing ceases suddenly on all cylinders it may be due to an accidental short circuit in the magneto earth cable; this may be checked by removing temporarily the end cap to which this

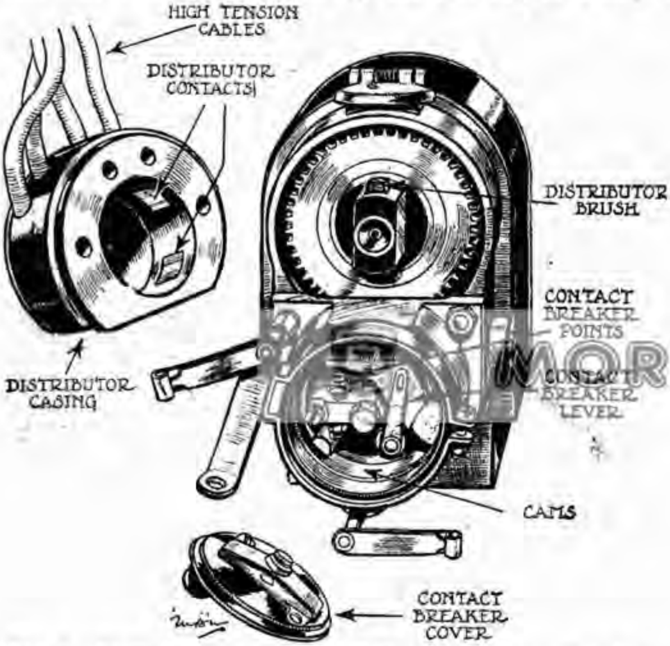


Fig. 2.—Contact breaker and distributor of the Lucas magneto.

cable is fitted, when sparking should at once take place normally. The sparking plug gaps should also be verified occasionally, especially if trouble is suspected in the ignition system; for example, when misfiring takes place. The gap between the plug points should just admit a visiting card, or the gauge supplied on the magneto spanner.

Supposing that the plugs and cables are in good order, and that the magneto is suspected to be at fault, the cover of the contact breaker (fig. 2) may be removed by swinging aside its retaining spring and gently withdrawing it. Then turn the engine slowly by hand and carefully watch the contact-breaker lever to see that it is working properly. This is pivoted on a fibre bush, and in damp weather this material sometimes swells slightly. When this happens the lever will not return to its position, and so close the contact points, after it has been moved by the cams. In this case it should be withdrawn, the pin cleaned if necessary with fine emery cloth, and the bush cleaned. The pin should be just moistened with oil before replacing the lever. The platinum points on the contact breaker should open to a maximum distance of 0.4 mm., or about $\frac{1}{64}$ in. The points only need adjustment very occasionally. If the contacts are badly out of line or pitted, they may be filed flat with a very smooth file, care being taken to remove as little platinum as possible.

The distributor should be cleaned every 1,000 miles, and it is removed by withdrawing it after unscrewing the two securing nuts or swinging aside the spring clip, according to the type of magneto fitted, which varies slightly on models of different dates. The inside should then be wiped out with a dry rag and the electrode or brush on the rotating arm cleaned (fig. 2).

Fig. 3.—The Smith single-jet carburetter.

Difficult starting may occasionally be due to a dirty high-tension pickup; if this is suspected, the cover over the end opposite to the distributor should be removed, when the pickup may be taken out and the carbon brushes and slip ring carefully cleaned with a dry rag, while the engine is slowly turned by hand. Should the slip ring show signs of being burnt, it may be cleaned up with the very finest emery paper, but very great care should be exercised in doing this.

The reader may be reminded that the best results can only be obtained if the insulated parts referred to above are kept clean and dry.

The armature is carried on ball bearings which require very little oil; every 500 miles two or three drops of oil (no more) should be given through the spring cap lubricators at each end.

The Carburetter.

The simplest form of carburetter is merely a fine jet, which is supplied with petrol, projecting into a tube through which air is drawn as the pistons of the engine descend on the suction stroke. The air stream passing over the jet picks up petrol in a fine spray, just as a scent spray works.

The Smith single-jet carburetter (fig. 3), which is fitted as standard to 1924 Morris-Cowley cars, works on this principle. This carburetter is of the straight-through or fixed-choke type; it is of the simplest possible construction, and therefore should appeal to those owners who have no previous motoring experience. It consists of two portions held together by a single screw. The

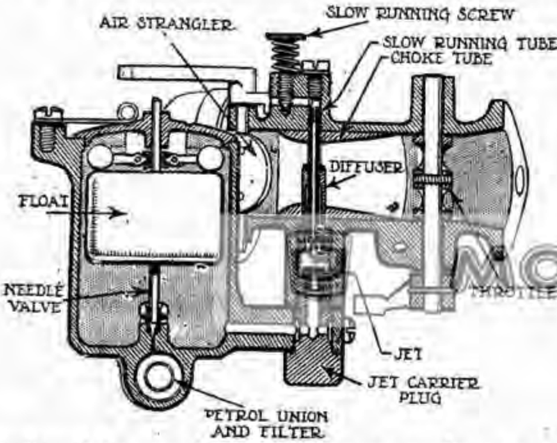


Fig. 4.—Section of the 1924 single-jet carburetter showing the various parts.

float chamber has a lid held in position by a spring clip, and if this be removed the needle valve and the balance weights will be withdrawn also. The balance weights are hinged to the lid and engage in a small collar on the needle, so that normally the weights hang down and lift the needle up. Within the float chamber, however, there is a hollow metal float through the centre of which the needle passes. When the petrol is turned on from the tank in the dash it flows by gravity through the petrol pipe and filter to the bottom of the float chamber, where it passes through another small filter and so through a small orifice into the float chamber. As the float rises it comes in contact with the balance weights, so that the needle valve is depressed on to its seat, thus cutting off the flow of petrol into the float chamber.

Projecting from the bottom of the float chamber is the connection to the second part, the carburetter body, the two being held together by the jet carrier plug (fig. 4). This portion of the carburetter has a flange at one end by which the instrument is bolted to the engine, and close to this is a vertical spindle carrying a butterfly valve throttle. A somewhat similar butterfly valve is fitted at the other end of this horizontal portion or mixing chamber, and the purpose of this is to close off the air supply to give easy starting. Between these two valves is located the choke tube, and projecting into the choke tube is the diffuser, which is immediately above the jet.

In the diffuser is fitted the slow-running tube, which projects into a hole in the top of the carburetter body with which a small air passage communicates; into this air passage there projects the slow running air screw which forms the only adjustment on the carburetter. When the car is received, this screw will be adjusted to the best position, but as the engine becomes run in, or should climatic conditions change considerably, a slight adjustment of this screw may be necessary. To strengthen the mixture the screw is turned downwards; to weaken the mixture upwards, the retaining spring beneath the screw keeping it in position. It is advisable to keep the slow running adjustment slightly on the rich side.

Fig. 5.—How the jet may be detached by means of the special spanner provided.

Apart from this, it is only necessary to keep the carburetter clean. Every thousand miles the filters in the petrol pipe and at the base of the carburetter should be cleaned out. Should, however, any water or dirt get through the filters into the float chamber it may stop up the jet; in this case the jet carrier plug should be unscrewed, and, if the petrol pipe has also been detached where it joins the carburetter, the float chamber may then be lifted clear away. The jet carrier plug may be removed entirely, and by means of the special carburetter spanner the jet itself may be detached (fig. 5). The diffuser may be removed for cleaning by means of the screwdriver end of the carburetter spanner, but no other screwdriver should be used for this purpose. With the diffuser will come away the slow running tube, and it can be screwed out of the diffuser if desired, although this is not necessary.

The diffuser should be cleaned only by blowing through it, and on no account should any sharp instrument be pushed into the holes in it, which are of a particular size.

When replacing the jet carrier plug, it is important to see that the two washers which it carries are in their correct positions, otherwise petrol will leak from this point.

The jet which experience has shown to be most suitable, when the car is run in, is size 110, but at the same time, due to variations in climatic conditions or in the cars themselves, a jet of a different size may sometimes give better results. Jets of the following sizes may be obtained: 105, 110, 115, 120, 125, 130, 135.

As regards petrol consumption, at 25 m.p.h. under good road and atmospheric conditions, a performance of 36-40 m.p.g. may be expected, or at 30 m.p.h. a figure of from 32-36 m.p.g. should be obtained.

Control of the carburetter is effected by the accelerator pedal and by two small knobs attached to rods running through brackets fixed to the instrument board. The left-hand knob has a rod which actuates the throttle to set the slow running position; turning this to the right opens the throttle, and to the left closes it. On starting up from cold it is advantageous to screw this rod about half a turn to the right, thus slightly opening the throttle and causing a bigger suction on the slow running jet. The knob on the right-hand side when pulled out operates the strangler valve to close off the main air supply, and this knob should be pulled out as far as it will go when starting from cold, and pushed right in directly the engine fires. When the engine has warmed up, the left-hand knob can be turned slightly to the left until the engine is ticking over quietly and slowly.

The accelerator pedal is attached to the throttle and opens this on being depressed, so giving the engine more mixture and allowing it to run faster.

Multi-jet Carburetters.

In order that the novice may more readily learn to understand his carburetter, the single-jet pattern has been dealt with first, although 1923 and 1925 models of both Oxford and Cowley cars, and 1924 models of Oxford cars, are fitted with carburetters having five jets.

Although these work on the same broad principle as the single-jet model, they differ considerably in design, and we will first consider the type fitted to the 1923 cars. With the float chamber we need not deal, as the difference lies in the body of the carburetter. The arm extending from the float chamber has a platform carrying four main jets and a well jet. Each of the four main jets projects into a separate vertical passage or choke tube, terminating at its upper end in a separate circular

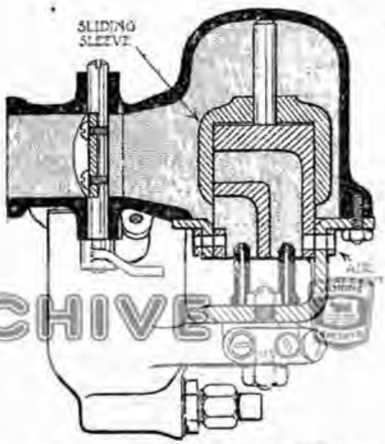


Fig. 6.—Part section of the 1924 Smith five-jet carburetter, showing two of the four chokes and jets. The sliding sleeve and air sleeve are plainly denoted.

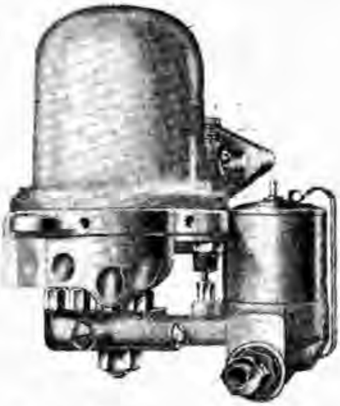


Fig. 7.—The 1925 five-jet carburetter, showing the four choke tube orifices and the air sleeve. The slow running jet and four main jets in line are also shown.

port opening radially in the circular wall of the upper portion, each port being at a different height. Over this circular upper portion is fitted a sliding sleeve valve or dash pot, automatically controlling the ports, which are arranged to overlap so that each begins to be uncovered before the previous one is fully opened. This ensures the regularity of the mixture.

Starting is controlled by a small sleeve sliding vertically up and down outside the well jet, and operated by a lever from the instrument board. This lever also controls a rotary air sleeve which admits air into each choke tube, with the exception of No. 1. In the starting from cold position all the holes are closed, and the well sleeve is at its highest position, entirely enclosing the well jet. As soon as the engine is sufficiently warm, the control lever is moved to the normal running position, the air holes still remaining closed, but the air sleeve being lowered to admit air to the well jet, and later still may be given a little further movement, opening the air holes and weakening the mixture as required.

It is important not to keep this control in the start cold position longer than is necessary. When the engine is started the suction is concentrated on the well jet only, and mixture from this is delivered through a passage partly surrounding the lower part of the carburetter body, through the centre of the butterfly spindle and out through the edge of the butterfly. Immediately the throttle is further opened the suction on the well jet is reduced and the controlling valve automatically rises, so opening the other ports and bringing the other jets into action in accordance with the volume of mixture passing to the engine.

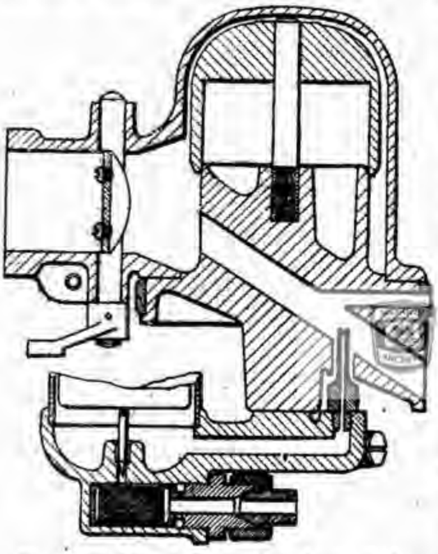


Fig. 8.—Showing how the four choke tubes run diagonally through the body of the instrument. The sliding sleeve is shown raised.

The five-jet carburetter fitted to the 1924 Oxford cars is an improved model, inasmuch as the various ports do not issue radially from the central portion of the carburetter, but are situated on the one side pointing towards the engine. This is clearly shown in fig. 6, from which the construction of the instrument may be clearly seen. The standard jet setting is: well jet 17, 1st jet 22, 2nd jet 27, 3rd jet 17, and 4th jet 10. If a 50 per cent. benzole mixture is used, the 1st jet should be 20, and for tropical climates the 1st jet should be 20, the 2nd jet 25, and the 3rd jet 15, the well jet and the 4th jet being the same in all three settings.

The carburetter fitted to the 1925 cars (fig. 7) is a further improvement of this Uni-directional model, so called because all four ports face in the direction of the outlet. The improvement consists of eliminating the right-angle bends in the choke tubes. In this carburetter the four choke tubes run diagonally through the central portion (fig. 8), and the result is an increase of speed and a decrease of fuel consumption.

The well jet (fig. 9) for starting is also replaced by a small pilot jet which projects into its own little choke tube formed in the body of the carburetter, at the upper end of which is a tapered screw for regulating the slow running mixture. To adjust this screw it down on to its seat, then unscrew about half a turn; screw down to weaken, and *vice versa*. Mixture is taken from this through a passage in the carburetter body and issues from a small hole, so placed as to be partly closed by the throttle when shut.

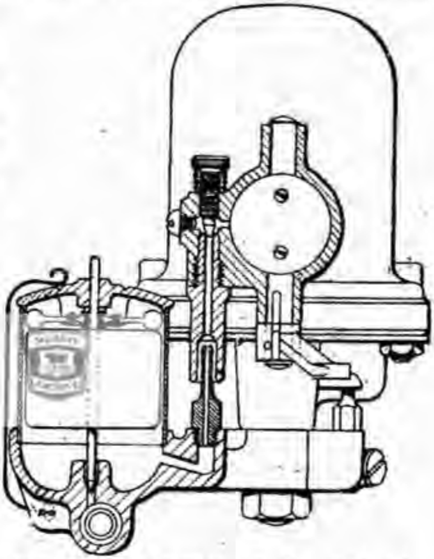


Fig. 9.—Construction of the pilot jet for slow running. The adjustment screw is screwed down to weaken the slow running mixture.

The mixture control operating the rotating sleeve which opens and closes the air holes should be used intelligently by the driver, for although the effect may not be perceptible as regards power or speed, it has a very definite bearing on fuel consumption. Those owners who wish to bring their cars up-to-date will find that the new carburetter can very easily be fitted.

The standard jet setting for this type is: slow running jet 15, 1st jet 17, 2nd jet 20, 3rd jet 17, and 4th jet 10.

CHAPTER IV.

GEARS AND TRANSMISSION.

How the Power of the Engine is Transmitted to the Road Wheels—Clutch—Gear Box—Torque Tube and Propeller Shaft—Differential and Rear Axle.

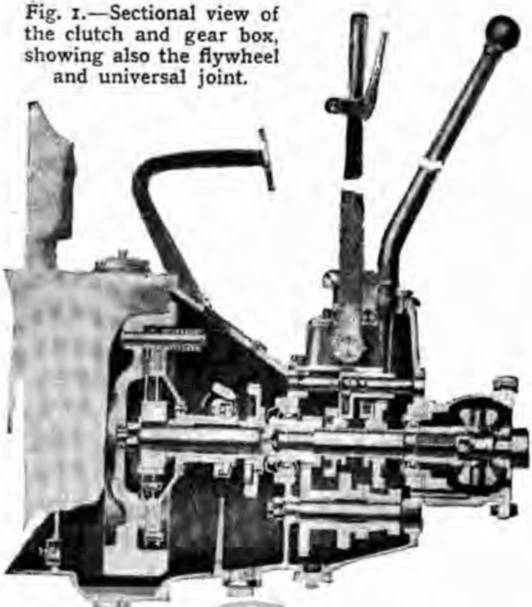
AS already mentioned in Chapter I., the clutch employed on the Morris car is of the plate type. If the floor boards of the car be lifted, the compartment of the crank case in which the flywheel and clutch are located will be seen just in front of the gear box. A large circular flange is, in fact, formed on the rear end of the crank case so that it completely encloses the flywheel, and to this flange there is bolted a somewhat similar flange which forms the forward extension of the gear box casing. The engine and gear box are thus rigidly joined together as a single unit, this being known as " unit construction."

Construction of the Clutch.

In order that the construction and method of working of the clutch may be grasped without difficulty, reference should be made to fig. 1, which shows the flywheel and clutch in section, and to fig. 2, which shows the various parts dissembled. It will be noticed that the flywheel is recessed, and that within the recess there are mounted four metal plates. Two of these plates, Nos. 2 and 4, counting from the flywheel face, are of larger diameter than plates Nos. 1 and 3, and through them pass six pins which are fitted into the flywheel. The second plate is known as the floating plate, or driving ring, while the fourth plate is known as the pressure plate, as on it the spring pressure necessary to keep all four plates together is taken. As the flywheel revolves, therefore, the floating plate and the pressure plate must revolve with it.

The two smaller plates, Nos. 1 and 3, are known as the driven rings, and they have let into them a series of cork insets. These plates are mounted on a toothed hub secured on to a short shaft by a coned seat, a key, and a large nut, one of the driven plates being between the flywheel and the floating plate, and the other between the floating plate and the pressure plate. On each of the six driving pins there is arranged a helical spring, of which one end bears on the pressure plate and the other end against the spring cup secured to the pin. These springs normally keep the four plates pressed tightly together against the face of the flywheel, and there are, therefore, four driving surfaces, *i.e.*, the

Fig. 1.—Sectional view of the clutch and gear box, showing also the flywheel and universal joint.



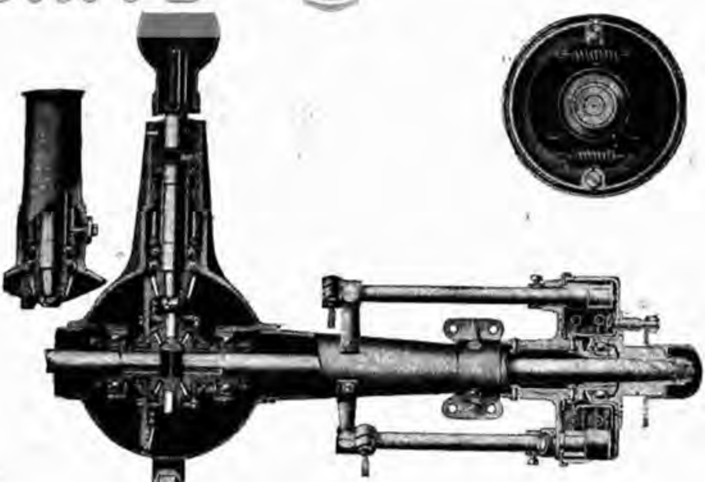


Fig. 9.—Part section of the torque tube and back axle assembly, showing the final drive and brakes.

rear face of the flywheel, both faces of the floating plate, and the forward face of the clutch pressure plate, while the driven surfaces are the faces of the cork insets in the two steel driven plates.

It is now necessary to explain how the spring pressure may be relieved in order that the clutch may be disengaged when required. Reference to fig. 1 will show that the pressure plate is also attached to a hub which is mounted on the short driving shaft already referred to as carrying the driven plates. This hub, known as the withdrawal hub, has attached to it a ball thrust bearing, and the shaft which carries the clutch pedal carries

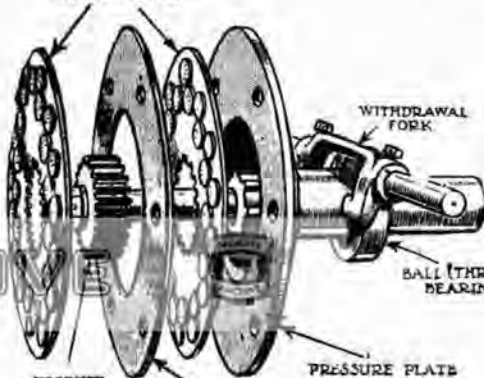


Fig. 2.—Component parts of the clutch dissembled to show the construction.

also the clutch fork, which is so arranged that when the clutch pedal is depressed the fork bears against the side of the thrust race and so forces the withdrawal hub slightly backwards, carrying with it, of course, the pressure plate and slightly compressing the clutch springs.

This clutch is designed to run in oil, and, in order that the owner-driver shall be relieved of the responsibility of attending to clutch lubrication, oil from the crank case is allowed to pass into the clutch case. Between the clutch case and the crank case there is placed an oil return valve, which allows any excess of oil in the clutch case to return to the crank case.

As it is desirable from time to time to remove the old oil a drain plug is located in the bottom of the clutch case, and when this has been done it is necessary to pour in through the clutch case about one quart of engine oil before running the car, as the automatic feed from the engine is slow in action and the clutch should never be run dry.

On the top of the clutch case there is an inspection door which may be removed in order to give access to the clutch. Should the clutch show signs of slipping at any time the six springs should be examined, as a broken clutch spring is a likely cause of the trouble. An adjustment is provided on the hub of the clutch pedal so that the position of the pedal may be regulated. During the early life of the car this adjustment may have to be called into service, for owing to its granular structure the cork consolidates considerably under pressure. The effect of this is to allow the pressure plate of the clutch to approach closer to the flywheel, carrying the withdrawal hub with it. This means that the withdrawal fork which is attached to the clutch pedal will move correspondingly, so that the clutch pedal will project slightly further into the body of the car. This movement may allow the clutch pedal to touch the bottom of the slot cut for it in the floor board, and it can easily be seen that this would in consequence prevent the full pressure of the clutch springs from being exerted on the clutch plates.

The shaft which carries the clutch driven plates is supported at its forward end in a ball bearing housed in the centre of the flywheel, while the rear end is supported in a ball bearing in the front of the gear box casing. Formed integrally with the shaft is the smaller of the two constant mesh pinions of the gear box, while on it there is also mounted a sprocket over which passes the chain for the dynamotor drive, this electrical unit, to be dealt with later, being mounted in an extension of the gear box casing on the near side of the car.

Gear Box.

Although the gear box (fig. 1) may appear at first sight to be complicated, it is in reality quite simple. At the front end of the box we have, as already seen, the driving shaft, which receives the power from the engine through the clutch, ending in a gear wheel. On the same centre line as this shaft there is another short shaft projecting through the back of the gear box, and carried by a ball bearing. This is the driven shaft, and the front end is reduced in diameter so that it may actually take its bearing in a bush fitted into the end of the driving shaft. This is known as a spigot bearing, and it will be seen that, although the driving shaft and the driven shaft are in one straight line, there is no connection between the two, and the one may revolve without causing the other to rotate. On the driven shaft there are mounted two gear wheels on keys in such a manner that they can slide along the shaft, although they cannot rotate without also turning the shaft, owing to the keys

Immediately below these gear wheels and their shaft there is another shaft—the layshaft—which does not rotate. This is securely fixed to the front and back of the gear box, but mounted on it on bushes, so as to be capable of rotation, there

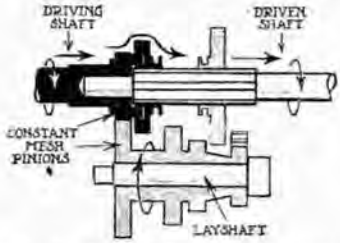


Fig. 3.—How the power is transmitted in top gear. The black portion represents the pinions actually engaged, while the layshaft pinions run idle.

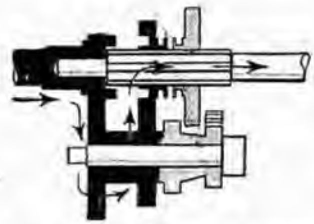


Fig. 4.—How power is transmitted in second gear. The layshaft has been brought into operation by sliding the pinion on the main shaft.

Fig. 5.—How power is transmitted in first gear by means of the second sliding pinion.

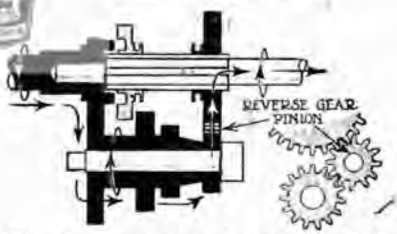


Fig. 6.—How power is transmitted in reverse gear and how the extra pinion is situated. The second sliding pinion has been moved to the extreme right.

are four gear wheels of varying diameter. These gears are formed as a single integral unit. The largest gear wheel is constantly in mesh with the gear wheel on the end of the driving shaft, and, therefore, these two wheel are known as the constant mesh pinions.

Top Gear.

As has been already explained, the purpose of the gear box is to allow the engine to run at a higher speed in relation to the speed of the road wheels, on hills, or in starting from rest. In dealing with the operation of the various gears, however, it will be better to consider first the top gear, for, as is shown in fig. 3, the power is transmitted direct from the driving shaft of the gear box to the driven shaft. This gear is accordingly sometimes known as the direct gear, for, although the gear pinions are revolving, they are not actually doing any work.

When top gear is engaged, the smaller of the two pinions on the driven shaft is moved forward along the keys on the shaft until the internal teeth, which are cut in a recess on its forward face, engage with the teeth of the small constant mesh pinion, which, incidentally, are considerably wider than the teeth on the larger constant mesh pinion, and, accordingly, project past it. In this case the driving shaft and the driven shaft rotate as one, as they are locked together by the engagement of the two gear wheels.

Second Gear.

When second gear is engaged, the smaller of the two pinions on the driven shaft is moved rearwards until the teeth on its circumference engage with those of the layshaft second gear wheel, which is situated next to the larger constant mesh wheel (fig. 4). The power from the driving shaft is then transmitted through the constant mesh pinions to the smaller gear wheel on the driven shaft. The result is that, in order to give the driven shaft one complete revolution, the driving shaft must revolve more than one complete turn.

First Gear.

Similarly, when the first gear is engaged (fig. 5) the larger of the two sliding pinions on the driven shaft is moved forward until it engages with the next smaller layshaft pinion, and the power from the driving shaft is transmitted through the constant mesh pinions and so to the larger sliding pinion on the driven shaft, with the result that the driving shaft must make still more revolutions in order that the driven shaft may make one complete revolution.

Reverse Gear.

In order that the car may be made to move backwards, the driven shaft must rotate in the opposite direction, since the engine, of course, can only run in the one direction, *i.e.*, clockwise, as seen when facing the front of the car. The driving shaft of the gear box will, therefore, also run in a clockwise direction, and the layshaft pinions in an anti-clockwise direction. Normally, on any of the three forward gears, the driven shaft will also run in a clockwise direction, and, in order to obtain an anti-clockwise rotation of the driven shaft, another small gear wheel is located on a small shaft of its own, parallel with the layshaft, so that it is in engagement with the smallest layshaft pinion. These two gear wheels, *i.e.*, the reverse pinion and the smallest layshaft pinion, are also constantly in mesh, and they are so located that, when the larger sliding pinion on the driven shaft is moved rearwards, its teeth engage with those of the reverse pinion. Accordingly, the anti-clockwise rotation of the layshaft pinions gives a clockwise rotation of the reverse pinion and, therefore, an anti-clockwise rotation to the larger sliding pinion, thus causing the driven shaft to be rotated in a direction opposite to that of the engine (fig. 6), which is what is required on reverse.

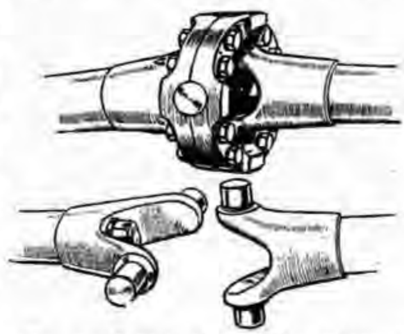


Fig. 7.—Construction of the universal joint.

Normally, when the car is stationary, the gears are in neutral position, *i.e.*, the two sliding pinions are both free, and are not in engagement with any other gear wheels. Thus, even if the engine is running with the clutch in, the car will remain stationary, for there is no connection between the driving shaft and the driven shaft.

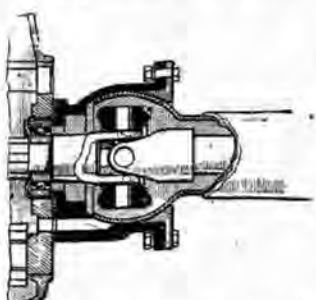


Fig. 8.—The universal joint is located within the ball joint of the torque tube at the rear of the gear box.

Gear Control.

The various movements of the two sliding pinions required to give the different gears are obtained by means of the gear lever. This is held by a ball joint in the top of the gear box, and the long upper part has at the end a round knob for convenience in handling. The short lower portion projects down to the selector mechanism. This consists of two rods running across the top of the gear box parallel with the shafts. Each of the two sliding pinions has formed on it a collar, with which engages a fork sliding on one of the selector rods. The fork for the top and second gears is mounted on the left-hand selector rod, and that for the first and reverse gears on the right selector rod. It is with these selector forks that the lower end of the gear lever engages.

In order that only one gear may be engaged at a time, each selector fork is provided with a simple locking device, which consists of a small steel ball held by a spiral spring in contact with its selector rod, and grooves are formed in the rods so that the spring-loaded balls engage with the grooves as the gears are moved into position. The gear lever is so mounted that when it is, for example, in first gear, it cannot be moved to engage another gear without automatically disengaging the first gear pinion and placing it in the neutral position, where the spring-loaded ball will retain it.

Universal Joint.

Although the engine and gear box unit is fixed in relation to the frame of the car, the back axle can move up or down as its springs bend on encountering an uneven road surface. Obviously, therefore, provision must be made for the shaft transmitting the power from the gear box to the back axle to accommodate this relative movement. Thus, the rear end of the driven shaft is squared to receive one portion of a universal joint (fig. 7). This is shaped like a U, and each of the sides carries a round pin. A similar fitting is carried on the front end of the propeller-shaft, and is located at right-angles to the U portion on the driven shaft. The four pins are connected by a bronze ring forming bearings for them, the ring consisting of two halves bolted together. One half of the joint allows movement in one plane and the other half in a plane at right-angles, so that, within limits, a universal movement is permitted.

Examination of the actual car will not disclose this joint, as it is hidden from view within the ball joint of the torque tube (fig. 8). Reference to fig. 1 will make the position of the joint quite clear, for it will be seen within the spherical shaped chamber immediately at the back of the gear box.

Gear Box Lubrication.

Before dealing with the propeller-shaft and torque tube, it will be well to consider how the lubrication of the gear box is effected. Oil is employed, and the grades recommended are Shell gear oil or Gargoyle Mobiloil C. On the side of the gear box there is an oil filler, so arranged that too much oil cannot be poured into the box, but on some of the early models the oil filler plug was supplemented by an inspection plug, which should be removed when replenishing the box with oil so that it cannot be filled beyond this level.

It is of considerable importance that the gear box should be kept filled with oil to the correct level, for, if too much oil is present, it may find its way down the torque tube into the back axle, eventually overflowing into the brake drums and impairing the efficiency of the brakes, while if the level is allowed to get too low, it will result in harsh running of the gears.

Fig. 10.—Spiral bevel pinion and crown wheel of the final drive.

Provided the correct oil level is maintained, all the components of the gear box will be adequately lubricated, for the spigot bearing of the driven shaft receives oil through holes drilled in the smaller constant mesh pinion, and an oil way is drilled through the driven shaft so that the four pins of the universal joint will also receive a sufficient supply of lubricant. Any excess oil which finds its way through the universal joint collects in the spherical housing for the torque tube ball, and, having lubricated this, drains back into the gear box through the passage provided for the purpose. From time to time it is desirable to drain out the old oil, and in the bottom of the gear box there is fitted an easily accessible drain plug. To refill the gear box after draining, about one quart of oil is required.

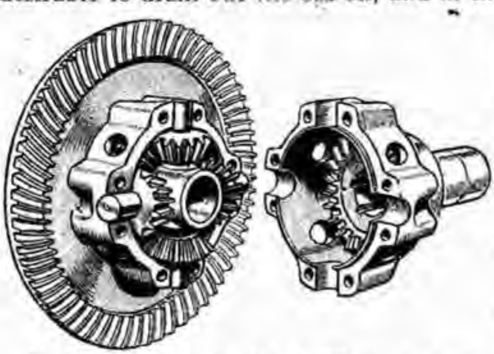


Fig. 11.—Crown wheel and differential gear partly dissembled to show the bevel pinions.

Propeller-shaft and Torque Tube.

The rear half of the universal joint has been referred to as located on the front end of the propeller-shaft. This is a steel shaft or rod which transmits the power to the rear axle, and it is surrounded by a casing known as the torque tube.

the purpose of which will be dealt with later. This casing at its forward end carries a large hollow ball, which fits in the spherical housing attached to the back of the gear box, thus allowing a certain amount of movement, just as does the universal joint situated within it. At its rear end the torque tube is attached to the back axle casing (fig. 9), and within it are the ball bearings which carry the tail end of the propeller-shaft.

Final Drive.

We have now to consider how the rotational motion of the propeller-shaft is transmitted to the axle shafts lying at right-angles to it. For this purpose a pair of bevel wheels is utilised, the smaller being known as the bevel pinion and the larger as the crown wheel (fig. 10). The crown wheel is mounted on the axle shafts, and the teeth of these two bevel wheels are of a special form known as helical, as it has been found that more silent running results from the use of spiral bevels, as they are commonly called.

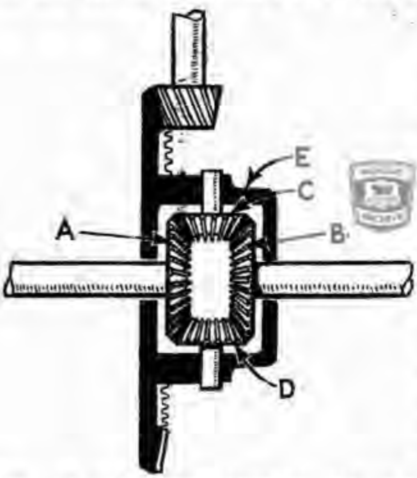


Fig. 12. — Diagram showing the construction of the differential. The mechanism is, of course, enclosed.

It has already been stated that every action has an equal and opposite reaction, and when the bevel pinion, which is secured to the end of the propeller-shaft by a coned seating, a key, and a nut, causes the crown wheel to rotate, there is a tendency for the casing of the back axle, which carries the axle shafts and the crown bevel, to rotate also. It is for this reason that the torque tube is fitted, for it resists this tendency of the back axle casing to turn, thus relieving the rear springs ot the duty. Furthermore, the rear springs are relieved of the task of taking the drive, *i.e.*, pushing the car forward, for, when the road wheels begin to revolve, the thrust is transmitted by the back axle casing and torque tube practically to the centre of the car, which has been shown by experience to be the best place.

Differential and Rear Axle.

Incorporated with the crown wheel of the final drive is the differential. This is admittedly difficult to understand, but a study of fig. 11 should render the construction clear. The necessity for the differential will readily be understood when consideration is given to the path followed by the rear wheels when the car is turning a corner. Obviously, the outside wheel will have to travel a good deal further than the inside wheel. A good analogy is the case of a line of troops wheeling, when the inner man has to mark time, while the outer man has to turn through a complete right-angle. The outside man, in fact, covers a considerable distance, while the inside man remains in the same position, acting as a pivot about which the whole line turns.

If the rear axle was solid throughout, then one wheel or the other would have to slip considerably in turning a corner. Actually, however, the axle is formed in two equal parts, to each of which one wheel is attached, the two inner ends of the shafts being united by the differential assembly. On the inner end of each shaft there is a bevel wheel, and, connecting the two, there are other smaller bevel wheels, held in bearings in a cage, which is bolted to the crown wheel. Normally, therefore, the crown wheel and the cage are driven round by the bevel pinion, and the bevel wheels of the differential rotate within the cage as a whole, *i.e.*, the smaller bevels do not rotate on their own axes. On a corner, however, the inner wheel requires to go more slowly than the outer wheel, so that the smaller bevels of the differential not only rotate as a whole, but also rotate on their own axes, *i.e.*, they run round on the bevels on the shafts. In other words, they allow relative movement between the larger differential bevels on the axle shafts, one of which, on the shaft of the outer wheel, is allowed to run faster than its fellow on the shaft of the inner wheel.

To make the action of the differential quite clear, let us study the diagrammatic sketch fig. 12. A and B are the bevel wheels carried by the inner ends of the axle shafts. C and D are the smaller bevel pinions which mesh with A and B. They are free to revolve in bearings formed in the cage E, which supports them and which is attached to the crown wheel.

Now, let us suppose that, subject to all the various parts working freely, we revolve the cage E. In this case there will be no tendency for the bevel pinions A and B, and C and D, to revolve in relation to each other, but C and D will act just as if they were solid bars connecting A and B together, and so the whole arrangement will revolve bodily, just as if it were made of one piece of metal.

Next let us imagine that, whilst the cage E is being rotated, the shaft carrying the pinion A is held so that it cannot revolve. It follows that the pinions C and D must revolve, each on its own axis. They run round on the teeth of A, in fact, and in so doing carry the pinion B with them. B will revolve *twice* as fast as the cage E, because each of the pinions C and D acts like a lever which is fulcrumed on the pinion A, whilst a movement is applied at its centre E. Now the movement of the end of the lever, *i.e.*, on the pinion B, must be twice as great as that of its centre, since B is twice as far away from the fulcrum A as is its centre E.

We shall have, therefore, E making one revolution, the pinion B making two revolutions, the pinion A making no revolutions.

In other words, E makes revolutions equal to half the sum of the revolutions of A and B.

If instead of holding A rigidly fixed we allow it to revolve slowly, so that whilst E makes one revolution A only makes half a revolution, then B will make one and a half revolutions. Thus at whatever speed A is allowed to rotate, B will make an appropriate compensation for it.

Actually the crown wheel and the differential assembly are carried on ball bearings in the central portion of the back axle casing, the inner ends of the shafts having keys which engage with grooves in the centre of the bevel wheels, while the outer ends of the shafts, and the hubs attached to them, are supported by large ball bearings outside the end of the axle casing.

This type of rear axle is known as the threequarter floating type, since the driving shafts only have to transmit the driving torque, and do not carry any of the load. The wheel hubs with the driving shafts attached can, indeed, be withdrawn from the axle casing without interfering with the differential and final drive, after removing the hub caps, the wheels, and the countersunk screws which secure the wheel hubs to the brake drums.

At the back of the axle casing there is a domed cover, which can be removed to give access to the final drive and the differential, and through the opening thus disclosed the differential with the spiral bevel can be removed complete after withdrawing the driving shafts and removing the differential bearing caps.

On the housing cover there is situated an oil filler, through which Shell gear oil or Gargoyle Mobiloil C should be introduced as required. The filler is so situated that too much oil cannot be poured in, and when, from time to time, the old oil is drained out through the drain plug underneath the axle case, about one quart of fresh oil is required to bring the level to the top of the filler.

Brakes.

Attached to each of the rear wheel hubs is a brake drum, and on each end of the axle casing there is riveted a circular plate, which carries the brake shoes and their operating spindles. There are two pairs of brake shoes situated side by side, and the shoes are semi-circular in section (fig. 13), being held together by spiral springs on to a pivot at one side and on to a cam at the other side. The cam is formed on a short shaft, which carries at its other end a lever attached by suitable rods to either the brake pedal or the brake lever mounted on the top of the gear box. Therefore, when either the pedal or the lever is brought into action, the brake cams are caused to rotate partly. Thus each pair of shoes is caused to expand slightly by its respective cam until the shoes come into contact with the inner surface of the brake drum surrounding it.

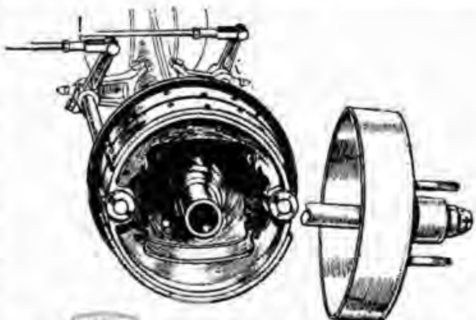


Fig. 13.—Two pairs of expanding brake shoes are housed in each rear wheel drum.

In order to give the greatest efficiency, the brake shoes carry a special fabric lining, and this, naturally, wears away in

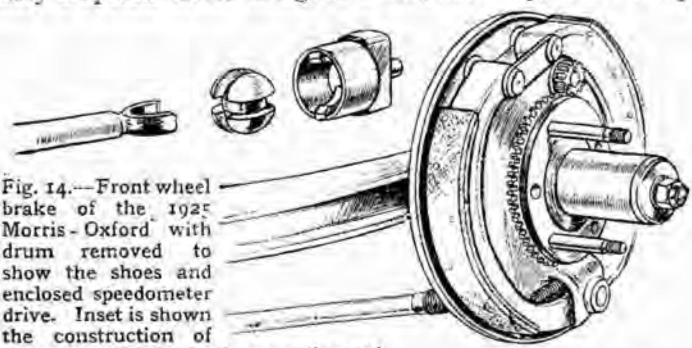


Fig. 14.—Front wheel brake of the 1925 Morris-Oxford with drum removed to show the shoes and enclosed speedometer drive. Inset is shown the construction of the universal joint in the operating rod.

time. To compensate for this wear, a turnbuckle is provided on both the hand brake and the foot brake connections. This has both a right-hand and a left-hand thread, so that when it is turned it has the effect of shortening the rods to which it is fitted. In order that one control, either the pedal or the lever, may operate a pair of shoes in each wheel, there is provided a brake cross-shaft, to which the two pairs of brakes are connected.

On 1925 Morris-Oxfords brakes are fitted on all four wheels, the front brakes (fig. 14) being similar to those in the rear wheel drums, although the operating gear is necessarily not so simple,

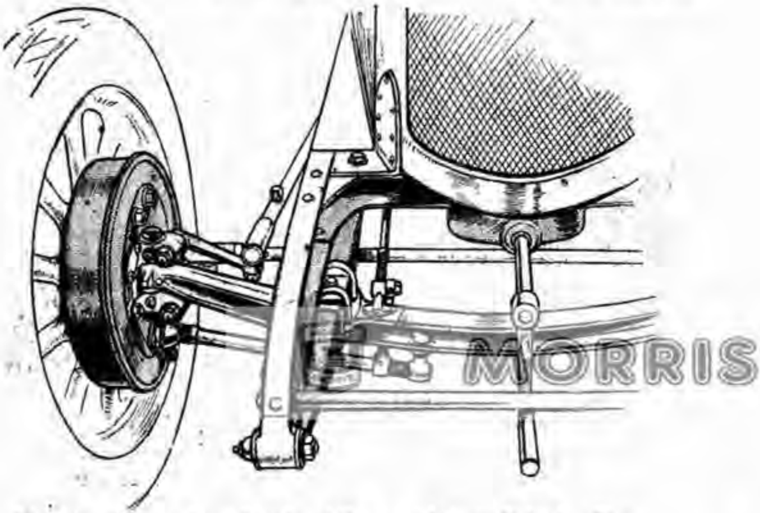


Fig. 15.—Front axle and brake of the 1925 Morris-Oxford. The wing nut adjustment is situated close to the spring pad. The axle is specially designed to take the braking stress.

since provision must be made for the wheels to turn for steering.

These brakes are made under Rubury patents, and are so arranged that when the car is cornering, the outside front wheel is not braked so much as is the inner front wheel. The shoes are pivoted at their upper ends, and the cam is situated beneath the stub axle, being supported in a bearing on each side. The cam operating shaft is carried beneath the axle beam, and it has in it a universal joint located on the extension of the centre line of the steering pin; the construction of this joint is clearly shown in fig. 14.

The lever on the inner end of each cam operating shaft has attached to it by a wing nut adjustment (fig. 15) the operating rod running back to a cross shaft. This is supported in brackets on the frame (fig. 16) and forms a compensating mechanism between front and rear brakes, since it carries a swinging link to which are attached the brake rod from the pedal and the rod to the rear brake cross-shaft. These rods

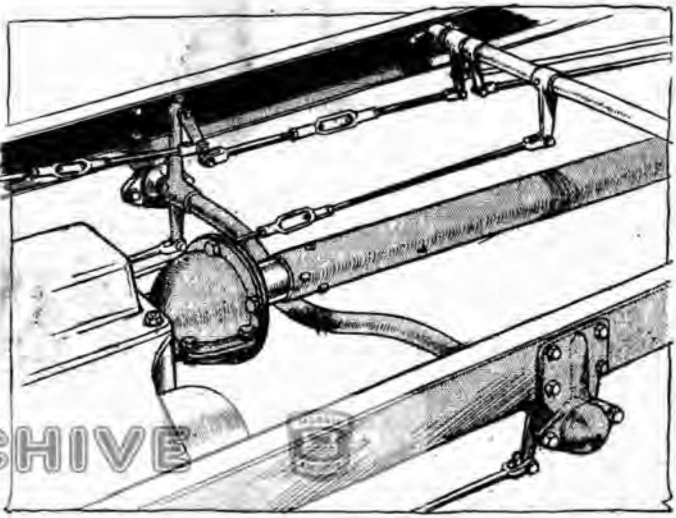


Fig. 16.—Compensating mechanism and adjustments. The turn-buckle on the left adjusts front and rear brakes, the upper right turn-buckle adjusts the rear brakes only, and the lower right turn-buckle is for hand brake adjustment.

have turn-buckles which allow for adjustment for wear, the wing nut adjustment being for equalising the braking effect on each front wheel

CHAPTER V.

STEERING, SUSPENSION, AND WHEELS.

How the Steering Gear Operates—Front Axle and Stub Axles—Springs and Shackles—Wheels and Tyres—Low Pressure Tyres.

STEERING is effected on the Morris car, as on the majority of cars, by a worm and worm wheel gear (fig. 1). The worm is mounted on the lower end of the steering column, and at the upper end of the column is the steering wheel. The steering gear is enclosed in a case which is rigidly attached to the engine by a bracket, and the worm wheel is formed on a short shaft which has bearings in the case. On the outer end of this shaft there is attached the steering lever, the end of the shaft being squared so that the lever may be fitted on to it in four different positions. The reason for this is that after a time wear will occur between the teeth of the worm and the worm wheel; when this happens the steering lever is removed, the worm wheel turned through 90° to a new position by rotating the steering wheel, and the steering lever replaced. A lubricator is fitted to the steering gear box so that the grease gun may be used to replenish it with lubricant.

The steering lever projects downwards, and carries at its end a ball joint. On the off-side stub axle is the steering arm, which carries a similar ball joint, and uniting the two is the steering tube or drag link. In the enlarged portions at each end of this tube are ball cups which are held in engagement with the ball joints by springs.

Also carried by each stub axle, or steering knuckle as it is sometimes called (fig. 2), is an arm for the steering cross tube or tie-rod. This, however, is connected to the two arms by pin joints formed in the yokes which are screwed on to each end of the steering cross tube. These yokes are also held by lock nuts and have right- and left-hand threads respectively, thus forming a means of adjusting the length of the steering cross tube so that the front wheels can be adjusted to give the best steering; actually the length of the rod should be such that the distance between the forward inside edges of the wheel rims measures $\frac{1}{8}$in. less than the distance between the rear inside edges, *i.e.*, the wheels turn in very slightly as seen from the front.

For the front axle itself a steel forging of I section is used in order to give strength, and each end is forked to receive the steering knuckle, a pin passing through the ends of the fork and through a hole in the steering knuckle, which is bushed to form a bearing for the knuckle on the pin. Lubricators are fitted to the heads of these steering knuckle bolts, and it is important to remember to use the grease gun freely in order to keep the steering free at all times.

The front wheel hubs are carried on the stub axles by two ball bearings, which are protected from dirt by a dust excluder and felt washer. The hubs are retained in position by a washer,

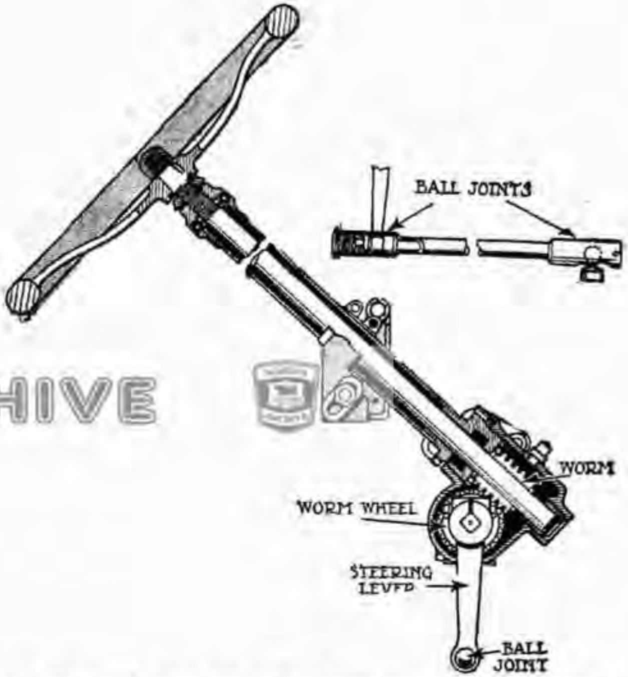


Fig. 1.—Worm and worm wheel steering lay-out, showing the steering lever and steering tube, or drag link, with its ball joints.

a nut, and a split pin, and, by removing these, may be easily withdrawn. This it is necessary to do about once every three months in order to clean them and renew the supply of thin grease which lubricates the ball bearings. The nut for the off-side front wheel has a right-hand thread, and therefore should be turned anti-clockwise to remove it, but the securing nut for the near-side front wheel has a left-hand thread and accordingly should be turned clockwise to remove it.

Suspension.

The front springs which form the connection between the frame of the car and the front axle are semi-elliptic in shape, and consist of a number of leaves of different length located together by a central bolt and attached to a small platform on the axle by two inverted U bolts. The front end of the main spring leaf is formed with an eye by means of which the spring is attached to the extreme front end of the frame, known as the dumb iron, while the rear end has a similar eye so that the spring can be attached to the spring shackle, which again is pivoted to the frame side member.

As regards the rear springs, these are of similar construction to the front springs and are bolted to, and beneath, the rear axle casing. The front ends of these springs are, however, attached by shackles or links to the frame, while the rear ends are attached by similar links to short quarter-elliptic springs which are rigidly bolted to suitable platforms carried by the rear end of the frame. The rear springs are, therefore, of the type known as threequarter-elliptic, as they consist of half-elliptic springs in conjunction with quarter-elliptic springs.

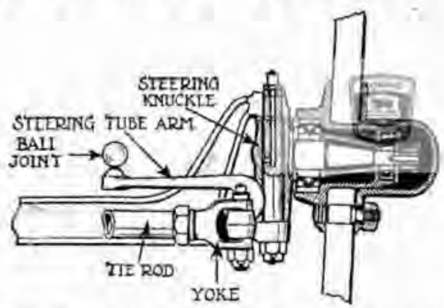


Fig. 2.—Uniting the two steering knuckles so that they move in unison is a tie-rod or steering cross tube.

The purpose of the spring shackles is to allow for the lengthening of the springs under load, for as the curved springs flatten out as the wheels negotiate a bump, the distance between the eyes at the ends of the springs will be increased. All the points where movement occurs, *i.e.*, at the front dumb irons and at all the shackles, are lubricated by the grease gun, suitable connections being fitted for the purpose.

For the lubrication of the spring leaves Wefco spring gaiters are fitted. These not only assure a supply of grease, but protect the springs from mud and wet, thereby preventing them from rusting and assuring the maximum riding comfort at all times.

Wheels and Tyres.

The wheels used on Morris cars are pressed out of steel, and they are made quickly detachable, so that when a puncture occurs the defective tyre may be replaced by removing it *in situ* on the wheel and replacing it with the spare wheel and tyre. The central part of the wheel is accordingly made so that it can slip easily into position on the hub. Each wheel is held by three studs and nuts and the hub cap; to change a wheel, therefore, it is only necessary to jack it up clear of the ground and to unscrew the three nuts, when the hub cap may be withdrawn and the wheel pulled off.

The tyres fitted as standard to 1924 models are $28 \times 3\frac{1}{2}$in. Dunlop Clipper Cords on the Cowleys and Dunlop Cords of the same size on the Oxfords.

So great has been the improvement in the methods of tyre construction that punctures and bursts are now very infrequent troubles. Should, however, it one day be necessary to repair a puncture, the cover can best be removed by laying the wheel flat on the floor and beginning by removing the valve cap and interior, leaving only the valve stem projecting through the rim. A tyre lever should then be inserted under the bead of the cover at the side, opposite to the valve, care being taken not to nip the tube between the wheel rim and the lever or between the lever and the cover. Another lever should be inserted a few inches further round the bead, and then by bearing on the ends of the levers part of the edge of the bead may be pulled off the rim. A third lever should then be used a few inches further still round the bead, when the middle lever may be withdrawn and again used to coax a few more inches of the bead over the edge of the rim.

When the puncture has been repaired and the tube replaced, the cover has to be coaxed back into position. This time one should begin close to the valve, using two levers at points a few inches each side of the valve to force the bead over the rim into its position, meanwhile holding the valve well up into the cover so that the tube cannot be pinched as the cover falls into position. A practical demonstration of tyre repairing will, however, quickly teach the new motorist more than written instructions can possibly convey.

Low Pressure Tyres.

Mention must be made of the large section low pressure tyres which are now becoming so popular, and which are standardised on 1925 models. These, as their name implies, are inflated to much lower pressures than are the normal tyres, and they have the advantage of being able to absorb road shocks much more readily than tyres inflated to a higher pressure. This not only greatly improves the comfort afforded to the driver and

Fig. 3.—The Dunlop recessed rim for wired-on low pressure tyres. Covers may be removed without tools.

passengers, but also has a beneficial effect upon the whole chassis, since it is not subjected to road vibration to such a large extent. The size employed is 27×4.40in on the Cowleys, and 28×4.95in on the Oxfords, except the saloon and cabriolet which have 30×5.25in. tyres.

These tyres are of Dunlop make and are of the straight-sided or wired-on type. Owing to the special design of the rim—the Dunlop well base rim—it is very easy to remove or fit a cover with only a single tyre lever, or even with the hands alone. The edge of the tyre is pushed back into the deep well formed in the rim, and the edge on the opposite side can then be pulled over the rim without difficulty. The shape of the rim and the manner in which the tyre is manipulated may be gathered from fig. 3.

CHAPTER VI.

ELECTRICAL INSTALLATION.

Care of Battery and Dynamotor—Switchbox—Cutout—Lamps and Horn.

WHILE the majority of Morris owners take sufficient pride in their cars to bestow upon them periodically the little attention which is required to ensure complete satisfaction at all times, the electrical equipment is very often entirely excluded, because they think that a thorough knowledge of electrical matters is necessary before the equipment can be touched. Accordingly they decide to leave the electrical part severely alone, and although, in a number of cases, this procedure does not show any immediate detrimental effect, the length of life the equipment is designed to attain is largely diminished. There is no more difficulty in looking after the electrical part of the car than the mechanical.

The two chief components are the battery and dynamotor. The battery may be looked upon as an electrical reservoir from which current is withdrawn when the engine is started or the lamps are used, and which is replenished by an electrical generator when the engine is running. The engine starter and dynamo are combined in the form of one unit, which is known as the "dynamotor." The dynamo part of the set is controlled by a switchbox placed on the dash, and is provided with a switch for switching on and off the charging current as desired, and also a switch for controlling the lamps. The dynamo switch, when turned to the " off " position, also cuts off the ignition.

The battery, however, must be looked upon as the most vital component, and without it the electrical equipment is useless. With care the battery will last a considerable time before it is necessary to have new plates fitted, but, on the other hand, if it is abused—such as by depressing the starting switch and letting it run the engine for a minute or so, when actually the cause of non-starting is due to the ignition being turned off, or the petrol tap not being turned on—then it will be worn out rapidly.

Replenishing Electrolyte.

As far as attention is concerned, there are one or two simple rules to observe, the first is—inspect the battery at least once a month to see that the acid level in each cell of the battery has not dropped below the level of the plates. The acid can be seen in each cell by unscrewing the six vent screws which will be found between the lead connections in the top of the battery. The correct height is approximately ⅜ in. above the top of the plates.

For replenishing the acid solution, distilled water only should be used. Tap or rain water will not do, as these are usually full of impurities which will react on the chemical composition of the battery and reduce its life. Should it be necessary frequently to add distilled water to bring up the acid level to its correct height, and yet be no sign of a leak in the battery, then it is evident that considerable overcharging is taking place. This may not seem logical, but when once the battery is fully charged any excess current which is forced into it will decompose the water in the acid solution into its two component gases, hydrogen and oxygen, and thus gradually the acid level will fall. For this reason a naked light should never be placed near the vents, as, should the battery have been "gassing" through charging, the flame may cause the gases to explode.

If the battery should unfortunately be upset at any time and the acid lost out of the vent holes, it should be replaced by

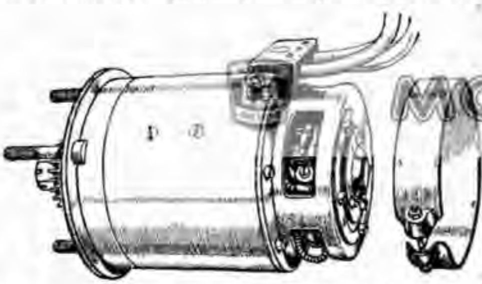


Fig. 1.—To inspect the commutator and brush gear of the dynamotor, first remove the dust cover.

a dilute solution of pure brimstone sulphuric acid and distilled water to a specific gravity of 1.225. The specific gravity of an acid solution is determined by an instrument known as a hydrometer, which is also well adapted for giving a good idea as to the amount the battery is discharged. With the usual form of hydrometer the reading 1.250 indicates that the cell is in its normal condition, *i.e.*, fully charged. A reading of 1.170 indicates that it is less than half charged, and it should be recharged as soon as possible by the dynamotor. If the battery is fully discharged the reading will be about 1.100, and steps should be taken to ensure that the battery is fully charged from a separate source of supply. Temperature causes a considerable variation in hydrometer readings, and it should be seen when adding fresh solution, or taking readings, that the liquid is about 60° F.

The danger of leaving batteries in a semi- or fully-discharged condition is that they will rapidly deteriorate, and, if left for any considerable period, the plates will be ruined.

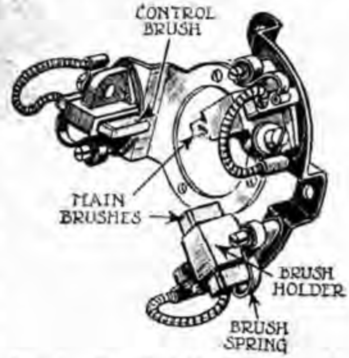


Fig. 2.—See that the three brushes slide freely in their holders.

It is also sometimes asked whether a voltmeter can be used for testing the condition of a battery. It certainly can, providing the instrument is sufficiently accurate to measure extremely small changes in voltage, but the ordinary voltmeter is usually not sufficiently sensitive to indicate the very slight difference between the fully-charged and exhausted state of the battery. In the former state the voltage is about 2.2, and in the latter 1.85, from which it will be seen, that the total difference is only .35 volt, and for a very long period the battery voltage remains practically constant at 2 volts. For everyday use, therefore, the voltmeter should not be considered as being of much use for ascertaining the condition of the battery.

Avoiding Corrosion.

Fig. 3.—Two switches and an ammeter are contained in the switchbox.

Periodically see that the battery terminals are quite tight. As far as possible the battery terminals are made of lead, or are lead-coated, as this is one of the few metals which withstands the corrosive effects of sulphuric acid. Lead cannot, however, be used for the cable pin, as a robust stem is required to pull up tightly the connection. Therefore, in order to prevent any possibility of corrosion, the battery terminals and brass pin should be well smeared with grease, preferably vaseline. To ensure this connection keeping tight, a spring washer is inserted under the nut, but, at the same time, the nuts should be occasionally tried with a spanner in case they should have become loosened slightly by vibration. As a precaution, care should be taken to see that, in tightening, the spanner does not touch the positive and negative terminals, otherwise a " short circuit " will occur, causing an excessive discharge from the battery, possibly amounting to 1,000 amperes or more, which will probably cause disintegration and buckling of the plates.

Should the brass cable pins become corroded, they should be well cleaned and smeared with vaseline. It is a good plan occasionally to remove the cables, thoroughly clean the pins and terminals, and smear them with vaseline to ensure that good clean contacts are always made between the battery and cables.

Dynamotor Attention.

After the battery, the dynamotor should occasionally be examined, and once every two months is ample if an average mileage is done. By lifting up the footboards under the front seat, the dynamotor, which is driven by an inverted toothed chain, will be found directly underneath, on the near side of the car. The chief items to be looked at are the commutator and brush gear; before these can be seen, the dust cover (fig. 1) should be removed by unscrewing the hexagon nut on the securing clip, when the cover can be removed by withdrawing it towards the rear of the car.

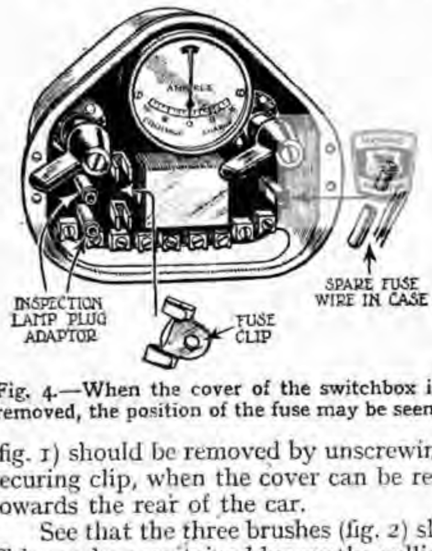


Fig. 4.—When the cover of the switchbox is removed, the position of the fuse may be seen.

See that the three brushes (fig. 2) slide freely in their holders. This can be ascertained by gently pulling up the brush by means of the flexible lead attached to it, and the brush should move without the slightest suggestion of sluggishness. The spring should be held away from the brush whilst this is being tried; on releasing the spring the brush should return to its original position. Do not, however, let the brush run down violently on to the commutator, otherwise it will be fractured, or, at any rate, the edges will be chipped and cause abrasion of the commutator.

If it is found that any oil or dirt has worked through on to the brush gear, it should be cleaned by well washing with a small paint brush dipped in petrol, but the petrol should be allowed to evaporate thoroughly before the dynamotor cover is replaced.

The brushes, when in good condition, should appear burnished on the surface adjacent to the commutator. If there are any signs of burning on the brushes it is probably due to the brush sticking in its guide, or the machine, when running, has been generating too much current, or else running with a loose connection on the battery.

Care should be taken to note, if the brushes are so worn that replacements are required, that the correct type and grade of new brushes are procured, as otherwise satisfactory results will not be obtained.

Cleaning the Commutator.

The commutator should also be inspected ; this also should appear burnished and free from any ridges or grooves. Between each commutator segment there is a slight recess which, after a time, may accumulate a certain amount of carbon dust, which should be scraped out by means of a thin saw blade or similar article. In the event of the commutator surface being rough or grooved to any extent, it is necessary to have it dismantled to be turned up in a lathe. Although the brushes are made adjustable, their position is correctly set before the machine leaves the manufacturer, and on no account should it be altered without competent advice being obtained.

The dynamotor armature runs on ball bearings, which are packed with grease before the machine is assembled ; a few drops of oil, however, may be added occasionally in the lubricators provided, and when the car is taken in for a general overhaul the opportunity should be taken of having the dynamotor bearings thoroughly cleaned and repacked with fresh lubricant. Make sure, also, before replacing the dynamotor cover, that the terminal nuts securing the two main cables are quite tight.

If the foregoing points are looked to it is practically all the attention that the electrical equipment needs, but there are one or two other interesting features of the set, a short description of which will be useful.

The first item is the switchbox (fig. 3). As previously mentioned, this contains the switches for controlling the set, and, in addition, an electro-magnetic cut-out and ammeter. The ammeter shows at a glance the amount of current being taken from, or put into, the battery, and, in addition, it gives an indication as to any trouble arising. If it is noticed that the ammeter needle is oscillating, this indicates either a loose battery connection or else that a brush is sticking. Should the ammeter needle go violently over to the full-discharge position it is certain that a "short circuit" has occurred somewhere. If this cannot be found immediately, disconnect the cables from the battery terminals to prevent damage to the battery.

The cut-out is not, as commonly believed, a device for automatically stopping the dynamotor from charging as soon as the battery is fully charged, but is simply for the purpose of opening and closing the dynamotor to battery circuit, depending upon the speed of the engine. It will be understood that the dynamotor armature must be rotated above a certain speed before it can generate sufficient electrical pressure (*i.e.*, voltage) to overcome that of the battery, and if it is connected direct to the battery under this speed, then the battery will discharge itself into the dynamotor and cause it to work as a motor. The cut-out, therefore, is so adjusted that it "cuts in" or closes the circuit as soon as the dynamotor voltage exceeds that of the battery, and opens the circuit again as soon as it drops below the battery voltage.

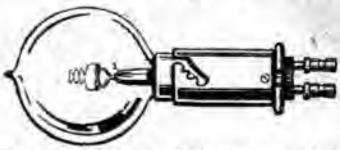


Fig. 5.—Three notches are provided in the bulb holder to allow for focussing.

It is often thought that the cut-out is the cause of any irregularities in working, but the cut-outs are accurately set before they leave the makers' works, and far more harm can be done by meddling with this instrument than if it is left alone.

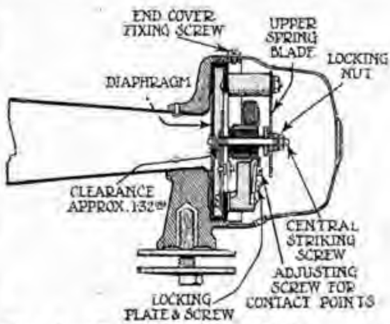


Fig. 6.—Section of the electric horn, showing the adjustments.

Should the charging cease without any apparent reason, and it is known that the electrical equipment on the car has recently been inspected and that the battery and dynamotor are in order, then it remains for the fuse in the switchbox to be examined. It will probably be found that the thin copper wire forming the fuse has "blown." To ascertain this the cover of the switchbox should be removed by unscrewing the two screws which keep the switch levers in place and the fuse examined. The position of the fuse holder will be seen on referring to fig. 4; the copper wire is held between two copper spring clips, attached to a piece of fibre, which, in turn, are held in place in two fuse posts.

If it is found on replacing the fuse, from the spare fuse carton fitted in the switchbox, that it again blows, do not put in two or three more strands to prevent this occurring, as by so doing the trouble will undoubtedly be overcome, but serious damage will be caused at some other point of the equipment. If the set does not work as intended, then have it thoroughly overhauled, as some trivial defect, if left, may cause serious damage.

While the switchbox lid is off it should be seen that the cable ends are securely fixed by the terminal screws, and also that there are no bare strands of wire which may touch adjacent terminals and thus cause erratic behaviour of the set. This may be a difficult fault to locate, as the vibration on the road may be sufficient to make an intermittent contact.

It is often wondered by the owner how long he should have his battery on " charge " ; this, of course, depends almost entirely upon the purpose to which the car is put, as, naturally, the car on a long-distance tour will work under an entirely different set of conditions to the car that is used for town work only. In the former case, probably one or two hours' charging will be sufficient for the day's run, but in the latter case the charging switch should be on the whole time, owing to the frequent use made of the starter. As a general rule, the battery should be kept on charge all the time during winter, and half the daytime running in summer, and, of course, whenever the head lights are in use the charging switch should be on.

Focussing the Head Lamp.

It must not be forgotten that the construction of a head lamp, which provides not only for the beam being projected well forward but also spread sufficiently to illuminate the surface and sides of the road, has entailed much research work and consideration of optical science. Although the lamps on the Morris car give these results, and so ensure safe night driving, it is useless to expect good illumination if the bulbs are out of focus in the first place. The best way of ascertaining whether the bulbs are correctly focussed, or not, is to take the car out at night, and, after drawing up on a straight level road, to try the bulb in each of the three notches which will be found provided in the bulb holder (fig. 5) until the best road illumination is obtained.

The bulb can be easily got at by removing the front rim. This is kept in position by means of a bayonet fixing ; to release it, press the front evenly and rotate it to the left as far as it will go, when it can be withdrawn. It may be found that the three notches do not give sufficient range with the bulb to enable the correct focus to be obtained, therefore always ascertain that the bulb is suitable for the lamp in which it is used, as it may be that the distance between the bulb filament and the bulb cap is not correct.

Care should be taken that the surface of the reflector is not scratched or finger-marked in any way, as this will reduce the amount of illumination given by the lamp. If for any reason the reflector becomes tarnished, only a good quality chamois leather and finely divided rouge should be used for repolishing. On no account use metal polishes.

The same method of focussing and removing the front applies to the side lamps.

Adjusting the Horn.

The Morris-Oxford is fitted as standard with a Lucas electric horn, which is mounted on the lid of the battery box. This horn is capable of giving a deep-toned mellow note that has great penetrating power, but it is essential that it be rigidly secured to a substantial support. It is necessary, therefore, that the battery box be screwed tightly to the running board, otherwise the quality of the note may be affected. The only adjustment that is occasionally necessary, after the horn has seen considerable service, is to regulate the distance between the striker, or hammer, and the diaphragm. By slacking off the two small screws the end cover can be removed and the whole movement is then visible.

Due to the very rapid make and break of the contact points (which, to prevent excessive "arcing," are made of a special alloy), they are in time bound to wear a little. This naturally increases the movement and thus slightly alters the tone of the horn. To take up this wear it is only necessary to slacken off the locking nut of the striker or hammer screw (fig. 6), when the screw can be turned in either direction. To reduce the movement, screw inwards, *i.e.*, towards the diaphragm, until a sharp tap with the finger upon the free end of the upper spring blade is sufficient to cause the hammer to strike the diaphragm and emit a sharp note. The correct adjustment of these contact points is about $\frac{1}{32}$in., and each time it is tested care should be taken to see that the locking nut is secure, otherwise the contact screw may slacken under the vibration it is subjected to.

CHAPTER VII.

TAKING DELIVERY.

Position of the Controls—Running In—Dimensions for a Motor House —Rules of the Road—Simple Hints on Driving.

WHEN the great day at last arrives and notification is received that the car is ready, either at the agents or at the Morris works, there are one or two things which must be remembered, though it is none too easy to remember anything in the first pride of possession of a new car.

Setting aside the necessary formalities for completing payment, the first thing to do is to make sure that the car complies exactly with the order given and that its equipment is full and complete.

The tool kit given with the Morris car is fully equal to the kit supplied even with the most expensive vehicles, and a list of the spanners is included in the booklet which is given with the car. The owner should, therefore, ask for this booklet, have the tool-box opened, and see that each spanner is in position. At the same time check the remainder of the tool kit to see that nothing is missing. Make a mental note of where everything is disposed, so that time need not be lost later on searching for some elusive tool.

It is wise to see also for oneself that the oil level in the crank case is correct, that there is water in the radiator, and that the petrol tank is full.

When the engine has been started, ascertain that the dynamo charge is indicated by the movement of the ammeter needle and that the lights are all working. Make sure also that the spare tyre is inflated, that the hood and side curtains will operate, and that everything appears to be in order, for if there is any difficulty it is much better to settle it on the spot than to take the car away and then complain.

Position of the Controls.

Allowing that all these items have been checked and found to be correct, the next thing to do is to drive the car away. The controls (fig. 1) are simple. First speed is engaged by moving the gear lever sideways towards the front passenger and then backwards; second, by moving the lever forwards, sideways towards the driver, and then forwards, taking care that a side pressure is exerted towards the driver the whole time, lest by chance one touches the reverse gear. Top gear is meshed by moving the lever straight back towards the driver. Fig. 2 shows the position of the gear lever in the various gears.

The ignition control is a long lever under the steering wheel. One should first understand fully in which direction the ignition is advanced and in which retarded. Then there are two other controls that matter, both of them rods projecting from the instrument board having knobbed heads. Of these, the left-hand rod opens the throttle more or less to control the slow-running position. Screwing up the rod in a clockwise direction

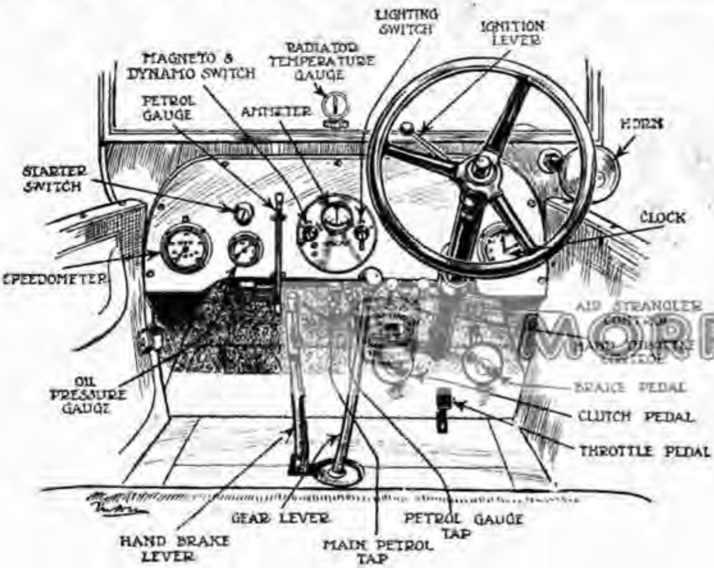


Fig. 1.—Diagram showing the controls and the various fittings on the instrument board of the 1924 model.

opens the throttle, while an anti-clockwise movement closes the throttle. The other rod cuts off all air to the carburetter when it is necessary to start the engine on a cold morning, and does its work when it is pulled out towards one. Note that one rod turns and the other slides.

Running In.

By this time the proud owner will have noticed on the windscreen in front of him a large printed notice stating that the car is not to be driven at more than 20 m.p.h. for the first 500 miles. It is essential that the driver complies with this notice, the reason being that the bearings of the engine are naturally very tight when new, while the pistons are also relatively tight in the cylinders. Only by careful running for 500 miles can the engine be brought to that state of perfection in which it is ready for anything, and the same applies to the other bearings throughout the car. Should the engine be driven too fast at first it is likely to become very hot, and the result may actually be a seizure of the pistons in the cylinders.

Accordingly, the owner should be careful that there is plenty of oil in the engine during the whole of the 500 miles, that the radiator is kept full of water, and that everything is handled carefully. The 20 m.p.h. limit on top gear should be strictly observed, but the driver must also remember that on second gear the engine should not be allowed to "rev." at high speed even if the car is going slower. Do not travel at more than 12 m.p.h. on second gear.

When once the machine is brought home, there are one or two small additions which can be made to the equipment, if the owner is anxious to have everything which makes for comfort and convenience. The standard equipment includes everything which is really necessary, but there are some useful fittings which can still be added. Of these, one is an inspection lamp with a flexible wire connection having a plug at the end suitable for a socket in the Lucas switchboard. This inspection lamp (fig. 3) is very useful, and it may be supplemented by another lamp fixed to the switchboard itself to illuminate the dials at night.

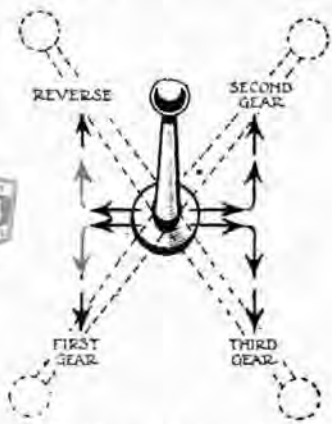


Fig. 2.—Position of the gear lever in the various gears.

Spare plugs of the same type as those used in the engine should also be bought, and spare bulbs for the lamps, which should be carried in a special case so that they will not be broken. The tool kit should be supplemented by a roll of copper wire and a similar roll of insulating tape. A good plan also is to arrange for a certain number of spare nuts of the sizes most commonly used on the car. A good funnel, not so large that it cannot be stowed conveniently on the car, is another accessory which many people like to have, and it is generally wise to have one good, large, adjustable spanner, as this may be very useful for all sorts of jobs.

Most owners like to arrange to store the tool kit and spares in accordance with their own pet ideas; thus the jack and tyre brace can be placed together so as to be readily accessible in case of a puncture, and so on.

Dimensions for a Motor House.

If it is desired to erect a motor house for the car, the dimensions to be remembered are length 14 ft., width 8 ft., and height 10 ft., which represent the minimum size of shed in which the car can be housed leaving any room at all in which to work when adjustments are necessary. Easily erected motor houses of about this size can be obtained made in sections which merely bolt together. A suitable motor house of these dimensions is now supplied with the car, if the purchaser so desires, at the price of £15 15s.

Fig. 3.—The Lucas inspection lamp has a plug which fits in a socket on the switchboard; the cable is wound neatly on to a drum by means of the wire crank.

Washing the Car.

For washing the car there is nothing better than a hose long enough to go all round it, a good chamois leather, a sponge, and a light but stiff spoke brush, all of which can be obtained from any accessory dealer or garage. Mud should never be removed when it is dry, or the varnish of the coachwork will soon be ruined. It is best to wash the car on coming in from a run when the mud is still wet, but this cannot always be done. Accordingly, the mud should be softened by the jet from the hose-pipe, plenty of water being used and as much of the mud being sluiced off as possible. The sponge should then be used to wash the remaining mud off, being held in the right hand while the left is used to manipulate the hose to pour a copious stream of water over the sponge and the surface it is wiping. Finally, the wash-leather should be employed to wipe off the water, and the result should be surfaces free from smears or spots. If tar spots are thrown on to the car they may be removed by rubbing them gently with butter to soften them, finally being wiped off with a soft, clean rag.

Keeping Accurate Records.

An accurate account should be kept of the car's mileage, the amount of petrol and oil consumed, and the distances which the tyres run, as these are extremely useful items in judging how well the machine performs its duties. Records of small repairs and replacements should also be carefully kept, for they must all be taken into account when the annual budget for running expenses is gone into. In case there should come a time when one does not want to use the car for a month or so, it is as well to provide wood blocks which may be put beneath the axles. These should be of such height that the car, when on these blocks, has its wheels in the air, since to rest the car on the same spot in the tyres for a long time is bad for the rubber. A dust sheet also should be placed over the machine in such circumstances, the water emptied from it, and the batteries taken off and either stowed in some dry spot or handed to an expert electrician for storage,

FIG. 4.—A should not overtake B on the corner, for C, though hidden round the bend, has the right of way.

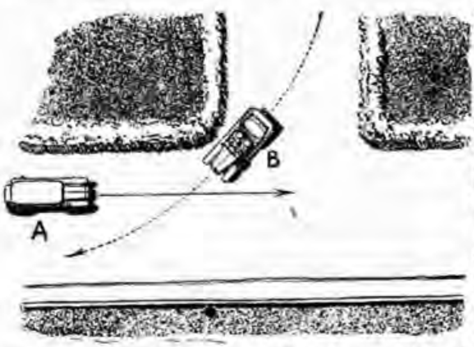


FIG. 5.—B should have kept to his own side of the by-road until the moment of crossing, and should, if necessary, give way to A.

Fig. 6.—Recognised police and drivers' signals.

great care being taken to note which wire goes on each battery terminal, as to cross them would have very serious results.

Rules of the Road.

It is most important for a man who has not handled a car before to remember some of the simpler rules which govern traffic on the highway. Of these, the chief and first is that the car must always be kept on the left-hand side of the road, and only taken on the " off " or right-hand side when it is absolutely necessary—and then only with the foreknowledge that the machine is, for the moment, on its wrong side. One may, for example, have to overtake another vehicle on a narrow road, and to do so it may be necessary to cross to the right-hand side, but on no account must one do this if another vehicle is approaching,, or if one cannot see plainly that the road ahead is quite clear. In fig. 4, for example, the driver of the car A is at fault in overtaking car B, while approaching a corner, for when he drew out to pass B he could not see that car C was approaching in the opposite direction. Quite conceivably all three cars might be involved in a collision for which A would be solely responsible.

There are several unwritten rules of the road, and of these one is that when a car is driven from a side road on to a main road the driver of that car must make doubly certain that there is nothing coming on the main road and must give ample warning of his approach. If the car is driven to the corner and the driver then sees another car approaching, he should always stop until that car has passed, and never try to cross in front of him. Moreover, he should never take a right-hand corner by first crossing over from the left-hand to the right-hand side of the road (fig. 5).

This does not imply that the driver of a car on the main road need not exercise care at side roads or crossings. At present the law does not give main road traffic priority (*see* Chapter XI.), although it is customary, and a matter of road courtesy, for side road traffic to give way to main road traffic. Drivers of cars on the main road should, however, on approaching a side road, reduce their speed and give warning of their approach

Driving and Police Signals.

It is also customary—and very helpful to other traffic—to give signals as to one's intended movements. It should be remembered, however, that to give a wrong signal is extremely likely to lead to a bad collision. The recognised signals (fig. 6) are :

(1) *You may overtake me.* Pass the right hand and arm, extended downwards, palm to the front, backwards and forwards in long sweeps.
(2) *I am turning to the left.* Extend the right arm, palm of the hand to the front, and swing it forwards.
(3) *I am stopping.* The right hand and forearm should be held up vertically, palm forward.
(4) *I am turning to the right* Extend the right arm horizontally, palm of the hand forward. The driver of a following car will then know that he may have to reduce his speed, and that he may pass on the left-hand side if the road is wide enough to permit this.
(5) *I am slowing down.* Pat the air, as it were, with the right hand, palm downwards, arm extended.

A common fault in giving these signals is to extend the right arm and hand, *i.e.*, indicating a right turn, then to turn to the left. This is likely to lead to trouble through a following car coming up on the left, and it is in any case most disconcerting to the driver behind. Sometimes also the "stop" signal is given in place of the "left turn" signal, and while this is not actually likely to lead to trouble, it is annoying to following drivers. It is quite easy to memorise these signals and to give them correctly.

It is of great importance that the signals of the police on traffic control duty should be understood. They are very simple, and are so clearly shown in fig. 6 that explanation is unnecessary. Usually the police give the signals in an unmistakable manner, but should a driver be in any doubt it is well to wait for the signal to be repeated rather than to make a move which may be other than the traffic controller intended.

Simple Hints on Driving.

When once the car has finished its 500 miles and the engine is in good condition, it will pay the driver to change from top to second speed—or from second to first—by double clutching before the car has lost all way. In no case should the gears be grated or crashed as is so often done. Gear-changing is quite a simple operation of which there is nothing to be afraid. It is simply a question of understanding one or two simple facts, and it will pay any owner to spend an hour, or even two hours, in company with some expert or in experimenting for himself until he can change gear without noise.

It is also necessary to practise reversing, although nine people out of ten do not do this. The power of handling accurately a car proceeding backwards is well worth attaining, and can only be obtained by practice. For instance, to back a car off the road into position between two other cars at the roadside is not so easy as it looks, but it is an everyday matter almost when motoring in a large town. Fig. 7 shows exactly how the car is manœuvred, and it is only necessary to remember that there are two rear mudguards, of which only one can be seen,

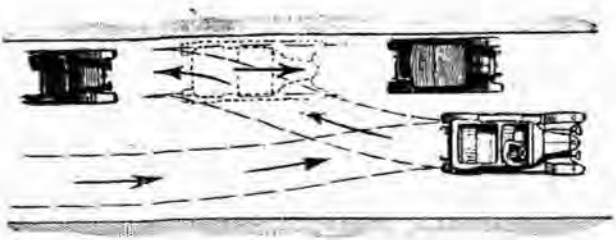


Fig. 7.—**How to reverse into position between two other cars. (Do not attempt to drive directly into the gap in a forward direction.)**

while the position of the other must be judged. Moreover, the front of the car is moving in a somewhat unusual manner, so that one must keep an occasional eye on the near side front mudguard as well. If one attempts to drive forwards into position between two cars close together it will be found impossible.

When stopping do not jerk the brakes full on, but draw up as gradually as is possible, even in an emergency, and above all things avoid sudden violent action to any part of the mechanism. Let everything be done gently and well, with precision. Finally, one should accustom oneself to an easy attitude in the car, for nothing looks worse than that type of driver who clutches the top of the wheel with both hands, sits bolt upright away from the upholstery, and assumes a facial expression of intense fright even when there is no emergency.

As regards the minor adjustments and care necessarily bestowed on the car during running, it is always well to check the oil and water levels before a journey. The tyres must be kept at the correct pressure as shown by a gauge, otherwise they will not wear well, and they should be inspected periodically for nails and sharp flints which may have become embedded in the treads.

The petrol gauge will show the driver the contents of the tank, although there is sometimes a lag which causes the gauge to show the tank half-full when it is really quite full. This lag occurs only when petrol is being poured into the tank, and the gauge soon rights itself.

The chapters explaining the mechanism of the car also give a good working knowledge of what to do when anything untoward occurs, but diagnosis of the simpler troubles is fairly easy. If the engine suddenly ceases to fire without any other symptom, it is almost certain that the ignition current has been cut off, which may be due to a short circuit on the magneto switch wire. This is very easily tested by removing the switch wire from the contact breaker and trying to start the engine again.

Similarly, if the engine splutters and will run slow but stops when the throttle is opened, or will only start with the throttle almost wide open and will not run slow, then it is probable that the carburetter is at fault and the trouble there is almost certainly dirt in the jet. This applies, of course, after the engine has become hot as it will sometimes splutter when cold in the ordinary way.

Intermittent misfiring is nearly always plug trouble, and if, after the engine has been "revving" on a low gear up a long hill, an intermittent spluttering noise is heard, the trouble again is probably plugs.

An unusual hissing noise can usually be traced to a washer on the exhaust pipe having become defective, and the spot at which the leak occurs can be traced quite easily, though if there is any difficulty over-lubricating the engine will usually show the fault by smoke issuing from the defective part

As a general rule, however, the owner will soon become accustomed to the engine and will be able to spot the trouble by lifting the bonnet and looking at the engine, where, in nine cases out of ten, something out of place will give a clue to the mystery. If, however, the car has been running well and some small adjustment is made overnight, *e.g.*, the contact breaker removed to clean the points, and if the following day faulty running sets in, it is almost certain that the cause of the trouble is whatever component the owner has touched.

A golden rule is to go round the car whenever one has a leisure moment and to make quite certain that all the nuts and bolts are tight. Very much trouble can be avoided by doing this, and very much trouble can be forestalled by careful inspection after the car has been washed to see whether play is developing at any point. In course of time, for instance, play will develop in either the front wheel bearings or stub axles. Both these troubles can be discovered in their infancy as the axle is being jacked up while one is washing the car, and, if new parts are obtained then and fitted, it will cost much less than allowing the wear to develop to its fullest extent before tackling the matter.

CHAPTER VIII.

CARE AND MAINTENANCE.

Why Attention is Necessary—Lubrication of Engine and Chassis—Timing Valves and Magneto—Transmission Adjustments.

THE running of a small car is an affair in which its owner is definitely and directly interested, as it is rarely that a paid driver can be afforded, or is, indeed, desired, while modern garages, though effective enough in most matters, are hardly, as a rule, organised to deal with the care and maintenance of individual makes of car. There is, of course, a service scheme very complete in itself in connection with Morris cars, and certain of the chief agents are supplied with the number of tools necessary to deal with their repair and upkeep, and are, moreover, instructed in their maintenance so that owner-drivers may rely on them almost as they would on the works: but it is obvious that no service system can ever deal adequately with every car, and in any case the life of a small car depends so greatly on the skill and methods of its owner that any hints and suggestions as to adjustments must be of some value. It cannot be emphasised too much that the small car needs just as much attention as its larger and more expensive rival, but whereas the large car usually is in the hands of a professional chauffeur, the small car is generally the owner's concern and his alone.

Why Attention is Needed.

It is always advisable to look over a car superficially after every 100 miles or so, because one of the chief assets in maintaining perfect running order is that all bolts, nuts and screws are tight. In spite of spring washers, split pins, and other special devices, it is surprising how many cars with loose nuts are to be found in garages and motor houses, and although to screw up a nut is an easy and simple operation within the powers of the most unmechanical, yet how often is this neglected and how often does the neglect lead directly to the renewal of larger and more expensive parts which otherwise could have been saved!

Another point is that a car will last almost indefinitely if any defects which develop—and all cars develop defects sooner or later—are tackled at once, before, in fact, they become serious, remedied for ever if possible, but at all events attended to carefully. In such things as are not defects, connections or bearings, for example, subject to wear, if the wear is discovered at once, carefully watched, and the parts renewed as soon as possible, the car will remain in the state in which it was when it left the works and was thoroughly run in. In such circumstances years of useful work can be expected from the vehicle, and though the private owner has seldom very much time to spend on the car, yet it takes so little time to follow out these suggestions that even the busiest man can afford to do so, more particularly as it is saving him money.

Engine Lubrication.

Turning now to the chassis, let us take the engine first. On the right-hand side of the engine is a breather, in the head of which is a rod; on the earlier models the rod is rigid, on the later models flexible, but in both cases it is provided with a plain end marked "$\frac{1}{4}$," "$\frac{1}{2}$," "$\frac{3}{4}$," and "full." These marks represent the level of the oil in the sump.

It is well to remember that the disc head of this rod is cut away in one place to clear the float chamber of the carburetter, and it is important to lift the rod out with the slot in the right position, instead of forcing the lid past the float chamber and thereby bending the rod, in the case of earlier models.

To ascertain the oil level the rod should first be taken out and wiped, then inserted once more, and withdrawn, thereby giving an accurate reading, with the car, of course, on level ground. Three quarts represent the amount which would bring the level up from the bottom of the rod to the top of the marked portion, but in any case the level should not be allowed to fall below the "$\frac{1}{2}$"-mark, and should be at the "$\frac{3}{4}$"-mark when the engine is run in.

Use of the Oil Gauge.

Much can be ascertained from the oil gauge on the instrument board. This gauge is connected to a tap which projects from the fore-end left-hand side of the crank case, the tap having a pipe leading to the gauge on the instrument board, and another pipe connected to the plunger oil pump delivery. The gauge will show that the pump is pumping oil, but not, of course, that oil is reaching the bearings.

In the early morning, or if it is a trifle cold, when the engine is started, and while the lubricant is thick, this gauge will easily record over 10 lb. pressure, the needle travelling even further than the markings on the gauge. This, at all events, shows that the sump is supplied with oil, as it will not show such pressure if it is not, but it does not prove that the sump is filled to its correct level. Once things have warmed up on a cold day, $1\frac{1}{2}$ lb. pressure is roughly the right figure on the gauge, and

1 lb. pressure on a warm day. In both cases it is assumed that one of the recommended oils is being used.

Renewing the Oil.

Right below the oil pump is the filter, which is withdrawn by undoing a hexagon nut below the crank case, this entailing emptying the sump in the process. Considerable importance is attached to changing the lubricant at intervals. For example, oil should be taken out of a new engine at the end of 500 miles; after more has been put in it should be removed every 1,000 miles until 5,000 miles is the distance which it has travelled, and after that every 2,000 miles.

As filling up is a process which is important, it should be remembered that an empty engine should have put into its sump three-quarters of a gallon of oil, and if the clutch housing has been emptied also, this must, in all circumstances, have about one quart to itself, introduced through the brass cap on the top of the flywheel casing. Oil works from the engine into the clutch by design, but it takes some time to do it; and to put lubricant in the engine and none in the clutch might result in the clutch burning out long before the oil could reach it.

When the valve stem chamber plate—the pressed steel plate which lies along the side of the cylinders underneath the exhaust branches—is removed, not only are the valve stems and the valve springs exposed, but also the timing wheels, and on the left-hand side near the magneto driving wheel will be noticed a copper pipe. On the side of this copper pipe is a very small hook-shaped pipe which might appear almost to have been left there accidentally; indeed, one or two people have removed it under this supposition. In actual fact, the small pipe has a definite duty, in that it allows oil to run on to the timing gears. Much damage can be caused by removing this pipe, or by allowing it to become obstructed.

Apart from the engine there are two minor components which need lubrication, though it is very easy to overlook them. One is the fan spindle, and, as there is no obvious greaser or oil cup on the spindle, this is very liable to be missed. There are, however, two hexagon-shaped screws on the fan boss, both with screwdriver slots, and one or other of these screws has to be removed, after which grease, not oil, should be packed into the fan spindle and will last a considerable time. The second item is the bearing in the front extension of the crank case which supports the starting handle. This bearing is a plain bronze bush, and with an old engine would probably receive sufficient lubricant from the crank case, but with a new engine is very liable to run dry. Solely as a result of this, the starting handle becomes extremely stiff to turn, and one or two alarmed owners have returned their cars to the works under the impression that the engine was seizing. The matter can be dealt with at once by a few drops of oil on the starting handle, but as the bush in question is well underneath the frame it is liable to be overlooked.

As regards a leakage of oil, there is a felt washer at the back of the crank case and underneath the tail bearing bracket. If the sump is taken down, the rear felt washer should be inspected and renewed if necessary—it is quite an easy operation.

A Regular Routine.

In order to ensure that no important items are overlooked, the following regular routine should be followed.

Every Day (when the car is used freely). Inspect oil level in engine. Attach grease gun to all lubricators and give plunger three or four turns. These lubricators are situated as follow: fourteen on the spring shackle bolts, two on the steering knuckle bolts, two on the steering arm bolts, two on the rear spring seats, eight on the brake camshaft bearings, one on the steering gear box, one on the universal joint housing, and one on the intermediate brake shaft. It must also be seen that the radiator is full of water. The water level should be 2in. below the bottom of the filler cap funnel, but must never allow the outlet pipe from the cylinder block to be uncovered.

Every Week. Thoroughly lubricate the steering gear.

Every Month. Remove all four wheels, clean and grease the hubs, and before replacing the wheels put a little oil on the wheel nuts and studs. Fill the hubs with grease. Clean petrol filter and petrol pipe. Check valve tappet clearance. Examine sparking plug gaps and reset.

Every Three Months. Drain sump, clutch case, gear box, and rear axle. Refill with fresh oil.

Every Six Months. Examine valves and valve seatings. Scrape off carbon deposit from pistons and cylinder head. Remove sump, and clean oil pump and filter.

Every 250 Miles. Inspect oil level in sump, clutch case, gear box, and rear axle. Refill if necessary.

Every 500 Miles. Oil magneto, three drops in each oil hole. See that wheel hub cap nuts are tight.

Adjustments.

The adjustment of the camshaft is effected by shim packings under the front end cover, and should only be undertaken with professional aid, as it is a delicate matter, owing to the fine limits of travel which are necessary. There is a tolerance of

.001in. allowable, *i.e.*, not less than .003in. nor more than .004in. end play.

There is nothing in the water circulation which should cause trouble, or that requires special attention, with the exception of the short pipe from the radiator back to the cylinder jacket. This pipe is nearly all rubber, but when detaching the radiator for any purpose the rubber connection should be left intact and the flange on the crank case side undone. It is important to remember, however, that there is a special washer between this flange and the crank case, and when the flange is replaced care must be taken to see that the washer is placed carefully in position (fig. 1).

A similar washer is behind the flange bolted to the cylinder head for the pipe from head to radiator, but this one, being in plain view, is not liable to be overlooked. Here again, however, the flange should be undone, and not the rubber hose, when removing the head to decarbonise.

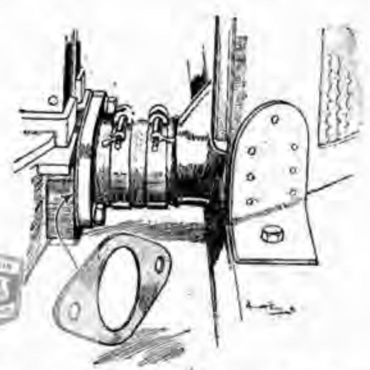


Fig. 1.—When re-making the lower water joint, after the radiator has been removed, replace the washer very carefully.

Decarbonising, being an operation which many owner-drivers will probably have to perform without skilled aid, has been made especially easy, and all one has to do is to remove the nuts round the head, take out the sparking plugs, undo the water pipe connection, and lever the head off with screwdrivers, using for the purpose the ears left on the casting by the manufacturers. The cylinder head should be taken off when the engine is warm, otherwise the gasket may stick and be damaged. The only point that needs watching is that when the gasket is to be replaced with gold size too much must not be used, or it may find its way to the valve stems and cause the valves to stick. In addition, the head nuts must be tightened evenly and carefully, the centre ones first.

If a Valve Spring Breaks.

It is highly improbable that there will ever be any trouble with valves. When the engine is new, however, the valve stems may squeak a little, and as the squeak is difficult to locate it is well to undo the valve stem chamber cover if any particular squeak that may have arisen cannot be located. It is possible to remove a broken valve spring by inserting a bent tommy bar through the plug hole to rest on the head of the valve in question, afterwards levering up the spring and removing the cotter in the ordinary way. This, however, can only be effected readily with a few of the valves, but a specially shaped bar will enable the owner to tackle the spring of any valve with comparative ease. This is not a really important point, since the breakage of valve springs of modern engines is almost unheard of, while a special tool is available to aid spring removal (fig. 2).

Adjusting the Tappets.

Tappet adjustment is a matter calling for a certain amount of care, and the method to be employed is shown in fig. 3. Each tappet has two flats machined on its head, and in the tool kit are three small single-ended spanners used for tappet adjustment. The tappet adjusting screw is a hexagon-headed one with a lock nut on it. It is first necessary to see whether the clearance between the adjusting screw and the valve stem is correct, and it should be 0.003 (3-1000ths) of an inch. For checking this the owner should supply himself with a feeler gauge of the requisite size, which can be bought at any tool shop.

Fig. 2.—A special tool makes the removal or replacement of a valve spring an easy matter.

It is also necessary to rotate the tappet head before unlocking anything, to make sure that the head is even, as contact with the valve stem causes high and low spots on the head, and, obviously, if a high spot has 0.0003in. clearance from the valve stem, to set up the head until the low spot has the right clearance might keep the valve off its seat. Having ascertained which is the high spot and discovered that the clearance is too great, it must be remembered that this increase in clearance will alter the valve timing, and that to keep the engine in good tune it is necessary to restore the tappet adjustment to the proper setting. The movement of the piston may be ascertained by inserting a thin rod through the orifice left for the purpose in the head of No. 4 cylinder and sealed by a screw plug. Using the spanners provided in the kit, hold the hexagon head which operates the valve stem and unlock the lock nut. Having unlocked the nut, use the third spanner to hold the tappet stationary by means of the two flats machined in its head, and with the second spanner undo or do up the adjusting screw until the clearance is correct. To gauge when it is correct, lock the screw by means of its lock nut and once more check the clearance, which may alter as the result of the lock nut action. This can be done with the engine hot, but, owing to the proximity of the exhaust branch, it is difficult to achieve, and it is best to set the clearance when the engine is cold.

Fig. 3.—Three small spanners are provided for tappet adjustment and are used as shown.

Valve Timing.

To check the engine timing on a cold engine, first set the tappets to 0.008in. clearance with another feeler gauge obtained for the purpose. The engine timing, *i.e.*, 0.5 mm., as read by the thin rod alluded to above should be: inlet opens 0·5 mm. down (after top dead centre) and closes 91.5 mm. down (after bottom dead centre); exhaust opens 86.5 mm. down (before bottom dead centre) and closes 2 mm. down (after top dead centre). The timing with the 0.008in. clearance has the advantage that one is more easily able to check the valve movement, as, owing to the very slow lift of the cams, it is difficult to make quite sure when ıach valve lifts with the normal clearance. When it is certain that the timing is right, reduce the tappet clearance to 0.003in. Fig. 4 shows the timing when 0.008in. clearance is given to the tappets.

Altering the timing of an engine is a matter that should be checked carefully. There is at the front end of the crankshaft a small steel gear wheel; on one of the teeth of this gear wheel is marked an 0, and on the bronze gear wheel which it drives, and which is keyed to the camshaft, is a similar mark. The two should be placed exactly together, when the timing will be as set by the manufacturers. New gear wheels should be inspected carefully to see whether they have this mark, and the mark will be found opposite to the keyway. Incidentally, on both gear wheels, steel and bronze, are stamped figures which are very important. On some, for example, there will be —25, on others −6 or +4 or +25. In ordering a new gear wheel these figures must be quoted, otherwise an incorrect gear wheel may be sent.

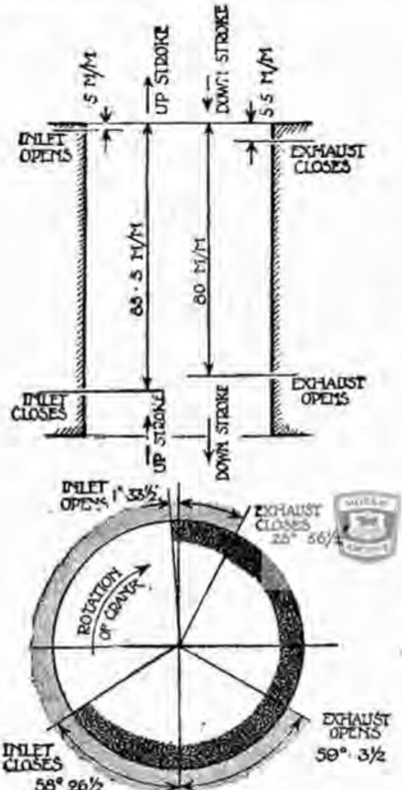


Fig. 4.—Valve timing diagram with 0.008in. tappet clearance (above), and crank position at valve openings with 0.003in. tappet clearance (below).

Magneto Timing.

Timing the magneto is a much easier operation, as the contact maker is in plain view, being driven by a cross-shaft from the camshaft gear wheel. On the drive shaft are two adjustments (fig. 5): one for fine setting; one, a vernier, for the initial setting. Of these, the fine setting is effected by moving the coupling bolts in their slots, while the initial setting is undertaken by altering the relative position of two discs which are coupled by two bolts inserted in four of many holes in the discs. On full retard the magneto should be about to break on top dead centre when using petrol, and should actually break if petrol and benzole mixtures are adopted.

The position on top dead centre can be ascertained very readily by inserting a wire through a plug hole on to the pistons, or, preferably, through the special plug hole on No. 4 cylinder, and by turning the engine slowly until top dead centre has been ascertained. The contact maker points can be inspected by removing the cover. If they are not right, the fine setting can be loosened and moved sufficiently to give the right timing, but if a grave error has been made in the timing the bolts between the flanges with holes in them are undone, and one flange is turned until the requisite position is almost attained. Then the bolts can be put back again in the nearest set of holes which offer, and the adjustment set correctly by means of the fine setting. The magneto points separate 0.5 mm.

The Carburetter.

As to the Smith carburetter, little adjustment is ever necessary. The petrol level is correctly set and should not alter. Adjustment of petrol level is carried out by sliding the collar on the float chamber needle either up or down as required, since it is not soldered in position. There is a filter in the base of the carburetter as well as the one below the petrol tank, both of which need occasional attention.

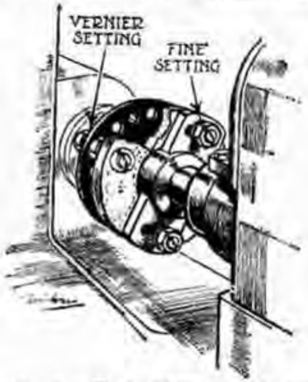


Fig. 5.—Two adjustments for the magneto timing are provided by the coupling.

The only points to be recollected as in any way concerned with the carburetter are that the petrol tank gauge glass shows no petrol when there is still a small reserve in the tank, but it is most important not to exhaust this completely, as an air lock in the filter may result and is difficult to deal with. Besides this, however, the manufacturers of the car lay great stress on the fact that, from their experience, an extra air inlet is not desirable. It is not so much that these fittings are not efficient, but that they are so often used to keep the mixture unduly weak, with the result that the engine is liable to become extremely hot.

Big-end Bearings and Pistons.

As regards the internal parts of the engine, it is well not to allow a big-end to remain slack once this fact has been discovered. It is possible to take up wear by removing one of the shims between the upper and lower halves of the bearings, and to make a satisfactory job thereby without bedding the bearings on the crankshaft. If, however, the play is allowed to continue for some time it will be necessary to refit the bearing altogether. Remember that the big-end bearings are not exactly in the centre of the connecting rods, and so the rods, if removed, must be replaced the correct way round. See also that the oil dipper scoop is the right way round, as if replaced wrongly it will not lift oil to the bearing.

Big-ends can be attended to from underneath the engine by dropping the lower half of the crank case, a simple and easy operation which also exposes the oil pump mechanism to view, and to change the oil pump spring the bracket holding the pump can be detached from its position. There is one important point, which is to remember that besides the bolts all round the sides of the crank case there are two other bolts at the nose of the engine having screwdriver slots in their heads, and so placed that they are liable to be overlooked.

Pistons vary slightly according to the date of manufacture, aluminium pistons being fitted in all 1925 cars, whereas cast iron pistons were previously used in Cowley models. Oxford models of 1924 date also have aluminium pistons, and as it is necessary that the pistons should match, emphasis is laid upon the fact that the number stamped on the piston head must be quoted when ordering new pistons, otherwise they may not be interchangeable. Piston ring gaps should be set at 0.005in., the gap being measured by a feeler of the requisite size when the ring has been inserted in the cylinder above the piston and correctly levelled up, it being necessary, of course, to put the ring at the top limit of the stroke, *i.e.*, where there is least wear. If the bore is worn, 0.005in. gap in the centre of the stroke, where there is most wear, will be insufficient.

Clutch Adjustment.

Turning now to the transmission, the clutch requires the definite quantity of oil already stated. Morris clutches, it will be remembered, are composed of a number of corks inserted in a plate. These corks can be supplied from stock, in which case they are left full size and must be ground, not cut, to an overall length of 10 mm. after being placed in position. Corks fitted as sent out are of no service whatsoever. Clutch slip is almost unheard of ; it may be said, practically, that there is no such thing as clutch slip, but in case the unexpected does happen, the only remedy is to strengthen the retaining springs by slipping a washer between the retaining spring collar and its securing cotter.

To do this and, incidentally, to remove the clutch springs, it is much better to make the tool shown in fig. 6, which is used at the works. This consists of a bar or lever, which is placed against some convenient portion of the gear box, and the upper end grasped in one hand. A tube is connected to the lever, which extends forward and passes over the bolt holding the clutch spring, until it rests on the clutch spring collar, suitable slots being made to clear the collar retaining cotter. By pressing on the lever the spring can be compressed very much like a valve spring and the pin withdrawn, after which it is an easy matter to pack up the springs. An even neater tool is the one shown in fig. 7.

It may be mentioned that clutch slip can occur through no fault of the clutch itself, but as the clutch pedal works in a slot in the floorboards it is liable to rest on the rear end of the slot. By so doing, it relieves the pressure of the clutch springs and may cause the clutch to slip, for which reason this is one of the first things that should be inspected if the clutch shows any sign of failing to transmit the drive.

On the very top of that part of the crank case which surrounds the flywheel is a gunmetal cap, which in some models is drilled, and in others is plain. If this cap has by chance been made too long, it comes so close to the flywheel that oil splashed from the wheel may come out of the holes in the cap. The remedy for this is to shorten the cap, and on occasions it is best to stop up the holes.

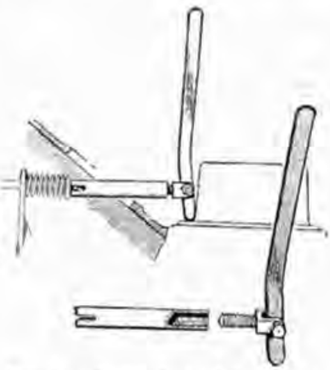


Fig. 6.—A simple tool for compressing the clutch springs to enable the cotter to be withdrawn.

On the clutch housing is a metal plate secured in position by four nuts. This plate is useful as a means for getting at the clutch springs, but it is also useful as an orifice through which it is possible to feel the chain of the dynamotor, which is driven by a sprocket from the clutchshaft. In front of the dynamotor, nearest to the flywheel, is a coverplate. When this is removed, three bolts are exposed, and if these are loosened, not undone, the dynamotor can be revolved slightly in its casing, thereby taking up the slack in the driving chain (fig. 8). When the tension has been judged carefully by a finger, the bolts should be tightened again and the coverplate replaced, the chain tension being checked once more as a final operation.

The joint between the clutch housing and the gear box is made in the works with shellac paint, and this has proved very serviceable. The clutch housing itself is a part of the gear box casting and comes away with that assembly when the gear box is dismantled, a considerable portion of the clutchshaft being in one with the gear box driving shaft. It is worth remembering that to replace the gear box two of the short studs which secure the clutch housing in position on the crank case should be removed and two specially long studs substituted, these studs being a good fit in the holes in the clutch housing flange. The two studs chosen should be those at the top, and the idea is that the clutch housing can be engaged with these two studs long before its flange touches the short studs in the crank case, and thereby the gear box is directed into the right position, while its weight is carried easily by the long studs.

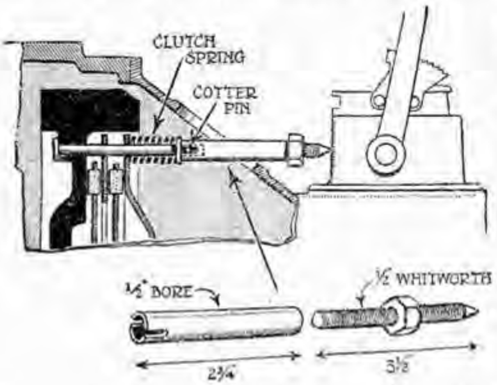


Fig. 7.—Another clutch spring compressor which is easily made.

Before the clutch housing comes home, the position of the clutchshaft can be judged, with the aid of an electric light, through the aperture between the flanges at the bottom, and the tail bearing entered correctly into the flywheel. Then the gear box can be slid forward until all the short studs are engaged, the long studs withdrawn, and short ones substituted.

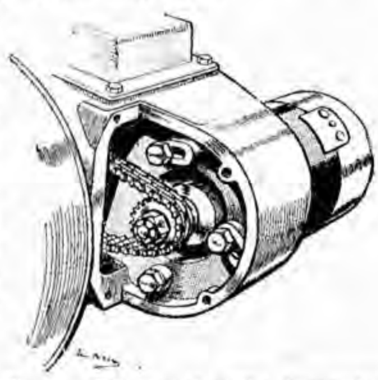


Fig. 8.—Adjustment of the dynamotor driving chain by swinging the unit on the lowest securing bolt.

Gear Box and Ball Joint.

The gear box itself offers very few problems. It should be filled with Shell gear oil or Mobiloil C to a height set by the filler, but before filling the box the filler tube should be cleared altogether of old oil. The assembly, which consists of the gear box lid, brake lever, bracket, and change-speed lever socket, comes away quite easily after four nuts have been undone, but can be withdrawn only when the lever is in neutral, in which position it must be placed when the lid is put on again.

At the back of the gear box is the spherical casing inside which is the universal joint, which is fed with lubricant from the gear box. This ball casing holds the torque ball in position by two flanges at the rear bolted together with steel shims in between, and it is important to notice that the ball joint is free when the car is new. The torque-ball may bed itself in—after a time may even become quite slack. As this slackness would cause a knock or chatter, the flanges should be unbolted, one shim removed altogether, and the flanges bolted together again, thus tightening the ball in its housing. It is very important not to get the ball too tight; the best method of judging this is to wait until the ball is bolted back again, and then to apply the hand brake, noticing that the ball moves slightly in its socket when the brake comes hard on. As an additional test, bounce the chassis on its springs from the back, which will show at once whether the ball is free in its socket or not. It is better to have it too free than too tight, provided that there is no noise when the drive is taken up. Owing to the design of the flanges adopted for securing the ball casing, the splined joint at the front end of the propeller-shaft can be entered into the universal joint quite easily, the position of the axle being located by the springs, for which reason, it need scarcely be mentioned, one should be careful to note that the shackles are at the same angle.

Final Drive Adjustment.

On the casing which forms the front cover to the rear axle pressing, and which has riveted to it the torque tube rear end, there is a small cover-plate held by two bolts. If this is undone and removed, inside the casing can be seen a casting very much resembling a cage with a series of rectangular slots in it. This (fig. 9) is the adjusting piece which will move the bevel pinion

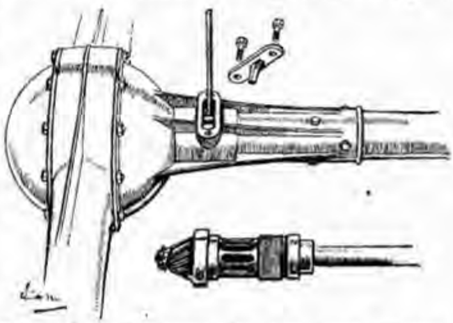


Fig. 9.—Adjustment for the bevel pinion, showing also the locking tongue on the cover plate.

further towards the rear axle or towards the gear box, and it engages it further or less with the crown bevel wheel. Turning the cage by means of the rectangular slots to the right engages the bevel further, and turning it to the left withdraws the bevel The adjusting piece is locked by means of a tongue, on the under side of the coverplate, which fits exactly into one of the rectangular slots already mentioned. It is, therefore, necessary to see that the coverplate is not put back upside down, but with the tongue inside. This adjustment is used to render the drive silent, consequently it is necessary to take the car for a run and then, by trial and error, to find the most suitable position.

This adjustment varies the depth of meshing of the teeth in a direction longitudinal to the car, and is quite separate from one which controls the mesh of the teeth transversely. To get at the latter (fig. 10), the rear pressed steel coverplate of the axle, the one having on it the oil filler, should be removed altogether. This will expose the bevel, the differential case, and the differential case bearings held by brackets inside the axle. On either side of these brackets are large nuts; one is right-hand, the other is left-hand; and by undoing one and screwing up the other the whole differential case can be moved from right to left, or left to right. From right to left withdraws the bevel pinion teeth from those of the crown wheel; from left to right engages the teeth more deeply. In the coverplate for the rear axle is a filler provided with a bronze cap, and the cap has a hole in the centre. The leakage of oil from this hole does not matter, as it is an escape orifice provided to allow an escape if the oil becomes warm and expands.

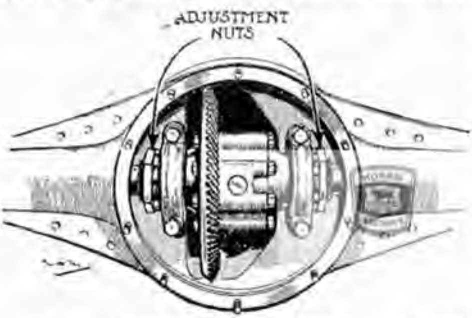


Fig. 10.—Bevel wheel adjustment is effected by two large nuts, which may be reached after the cover plate has been removed.

It is extremely important to keep the hubs well packed with lubricant at all times. The smooth hub cap on the outside should be unbolted and partly, not wholly, filled with lubricant and put back in position. If it is completely filled it will not go on. Careful attention to this point will prolong the life of the wheel bearings very greatly.

Care of the Brakes.

In regard to brakes, both, it will be remembered, consist of expanding shoes in the rear axle drums. The lining used is Don fabric, held in position by aluminium rivets. The brake adjustments consist of a right- and left-hand thread on a rod from the pedal to the brake cross-shaft in the centre of the chassis, and a similar right- and left-hand adjustment on the short rod from the end of the brake lever to this same brake actuating mechanism. It must be remembered, however, that when these adjustments are used because the pedal is touching the floorboards, or the lever is at the end of its travel, the other adjustment on the brake cam rod operating arms on the rear axle must be used also to ensure that the shoes make contact with their drums with equal pressure.

In the case of the front brakes of the 1925 Oxford, there is a turn-buckle adjustment between the brake pedal and the compensating mechanism, and another between the latter and the brake cross-shaft. The first adjusts both front and rear brakes together, and the second the rear brakes only. In addition, the front brakes each have a wing nut adjustment on the end of the operating rods close to the spring anchorage, and these are used to ensure that both the front brakes are applied with equal effect.

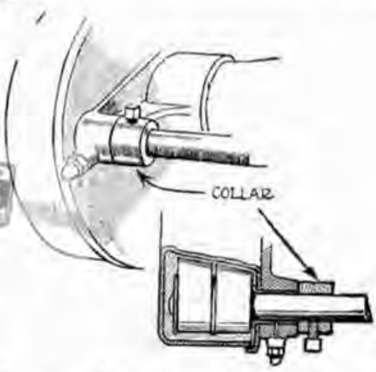


Fig. 11.—Collars on the brake cam shafts limit end play.

To carry this out the two front wheels should be jacked up clear of the ground, the jack being placed in the centre of the axle. The brake pedal should then be wedged partly down, by means of a piece of wood between it and the seat, when it will just be possible to turn the front wheels by hand. The wing nuts should then be adjusted so that each wheel offers the same resistance to rotation.

All normal adjustments for wear should, however, be made on the turn-buckles in the centre of the chassis. It is essential that all the moving joints in the front brake operating gear be kept properly lubricated and free from dirt.

It is also possible, in the course of time, for the brake cam operating rods to develop side play, and if this is so there are, close to the brake drums, small collars (fig. 11) which can be unlocked and screwed up a little more to take up all trace of side play whatsoever, this being necessary because the cam end of the rod may otherwise strike the brake drum.

In order to remove the brake drums, first remove the wheel stud nuts, and take off the hub cap and wheel, thus exposing the hub. Remove the three countersunk headed screws which hold the hub to the brake drum, and then with a wooden mallet gently tap the hub from side to side, after which it will be found easy to withdraw the hub and drive shaft together as one unit. If the hub is inclined to stick, ease it out by inserting a chisel or screwdriver between the hub flange and the face of the brake drum. Take off the large hexagon nut on the end of the axle housing, first bending back the fins of the washer under it, which are bent forward after the original assembly as a locking device. The nut on the near side of the car has a left-hand thread, and the nut on the off-side a right hand thread. Now place the special extractor over the wheel studs and put on the nuts. Hold the tommy head against the end of the axle housing and screw up the centre bolt until the drum is drawn off (fig. 12).

Fig. 12.—How to employ the hub extractor.

Steering Adjustment.

The bracket carrying the steering gear box is held to the crank case by a flange and bolts. The holes for these bolts pass through the crank case and are, therefore, liable to collect engine oil, which works up the bolt threads and allows the bolts sometimes to slack back a little. All three, therefore, should be tightened at intervals.

Another point is that at the very top of the steering column there is a cycle-type ball bearing and cups, the balls being visible. If the steering column is dismantled these balls must be carefully collected and stored away before the inner steering column is withdrawn, otherwise it is only too easy to allow the balls to fall inside the steering column proper, where sooner or later they may jam the steering. Similarly they should not be put back except in thick vaseline and when the inner column is in position.

As there is a complete worm wheel, a certain amount of adjustment may be made for wear by turning the worm wheel until another part of it is brought into use. The steering arm is secured to its shaft by a square and a pinch bolt, and it is necessary to set the steering arm in the proper position relative to the frame when this adjustment is made. The steering tube from the steering arm to the front axle arm is held by ball joints between cups backed by springs. The cups can be renewed when too much wear takes place, but it is most essential to lubricate these joints frequently.

As to the tie-rod, jaw joints with pins and bushes are used, the bushes being renewable and the pins requiring lubrication; but it should be remembered that on a new car the front wheels are deliberately set one-eighth to a quarter of an inch inwards. In other words, they converge towards each other by that amount. Because of this, the wheels gradually become parallel as the steering gear finds itself. It is a better plan than setting the wheels parallel when the car is new and relying upon the owner to effect the necessary adjustment, although this can be done by unlocking the tie-rod from its two jaw joints and turning the rod, as there is a right-hand thread on one side and a left-hand thread on the other, with the result that turning the rod in one direction makes the wheels converge in front, and in the other to converge at the rear. This adjustment should only be used when it is quite certain that the wheels are out of track, and then only with the aid of careful checking measurements.

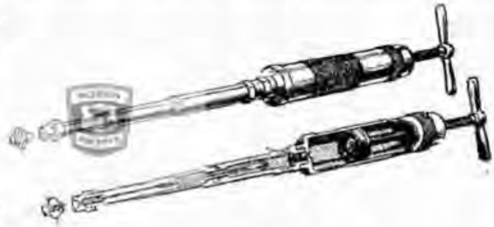


Fig. 13.—The latest type of Enots oil gun, which has a plunger action.

Stub axles, or axle swivels, as they are sometimes called, always require attention on any car, but very frequently are neglected. It is well to supply oil to them by means of the oil gun (fig. 13) as often as possible, as this greatly prolongs the life of the bronze bush which is inside the axle end and holds a hardened pin securing the stub axle.

Little now remains to consider except the exterior fittings and other accessories. The exhaust pipe and silencer are easy to deal with, as the exhaust branch, as well as the pipe, is held in position by bronze nuts, which do not tend, therefore, to seize, and the best way of dealing with the silencer when it is full of carbon is to direct the flames of a powerful blow lamp into its interior, since the silencer itself cannot be taken to pieces for cleaning.

Equipment Details.

The ammeter on the dashboard should show that the charge commences at 15 m.p.h.; at 30 m.p.h. should show 10 amps., but should not stand above 12 amps., although on starting up a full reading up to 16 amps. is often indicated, which will, however, drop as the generator warms up.

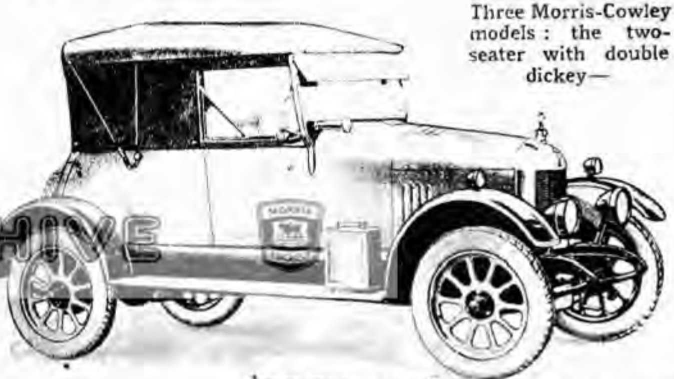
The battery, of course, should be looked over at frequent intervals to see that the level of liquid has not fallen too low.

There are two types of dynamo chains, one a Brampton, the other a Renolds, the sprockets for which are not interchangeable. In ordering these, as in ordering every single part, it is absolutely necessary to send the chassis number of the car.

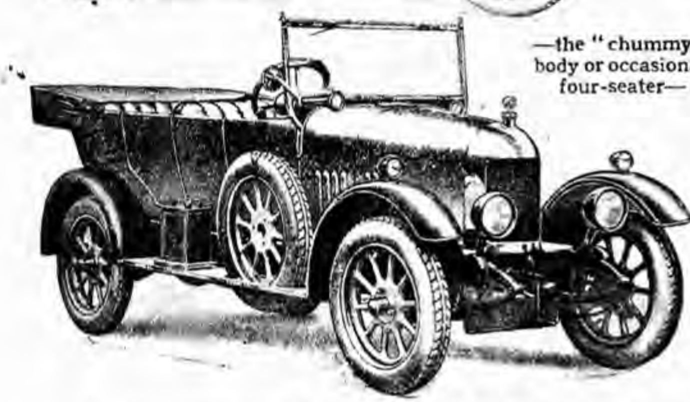
This, by the way, holds good whenever ordering spare parts, more especially in an emergency. The manufacturers cannot possibly guess what type is indicated unless identification is supplied, and, moreover, it is very unwise to order a part by name unless that part has been identified and called by the name correctly given to it in the price list of parts supplied by the manufacturers. On each part is a number as well as name, those of the engine and gear box unit being preceded by the letters CA or CB. The number is plainly shown in the diagrams, and if the part is ordered by these numbers, and the car chassis number, the right component will be sent, otherwise it would be impossible to guess what is meant, since some car parts are known by different names in various parts of the country. Each individual part has a number, so it is important to quote numbers for all the parts wanted. The chassis number is stamped on a brass identification plate fixed on the forward side of the dashboard and on the near side of the car under the bonnet. On the same brass plate is the engine number, which also is stamped on an additional brass plate riveted to the valve chamber coverplate.

The threads used on the Morris cars are mostly metric, a few, however, are Whitworth, and a few others of different threads. It is, therefore, best to obtain a supply of spare bolts and nuts from a recognised Morris agent, since metric nuts are not available at some garages, and Whitworth nuts will not do

Three Morris-Cowley models: the two-seater with double dickey—



—the "chummy" body or occasional four-seater—



—and the four-seater open tourer. Sloping two-panel windscreens and all-weather equipment are standardised.

CHAPTER IX.

COST OF RUNNING.

Effects of Careful Driving—Typical Annual Budgets—How Running Costs may be kept Down.

"HOW much will my car cost me to run?" This is undoubtedly an important question, which should receive due consideration before the car is actually bought. Nevertheless, it still remains important when the car is in commission, for the careful driver will find that his annual budget is considerably less than that of a driver who fails to treat his car well or to give it that attention which every car, however costly, must receive.

For example, the driver who habitually lets in his clutch with a jerk, and accelerates violently, later using his brakes just as violently when it is necessary to slow up, will materially shorten the life of his tyres. Also, his rough methods will cause undue wear and shock in the engine and transmission—indeed, in the whole chassis—so that the bill for repairing and overhauling in due course will be larger than it would otherwise have been. Similarly, the owner who neglects the simple instructions regarding the lubrication of the different components has only himself to blame when considerable wear or an actual breakage occurs.

Running Costs and Standing Charges.

Some idea of the upkeep expenditure involved in normal circumstances may, however, be gained from the following table of costs regarding a 1925 model four-seater Morris-Cowley which has been supplied by the manufacturers of the car.

RUNNING COSTS FOR 12,000 MILES PER ANNUM.

Actual Running Cost.	£	s.	d.
Petrol, 32 m.p.g., 375 gall.	28	18	1½
Oil, 1,000 m.p.g., 12 gall.	3	0	0
Tyres, set of 4 (27×4.40in.)	12	9	0
Tyre tube, 1	0	11	9
Total..	£44	18	10½

Actual running cost per mile, .898d.

Standing Charges.

	£	s.	d.
Interest on capital	9	15	0
Taxation	12	0	0
Depreciation	53	12	6
Repairs and overhaul	30	0	0
Total..	£105	7	6

Standing charge per mile, 2.107d.
Total running cost per mile, 3.005d.

These figures are based on the following prices and allowances for repairs and depreciation.

	£	s.	d.
Petrol, per gallon	0	1	6½
Oil (in barrels), per gallon..	0	5	0
Tyres, each	3	2	3
Repairs and overhaul, first 5,000 miles ..	10	0	0
,, ,, second 5,000 miles	20	0	0
Depreciation, first 5,000 miles, 15% ..	29	5	0
,, second 5,000 miles, 12½% ..	[illegible]	7	[illegible]

It will be seen from the foregoing table that the actual running cost—*i.e.*, fuel, oil, and tyres—is less than 1d. per mile on an annual mileage of 12,000. The items under the heading "Standing Charges" must, however, be taken into account when the total expenditure is being considered, and these amount to just over 2d. per mile, so that the total cost works out at just over 3d. per mile.

It will be noticed that no mention is made in the above table of one very important item, *i.e.*, garaging. If the owner is fortunate enough to have his own private motor house, this item can, of course, be omitted, but if he is obliged to house the car elsewhere it will, at a conservative estimate, cost him five shillings per week. In certain large cities this figure may, indeed, be more than doubled. Accepting the figure of five shillings per week, however, a simple calculation will show that this involves an addition to the standing charges cost of approximately ¼d. per mile. Insurance is also not included, as the car is already covered for the first year; it should, however, be taken into account in subsequent years. At £12 per annum this involves an increase of approximately ¼d. per mile to the standing charges.

rom an Owner-driver's Log.

It might be thought that the manufacturers would err on the low side in estimating the running cost, but that if anything their figures are on the high side is shown by the following table, compiled from an owner-driver's log book.

RUNNING COSTS FOR 13,457·5 MILES PER ANNUM.

	£	s.	d.
Actual Running Costs.			
Petrol (30.17 m.p.g.), 446 gall.	34	7	7
Oil (566 m.p.g.), 23¾ gall.	7	6	6
Tyres (2)	6	4	6
Tube (1)	0	11	9
Total	£48	10	4

Actual running cost per mile, .843d.

	£	s.	d.
Standing Charges.			
Interest on capital	9	15	0
Taxation	12	0	0
Depreciation	53	12	6
Repairs and renewals	12	12	4
Garage rent	12	10	0
Washing	46	1	3
Total	£146	11	1

Standing charge per mile, 2.613d.
Total running cost per mile, 3.456d.

It will be seen that in this case the annual mileage was 13,457·5, so that the fuel and oil bills are naturally higher. Certain of the standing charges, such as interest on capital, depreciation, and taxation, have been added, as they were not originally taken into account, the appropriate figures from the first table being accepted. On the other hand, the cost of renewals and repairs is considerably less than is estimated by the manufacturers, amounting to but £12 12s. 4d., which sum also includes oiling, greasing, and decarbonising, in place of £30 allowed in the first table. The second table does, however, include an allowance of £12 10s. for garage rent, the owner in this particular case being fortunate enough to secure accommodation for his car at five shillings per week.

Another large item which is not included in the first table is car washing. In this case the car was washed daily, and the annual figure of just over £46 is involved, which is equivalent to a cost of .82d. per mile. In order that this table may be compared with the first table, this allowance of .82d. per mile should be subtracted from the total running cost per mile, giving a figure of between 2½d. and 2¾d. per mile, as compared with 3¼d. per mile as given by the first table.

Where Economies can be Effected.

There are one or two interesting points raised by comparing the two tables. Regarding fuel consumption the manufacturers' estimate of 32 m.p.g. agrees very fairly with the actual figure of 30.17 m.p.g. obtained by the owner-driver, but in this case the car was running mostly over bye-roads, and, had a greater distance been covered on good main roads, this figure would undoubtedly have more nearly approached the estimated consumption of 32 m.p.g.

Again, it will be observed that the owner-driver's car only averaged 566 miles per gallon of oil, whereas the estimated 1,000 m.p.g. is by no means unduly high. The oil used, moreover, was not apparently purchased in bulk, for it cost 6s. 3d. per gallon as against 5s. per gallon allowed in the first table.

These two points are an indication of how running costs may be kept down, for if the fuel consumption is carefully checked any wastage will soon be detected, as will any undue increase of consumption due, for example, to brakes so adjusted that they rub slightly on their drums. Oil, too, can be purchased in bulk much more cheaply than in 1- or 2-gallon tins, and the 5- or 10-gallon drums show a considerable saving over a year's running of some thousands of miles.

It may appear a trifling matter that a little petrol or oil should be spilled on the floor when replenishments are being made, but bear in mind the fact that in 12,000 miles' running close on 400 gallons of petrol and 12 gallons of oil are used, and it may then be realised that many small wastages represent a loss of some pounds sterling in the course of a few months.

Naturally, on a smaller annual mileage the pence per mile figure will appear rather larger, for most of the standing charges will be unaffected; in fact, only the allowances for repairs and overhauls, and depreciation, will be lower. An annual mileage of 12,000, however, is by no means uncommon for those motorists who use their cars for business purposes as well as for pleasure, but for those who limit their motoring to pleasure runs at the week-ends, in the evenings, or a holiday tour, the annual mileage is not likely to exceed about 6,000.

Cost per Passenger per Mile.

While the figure for the bare running cost of approximately 1d. per mile is very attractive, some would-be motorists are discouraged when they take into account the standing charge cost per mile which so swells the total running cost figure. It should be borne in mind, however, that there is another aspect of the case, for both the tables refer to four-seater cars, and if a full complement of passengers be carried the cost per mile figures should be divided by four, so that the cost per passenger per mile may be considered. Thus a budget which gives a total running cost of 4d. per mile for a four-seater car gives a figure of 1d. per passenger per mile, which is considerably lower than third-class railway fare. When, therefore, the car is used fully loaded in place of making a journey by train, a considerable saving in railway fares may be effected and should be taken into account.

There are also other considerations, greatly in favour of the car, upon which it is difficult to place any actual monetary value. A car, for example, takes one from door to door, in other words it eliminates the necessity of going to the railway station to make one's journey and, at the other end, going from the station to one's actual destination; this, incidentally, may involve a further saving in the matter of cab fares. Apart from this, however, the car is ready for a journey at any time and one may travel at one's convenience, irrespective of time-tables. For the business man this saving of time is often the decisive factor when he is considering the purchase of a car, for on a cross-country journey the car generally proves very much quicker than the train, as it eliminates the time wasted in waiting for connections at junctions. On a main line journey between two important centres it must, of course, be conceded that the train is much faster.

It hardly needs to be mentioned that in these days of all-weather coachwork the car is at all times a much more comfortable means of conveyance than a crowded railway carriage. A motorist who uses his car principally for getting out into the countryside in search of fresh air has already realised this, of course, but those who buy their vehicles for strictly utilitarian purposes are also not long in perceiving this point of view.

Although these advantages cannot be summed up in terms of pence per mile, they should be taken into account when the intending motorist is considering the purchase of his first car.

CHAPTER X

THE ONE-TON MORRIS.

Details of the Popular Commercial Vehicle.

EARLY in 1924 there was introduced a Morris one-ton commercial vehicle (fig. 1), and, as it is in essentials of the same design as the touring cars, it is fitting that it should be dealt with in detail, since the care and attention it requires are similar to that which must be given to touring cars.

The adoption of the 75×102 mm. four-cylinder power unit of the Morris-Oxford car for use in the one-tonner has two important advantages. In the first place it eliminates the element of uncertainty that might have arisen if an entirely new design had been adopted for what is undoubtedly the most important component. The Morris engine, clutch and gear box form a unit which has a reputation for sturdiness, reliability and efficiency; at the peak of its power curve it shows approximately 30 b.h.p., thus developing, despite comparatively modest cubic capacity, more power than many of the imported chassis. The second advantage of adopting this unit is that all the benefits of high-grade quantity production and the widespread Morris "service" facilities are immediately available to users.

As in the power unit, the remaining parts of the chassis are notable for their simplicity of design without lack of other desirable features. No attempt has been made to utilise the components of the Morris cars that entail lighter torque, load and braking stresses. Front axle, steering, frame, springs, back axle, final drive and wheels, are all designed specially for the heavier work, and in each case a high factor of safety has been adopted.

The Front Axle and Steering.

Dealing first with these units, the front axle (fig. 2) is of H section with jaw ends and heavy stub axles pivoting in long phosphor-bronze bushes and provided with ball-bearing thrusts. Large ball-bearings are used for the wheels, and here special provision is made to exclude water and dirt and to prevent leakage of the lubricant. Each hub cap is of pressed steel and forms the outer nave plate of the detachable wheel, being held in place by the usual series of capped nuts.

The steering cross rod, behind the axle, is a stiff tubular detail with adjustable fork ends. Its coupling pins, where they

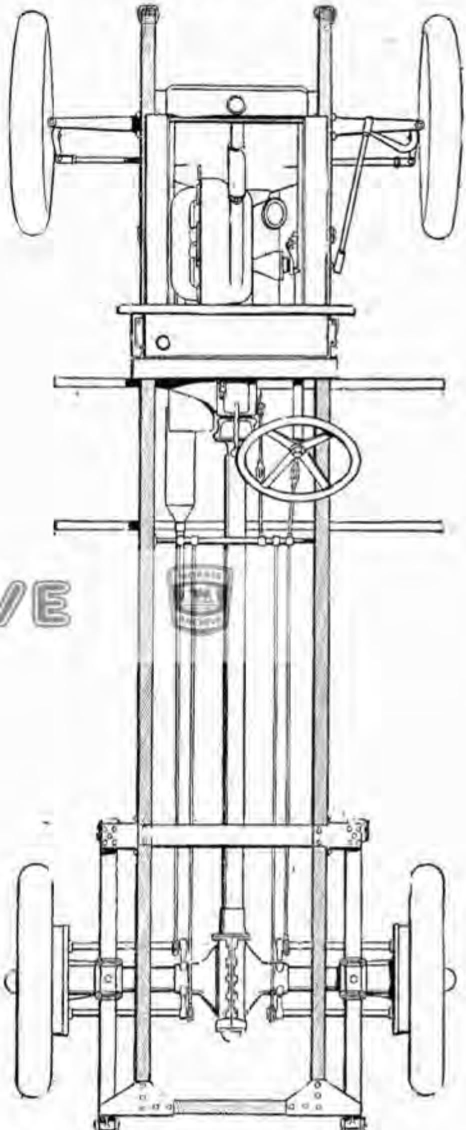


Fig. 1.—Plan view of the Morris one-ton commercial vehicle chassis.

pass through the stub axle levers, are in bronze bushes an inch in length, and so an unusually generous bearing surface is afforded at these important points. Each end of the drag link is connected by a spring loaded and adjustable ball joint, the balls themselves separate from the levers, and therefore renewable. Of the worm and complete worm wheel type with four "lives," the steering gear is mounted on the side of the crank case, with a second support for the column in the form of a bracket secured to the bearer arm of the engine. The worm is also separate and renewable, with hardened steel thrust washers and adjustment for taking up axial wear.

Transmission Particulars.

Turning now to the transmission: from an enclosed star type of universal joint behind the three-speed gear box, the

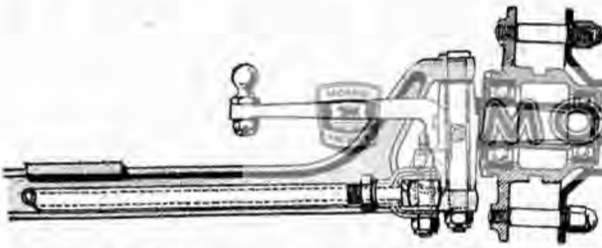


Fig. 2.—Designed especially for the heavier load, the front axle of the commercial vehicle is of stout construction.

propeller-shaft runs in a torque tube to a sleeve coupling with the overhead worm shaft. Worm wheel and differential—the latter of the four-star bevel gear pattern—are supported by combined load and thrust ball bearings, with a special form of oil-retaining gland at each side. The worm gearing, differential case, bevel pinions, and bearings are all rigidly housed and of dimensions rendering them well above their work, while the axle driving shafts, castellated at each end, are of $1\frac{5}{8}$in. diameter at their smallest section. The standard worm gear ratio is 7 to 1, but an optional ratio of approximately $5\frac{1}{2}$ to 1 is available if required.

The axle casing consists of cast-steel halves at the centre, divided vertically, with weldless steel tube extensions of $3\frac{1}{2}$in. diameter for the greater part of their length (fig. 3). The outer ends of these axle tubes are drawn down to a diameter of $2\frac{3}{8}$in.

and carry double-row ball bearings for the wheel hubs, the latter also being supported on the castellated ends of the axle shafts; thus the axle is of the three-quarter floating type.

Brakes, Wheels, and Springs.

Both sets of brakes take effect within drums attached to the rear hubs; the drums are of 15in. diameter with the two sets of shoes lying side by side, and having facings of fabric 1½in. wide. The shoes and the camshafts at their outer ends are carried by a cast-steel bracket which is a force fit on the axle casing and is held in position by rivets, while the brakes as a whole are enclosed by steel plates attached to these brackets. Each

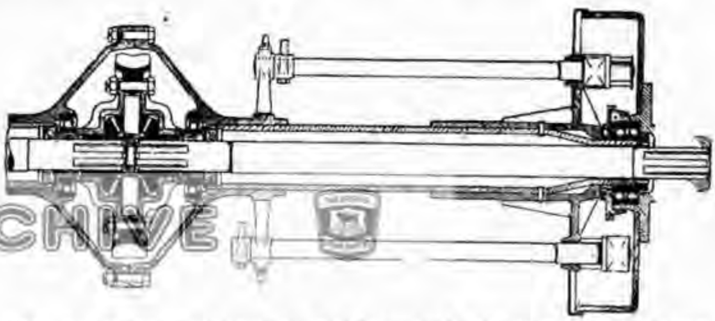


Fig. 3.—Section of the 1-ton vehicle's rear axle, showing worm drive and differential, brake drums and camshafts, and construction of the axle casing.

camshaft has a second bearing, widely spaced from the outer one, in a bracket integral with the centre casing. The brake linkage is compensated and has left- and right-hand threaded turn-buckles for adjustment.

The wheels may be of either the pressed steel hollow spoke or the disc pattern, detachable and interchangeable, and fitted with 34×4½in. cord pneumatic tyres. Front and rear springs are of the semi-elliptic variety, almost flat when normally loaded; those at the front are 2in. wide, while the rear ones measure 2½in. in width.

Some Unusual Frame Details.

Absolutely straight in plan from end to end, the side members of the frame are of pressed steel 2in. wide, 3/16in. thick, and 5in. deep, dimensions which obviously afford a high standard of rigidity and strength. There are three cross members, all of pressed steel; two are respectively at front and rear ends, while the third, in transverse alignment with the front ends of the back springs, is arched at its centre to give clearance for the torque tube. Pressed steel extensions in line with the two rearmost cross members form the rear spring brackets, and, in the case of those at the end of the frame, serve also as gusset plates to provide increased rigidity. To these extensions are riveted small steel stampings to which the spring shackles are pivoted. The need for a second frame cross member in front is eliminated by the mounting of the power unit, the four bearer arms of which serve to brace the side members thereabouts.

As is but natural, the radiator differs appreciably from Morris car practice. Flat-fronted, its aluminium top and bottom tanks and sides are supported by the front cross member of the frame with rubber pads intervening.

A pressed steel construction constitutes the dashboard and its latticed side supports, and to the dash the fuel tank is attached so as to afford a very considerable "head" above the carburetter for gravity feed, while projecting at a convenient angle from the tank base is a pressed steel instrument board.

Controls.

Pedal controls—throttle, clutch and brake—are normal in arrangement, the throttle-setting and ignition levers projecting conveniently from the instrument board. The latter also carries an oil-pressure gauge, ignition switch, and the switchboard of the electric lighting equipment, which, with a set of three lamps and a dynamo for charging the battery (the latter carried on the off-side running board), is standard equipment. An electric starter is offered as an optional extra, provision for its drive being available in the design.

For the lubrication of the chassis details, where grease is required periodically, the Enots grease-gun system has been adopted, and there is no parsimony in the provision of the nipples which displace the usual grease cups.

Sturdy and Orthodox.

The sturdiness and efficiency of the Morris power unit have already been mentioned, but its suitability for industrial motors may be emphasised, especially when carried on pneumatic tyres.

As for the chassis, it will have been realised that there is nothing unorthodox or experimental about it. A straightforward job, with the maker's experience concentrated upon securing the utmost simplicity in upkeep, it shows a keen knowledge of the requirements of transport motor users. Durability should be a marked feature, for no attempt has been made to secure a reduction of weight by sacrificing strength ; and yet on account of the simplicity of the design the weight of the chassis comes out at no more than about 18 cwt.

In an open lorry the loading space is 8ft. × 5ft. 6in., and in a van 7ft. 6in. × 4ft. 8in., though obviously these dimensions can be varied to suit the requirements of users.

Fig. 4.—The Morris one-ton truck.

Various types of bodies are available on the one-ton chassis, including the ordinary lorry (fig. 4), a tipping lorry, a van, a de luxe model van, a motor coach, an ambulance, and three types of 14-seater saloons. With regard to fuel consumption, this should be in the neighbourhood of 24 m.p.g. with a full load.

CHAPTER XI.

THE LAW AND THE CAR.

Legal Requirements—Licences—Speed Limits—Insurance.

By the R.A.C. Legal Department.

IN considering the question of how the law affects a car, the first subject for enquiry should be as to whether the car itself complies with the legal requirements as to its construction. Manufacturers are, of course, fully conversant with these requirements, and a purchaser may therefore reasonably assume that the car is properly constructed according to law.

Driving Licence.

The person who is to drive the car must first obtain a driving licence from the Council of the County or County Borough in which he lives. This is done by filling up the requisite form, which can be obtained at the offices of the Council, and the licence is issued as a matter of course upon payment of a fee of 5s. Any person who is over 17 years of age may obtain a licence to drive a car, and a person over 14, but not over 17 years of age, may obtain a licence to drive a motor cycle only. The licence is for a period of one year, and must be renewed annually at the expiration of 12 months from the date of issue. The Council is bound to renew a licence unless the person holding it has, by an Order of a Court, been deprived of the right of holding a driving licence.

Where a driving licence has been endorsed with particulars of convictions, these particulars are automatically carried on to renewals of the licence until a period of three years has elapsed during which there has been no endorsement. At the expiration of this period of three years the holder of a licence can obtain a new licence free from endorsements upon payment of a fee of 5s., even if the licence then in force has not expired.

Registration.

Before a car can be used on the road it must be licensed and registered with the Council of the County or County Borough in which it is usually kept. Registration takes place automatically upon payment of the licence duty, and a registration book is issued to the owner, which contains the registration number of the car. This number must then be placed on the car, one at the back and one at the front, on separate plates of the required size, with letters and figures of the prescribed dimensions. The licence itself must also be displayed on the car in a water-tight holder in conformity with the regulations.

Speed Limits.

When all the above matters have been seen to, the car may be driven on the highway, and this brings us to the question of what the requirements of the law are as to the manner in which the car may be driven. The law is applicable to any road to which the public have access, whether such road be a public highway or not, but, of course, it does not apply when a car is being driven in private grounds to which the public do not have access. As the law stands to-day, the maximum speed permitted is 20 miles per hour. This limit is enforced in various parts of the country by the Police, and it is very desirable that people driving cars should not overlook the fact that the speed limit has not yet been removed. Special observation should be kept for villages and other places where there is a reduced speed limit of 10 miles an hour. These reduced speed limits are shown by the erection of appropriate signs, and in some places the lamp posts have a red band painted round them.

Although the law permits a maximum speed of 20 miles per hour, it also provides that under no circumstances shall a car be driven at a speed or in a manner dangerous to the public, and there is a duty on the driver not only to so regulate his speed in all circumstances as to be able to avoid actual danger, but also to be prepared for contingencies which might involve danger to the public, of whom, of course, the driver and occupants of the car form part. For instance, if a person drives on a wet road at a speed which would prevent his pulling up in an emergency without skidding, he might reasonably be held by a Court to be driving at a speed dangerous to the public.

At Cross Roads.

At present there is nothing in English law which gives main road traffic priority over side road traffic, and, therefore, even when driving along a main road there is an obligation on the driver to so reduce his speed at side roads and cross roads as to be able to avoid any possibility of an accident. It is not sufficient merely to blow one's horn at a side road. Traffic is entitled to come out of a side road on to the main road just as much as traffic is entitled to travel along a main road, and if the traffic wishing to come out of the side road arrives at the junction before the traffic proceeding along the main road, it is entitled to come out, and the main road traffic should be so controlled as to be able if necessary to stop, and allow the side road traffic to come out. A large number of drivers on the road to-day seem to imagine that all they need do on arriving at a side road is to blow the horn, and it is therefore as well that the law should be very clearly stated on this point.

In the streets of London and other large cities and towns where the traffic is regulated by Police on point duty, proceedings are usually taken against the drivers of cars who fail to observe and obey the signals given by the Police. Great care should be exercised, as the Courts hold that the obligation is on the driver to look for the signals of the Police, and to make quite sure what the signal is intended to be before proceeding. Great care should also be exercised when driving through towns to keep on the proper side of street refuges. Where a driver goes to the wrong side he is usually prosecuted and convicted as a matter of course for dangerous driving, even although the off side of the road may be perfectly clear at the time of his doing so.

Insurance.

A prudent motorist will, of course, insure his car against damage to it, and against all risks arising out of the use or ownership of it, and the question of civil liability in the case of accidents in such cases is dealt with by the Company with whom the motorist is insured, but it may not be out of place to state the broad principles upon which the question of liability is decided by the Courts. In order to succeed in a claim it is necessary for a Plaintiff to prove that the damage sustained by him arises solely from the negligence of the Defendant. If the Defendant can prove that the accident was partly due to contributory negligence on the part of the Plaintiff, the Plaintiff will not succeed, even although the Defendant has been negligent.

It should be borne in mind, however, that in criminal cases as distinct from civil cases, for example, where a motorist is prosecuted by the Police for driving negligently, it is no defence for him to prove that there was contributory negligence on the part of any other person involved in the accident if the Court is satisfied that the Defendant himself was negligent.

In civil cases the question of what constitutes negligence is one to be determined by a jury in most cases on the facts of each particular case, that is to say, it is a question of fact and not a question of law, and therefore there are no cases which have been decided in the Courts which can strictly be said to have any bearing on the findings of a jury on this question of fact in any subsequent cases which may be before the Courts. The owner of a car is liable not only for his own negligence but for the negligence of his servants or agents whilst acting in the scope of their employment, and he is liable to pay damages to the passengers in his own car in the same way as he is liable to pay damages to any other person.

Obstruction.

Motorists should remember that the highway exists for the free passage of all forms of traffic both pedestrian and vehicular. A pedestrian has as much right to walk along the roadway as a motorist has to drive his car along it, even although footpaths are provided for the use of pedestrians only. Furthermore, if a motorist in any way impedes the free passage of traffic along the highway, he can be prosecuted for obstruction. A very large number of cases have recently been heard in the Police Courts of the Metropolis against persons who have left their cars unattended in the streets. In such cases the Magistrates invariably convict because they take the view that in the busy streets of the Metropolis a car left unattended must as a matter of course impede or divert from their course other vehicles. Certain places have now been set aside by the Commissioner of Police where cars may be parked, and any person driving a car who wishes to do any shopping or to leave his car for any other reason unattended in the street, should enquire of a police officer where the nearest parking place is for him to leave his car if he wishes to avoid being summoned for obstruction.

It is, of course, impossible in the scope of this chapter to deal with all the technical regulations which apply to the use of motor cars, but there is one point to which attention may perhaps be usefully directed, and that is the position of number plates. Where number plates are placed low down, for instance, on the front axle, it is impossible to prevent their being covered in mud on a wet day. There is a statutory defence to a charge of using a car without the identification mark being easily distinguishable, whereby it is open to a defendant to prove that he has taken all steps reasonably practicable to prevent the mark being obscured, and it is very often argued by a defendant that on wet days it is impossible to prevent the marks getting dirty, and therefore that he has taken all reasonable steps to keep them clean, but the Courts have held that where a mark is fixed in such a place that it is likely to become obscured on a wet day a motorist has not taken all steps reasonably practicable to prevent its being obscured, and a conviction invariably follows.

Hire-purchase.

Of recent years many cars have been purchased on the hire-purchase system; in some cases cars so acquired are registered only in the name of the purchaser, and there is nothing in the registration book to indicate the fact that the car is bought on the hire-purchase system. Where such a car is sold and the instalments are not kept up by the original purchaser, the new owner does not acquire a good title to the car as against the original vendor, and the original vendor can recover the car from the new owner, whose only remedy is against the person from whom he purchased it. It is, therefore, very desirable that anybody purchasing a second-hand car should satisfy himself that the person from whom he is buying it is the real owner, and the receipt for the purchase price should in all cases be demanded and its history traced back to the original vendor

Morris-Oxford four-door six-light saloon. Brakes on all four wheels, and low pressure tyres are standardised.

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TO THE MORRIS CAR HANDBOOK.