20 H.P. TYPE E.

Arrol-Johnston

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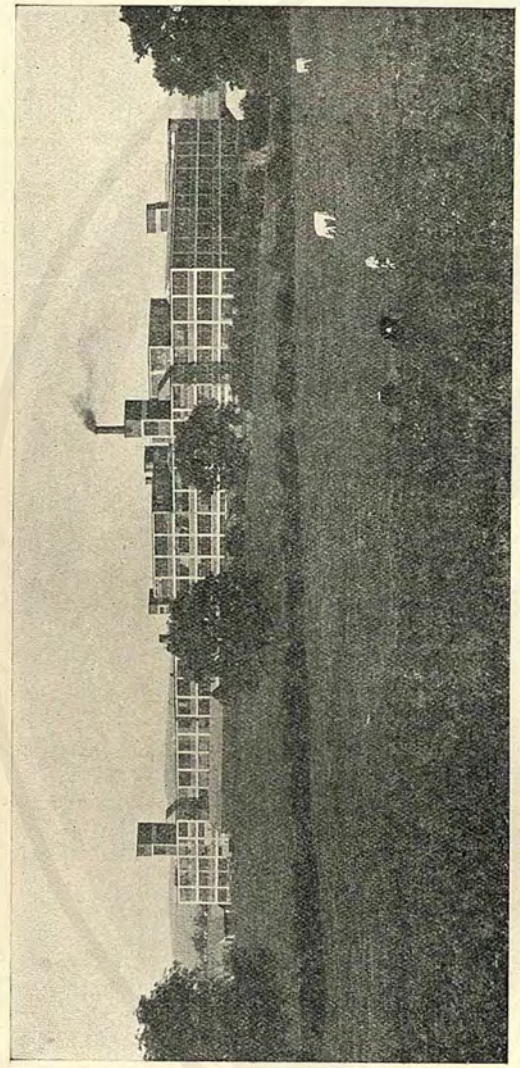

Arrol-Johnston

Motor Carriages.

—— THEIR ——
CARE AND MANAGEMENT

ARROL-JOHNSTON, LIMITED,
DUMFRIES, SCOTLAND.

Telephones:
281 and 282 Dumfries.

Telegrams:
"MOCAR, DUMFRIES."

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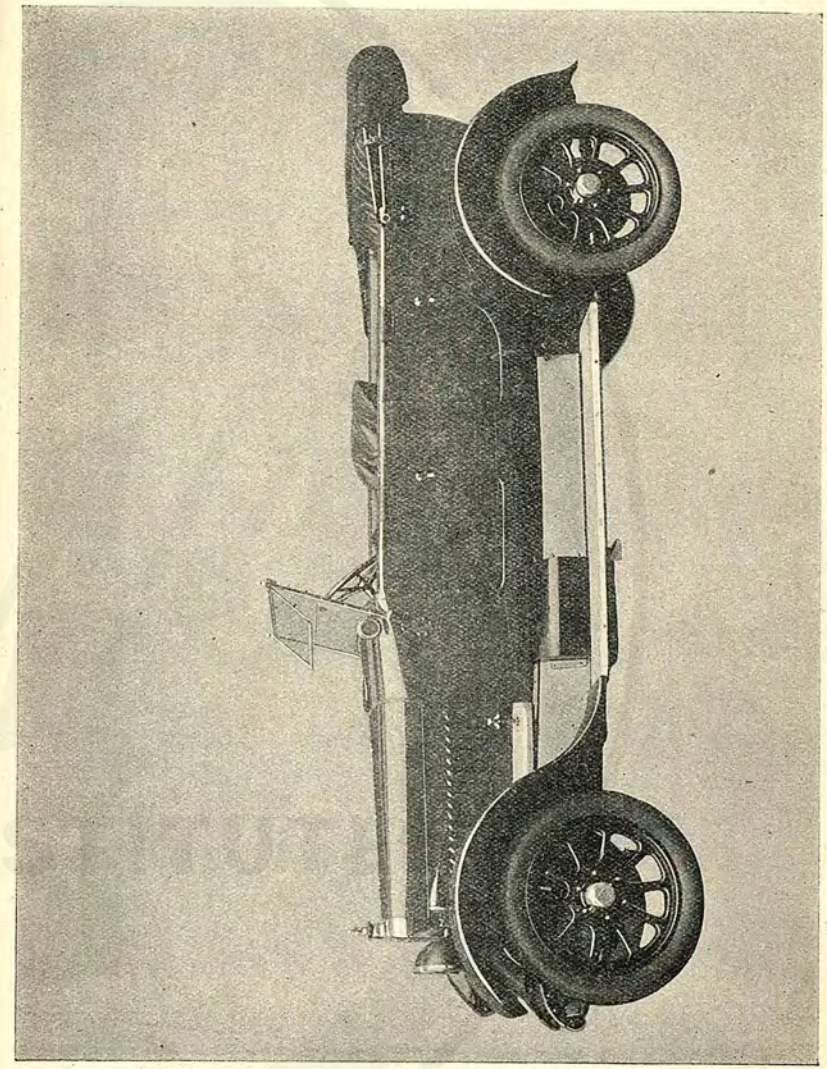
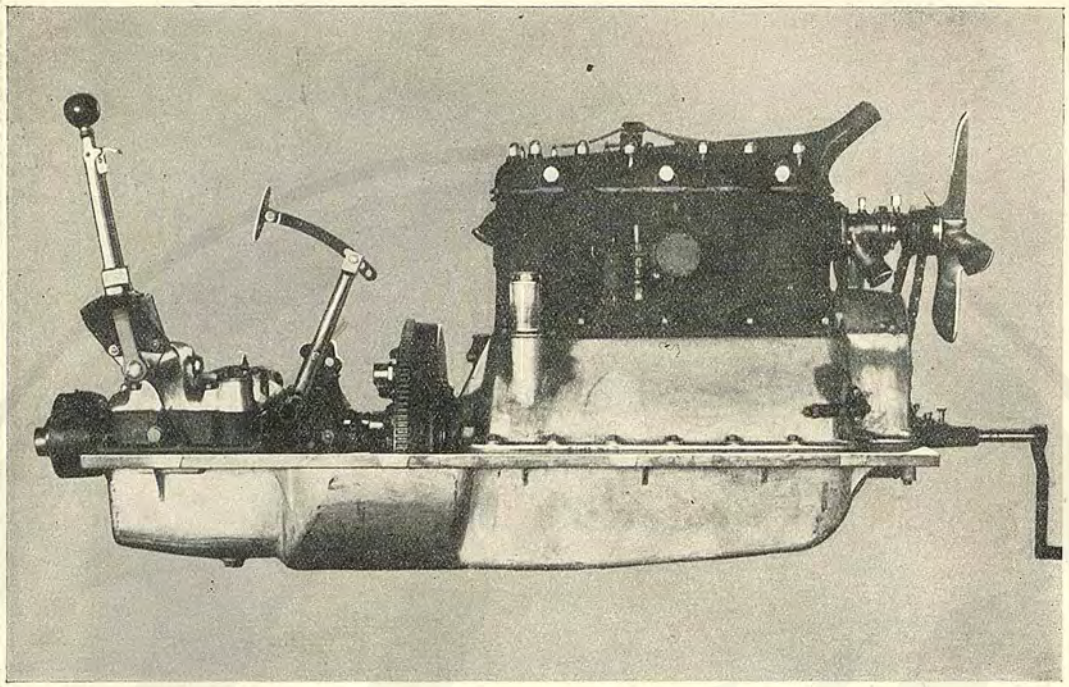


20 H.P. CAR. Type "E."



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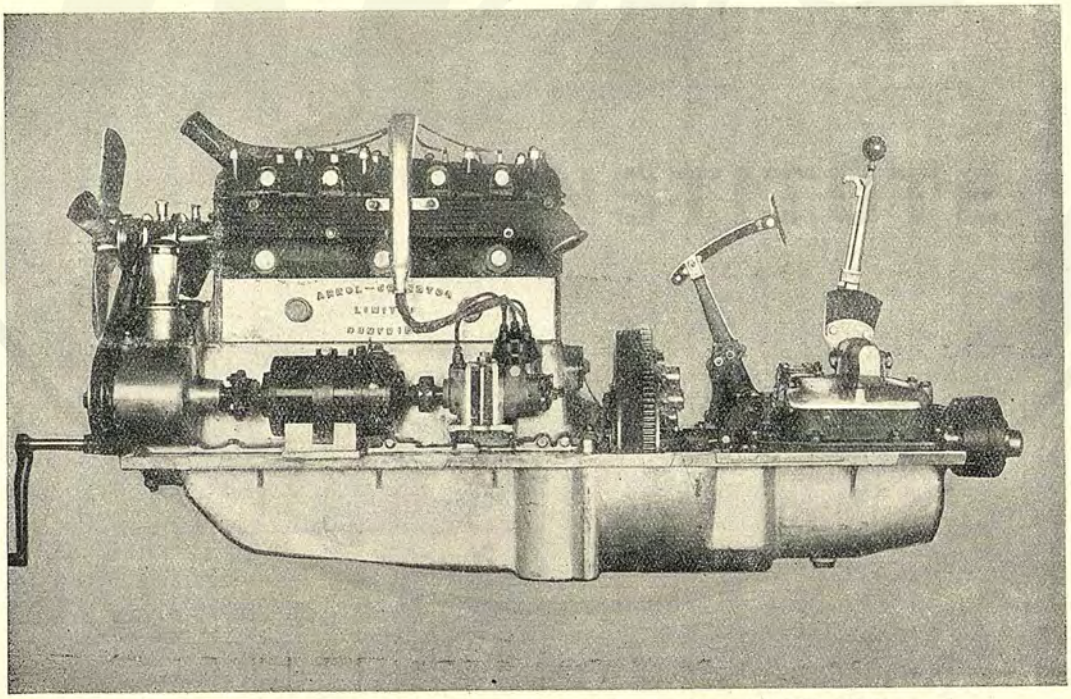

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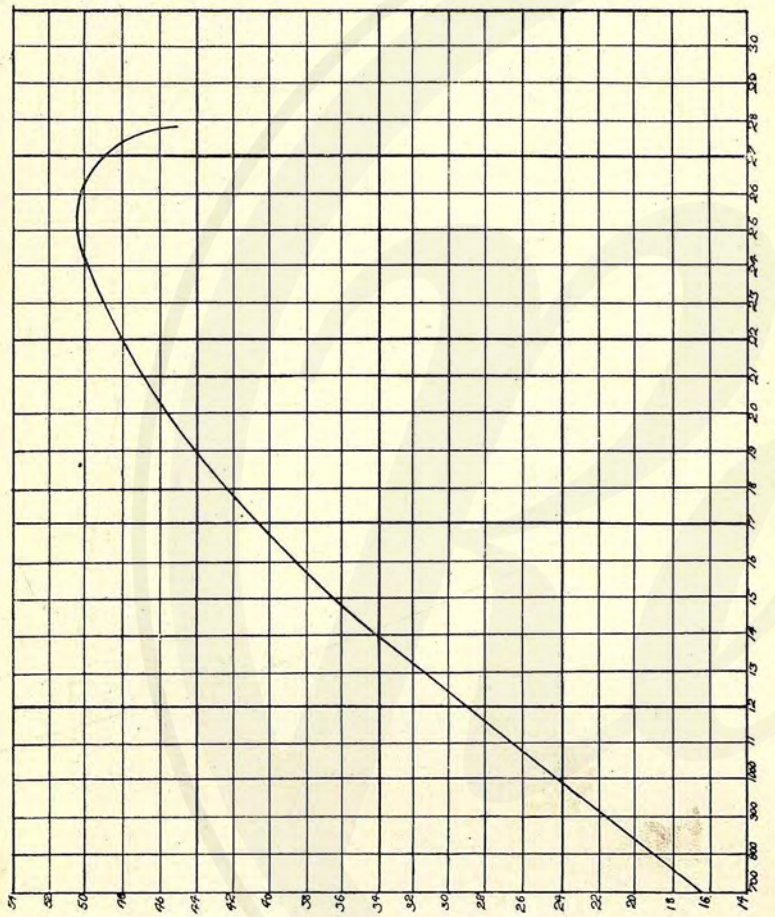


BRAKE HORSE POWER.

REVOLUTIONS PER MINUTE.

ENGINE POWER CURVE. 20 H.P. CAR TYPE "E."

INTRODUCTION.

THIS Handbook gives a clear and simple explanation of the construction and management of our cars, and is placed at the disposal of owners for the purpose of both information and guidance to enable them to get the maximum service out of the car.

It is not published with a view to instructing owners how to dismantle and assemble the car.

Motor cars, like all other moving machinery, require regular attention to lubrication and adjustment in order to keep them up to their standard efficiency.

The necessity for a Handbook of this nature can be readily appreciated by a visit to the Repair Shop of any Car Factory. Here may be seen cars suffering from nothing but lack of attention to lubrication or some quite elementary oversight.

Car owners, both novices and experts, are earnestly requested to read carefully the instructions contained in this Booklet. *They are written in plain and simple language, technical terms having been eliminated as far as possible,* and, if carefully followed out, will ensure comfort and pleasure for the owner, low running costs, and a corresponding increase in the life of the car.

Needless to say, if there is any point upon which Arrol-Johnston car owners are in the slightest doubt, we have always great pleasure in furnishing them with all the advice and assistance in our power.

EMPIRE MODEL
20 h.p. TYPE "E" CAR.

GENERAL INSTRUCTIONS.

The purchaser should make a careful examination of the car on its arrival, and any damage sustained in transit should at once be reported either to the Agents or to the Arrol-Johnston Company. In any communications regarding the car, invariably quote the manufacturers' number and type of car, which will be found on the small brass plate affixed to the dash or instrument board.

When examining the car the owner should refer at the same time to the various diagrams given in the Booklet. By so doing he will familiarise himself with the principal parts of the car, which will materially help him to follow the instructions.

It is advisable for the first 500 to 1000 miles to drive the car at a moderate speed—say 25/30 miles per hour —and thus allow the working surfaces time to run into their normal condition. By following out this suggestion the owner will add to the life of the car and his own comfort.

By following the instructions outlined in the Booklet, the owners of ARROL-JOHNSTON cars will incur the minimum cost of upkeep whilst obtaining the maximum of pleasure, with the reliability for which the productions of this Factory are so well known to the trade.

Bear in mind the old adage "Let well alone," and when the car is running satisfactorily, do not allow any experimenting with a view to making it run better.

DRIVING INSTRUCTIONS.

Before taking a new car out for a run, it is recommended :—

(1) That the chapter devoted to lubrication be carefully read over.

(2) That the correct quantity of oil is in the sump, gearbox, and rear axle.

(3) That a sufficient supply of petrol is in the tank.

(4) That the radiator is filled with water up to just below the filler cap.

(5) That the head lights are in order and all lamps burning brightly.

(6) That the tyres are properly inflated.

TO START ENGINE.

The engine is arranged to be started either by hand or by electric motor.

The electric motor is capable of turning the engine 200 r.p.m.

It is recommended that the electric motor be generally used ; the hand-starter to be used as an auxiliary in cold weather.

Pull out the magneto plunger switch.

Turn on the petrol, opening the cock on the AUTOVAC Tank fitted under the bonnet (on dash).

Flood the carburetter by means of needle valve extending through cap of float chamber.

Advance the ignition control lever on the steering wheel to the full extent of travel—outwards.

Open the throttle slightly (*i.e.*, outwards) by means of the control lever on the steering wheel. The best position for starting can only be determined by experience, but the lever should never be advanced so far as to cut out the sound of the petrol being sucked in from the pilot jet. Pull out the air strangler button and turn slightly to the right or left.

In this position, press in the button of the starter switch on the instrument board, and the starter pinion will mesh on the toothed rim of the engine flywheel.

Immediately the engine gets under way and commences firing, the starter will be automatically thrown out of gear, and when the engine is warmed up, release the air strangler by turning the button slightly to the right or left, and adjust the throttle until the engine runs slowly and smoothly.

If the engine fails to start in the first twelve revolutions, do not exhaust the batteries by uselessly keeping the switch in, but investigate the cause.

Continuous discharge of current at a high rate will cause disintegration of the plates, buckling, &c., and eventually destroy the battery, whereas it is quite capable of standing the heavy load imposed on it by the starter for comparatively short periods. Ten minutes' rapid discharge of continuous current, through the starter, would completely exhaust the cells, and probably place them beyond repair.

ENGINE.

Always open the throttle gradually, and never leave it very far open when the car is standing and the

engine running light. Racing the engine, especially when it is cold, is most injurious.

The engine should be kept clean. The regular use of a stiff brush and a soft cloth moistened with paraffin is all that is necessary.

HAND STARTING.

Proceed as before, but in place of using the starter switch, push in the starting handle to engage with the crankshaft ratchet and pull up sharply against the compression—*never under any circumstances press down* (as in the event of a back-fire you run the serious risk of a badly sprained wrist)—and the engine will start ; then gradually close the throttle until car is ready to drive.

CHANGE-SPEED QUADRANT.

There are four forward speeds and one reverse, the forward speeds being so arranged that the top gear is on the direct drive.

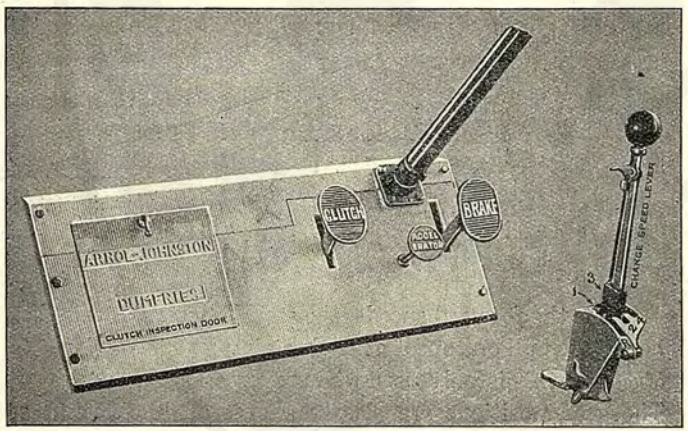
Before starting the car for the first time, it is necessary to learn by heart the positions of the change-speed lever for the various speeds.

The change-speed lever is in the neutral position when directly vertical and opposite the gate in the quadrant.

For the forward speeds, the small trigger a few inches below the ball on top of gear-changing lever *should not be touched ;* this is only used when reverse is to be employed. The gear positions are clearly shewn on illustration of Footboard given on next page.

TO START CAR.

Release the hand-brake (which should always be put on when leaving the car), press forward the left or clutch pedal firmly ; wait a moment so as to give the clutch shaft time to come to rest, then push the change-speed lever into the first speed position ; it will slip into gear quite noiselessly if the clutch shaft has had time to come to rest. Occasionally, however, it happens that the teeth of the two gear wheels come directly opposite one another, and if this occurs, do not try to force the gear in, but bring the gear lever back to the neutral position, release the clutch pedal as before, and try the gear again. By this means the clutch shaft has revolved to a different position, and the gear will mesh. Release the clutch pedal slowly with the left foot, at the same time slowly depressing the accelerator pedal with the right foot, and the car will glide gently forward ; no initial shock should be felt if the clutch is properly manipulated.



FOOTBOARD SHOWING VARIOUS CONTROLS.

LOW SPEED.

As soon as the car starts moving off on the 1st gear (*i.e.*, on the low speed) lose no time when on the level in changing up to 2nd as follows :—Press down the accelerator pedal slightly with the right foot to increase the speed of the engine, at the same time gently releasing the pressure on the clutch pedal.

Before attempting to change into 2nd speed, let the car gain some headway.

2nd SPEED.

As soon as the car is well under way, release the accelerator pedal, press the clutch pedal slightly and pull the change-speed lever back into 2nd position ; engage the clutch at once, and accelerate the engine as before.

3rd SPEED.

The change from 2nd speed to 3rd speed is made in a similar manner to that in the preceding paragraph.

4th SPEED.

Accelerate the engine until the car is moving forward rapidly, disengage the clutch and release the accelerator pedal. Move the lever lightly until you feel the top gear dog engages properly. The car is now in its normal driving gear.

To change " down "—*i.e.*, from a higher to a lower gear going uphill—the engine should not be allowed to slow down until it labours ; the correct speed at which to change can only be learned by practice. In changing

down, the clutch pedal should be only slightly pressed and the speed lever moved as quickly as possible, and until one is very proficient in changing, the foot should not be taken off the accelerator going from 3rd to 2nd. The change from 2nd to 1st should not be made until the car is going at not more than about 10 miles an hour. If the car is starting on an up-grade, it should be held on the side brake until the clutch begins to engage.

The remarkably easy gear-change is one of the features of ARROL-JOHNSTON cars, and if the foregoing instructions are carried out, no difficulty will be experienced in effecting the gear-changes noiselessly, and with a degree of ease hitherto unapproachable.

Do not attempt to start the car when the gears are in the 3rd or 4th position; to do so places a severe strain on the clutch and the driving parts.

Do not attempt to change gears until the clutch is disengaged.

In changing from a lower to a higher gear, it is necessary that the speed of the car be accelerated just before making the change, so that the two gears to be meshed are running at practically the same speed.

Practice will teach the driver not to accelerate too quickly. The engine will pull better if the accelerator pedal is pressed down slowly so that the throttle is opened gradually.

When the engine slows down owing to, say, a heavy gradient, practice will teach when and how the accelerator should be opened. If opened full, it is quite possible, in cases, for this action to reduce the engine power instead of increasing it.

TO STOP CAR.

Take foot off accelerator, press clutch pedal with left foot and brake pedal with right foot until the car stops, bring the change-speed lever to the neutral position, then release clutch pedal, put on the hand brakes, and if the car is to be left standing, switch off the current from the magneto.

By bringing the car to rest without using the brakes, the tyres will be saved to a considerable extent.

It will be readily realised that the foot brake is the handier brake of the two; therefore it is advisable to make a practice of using the foot brake whenever possible. Thus, when necessary, both brakes can be used together with ease and comfort.

TO STOP THE ENGINE.

Press home the plunger magneto switch and open the throttle slightly to allow the engine to take in a full charge of gas before coming to rest, and move the ignition control lever to the starting position. This will facilitate the re-starting up of the engine. In case of the car stopping a short time only, the engine may be kept running at its slowest speed—just ticking over.

TO REVERSE.

The car must be completely at rest before the reverse is put in.

Press the clutch pedal fully, lift up trigger on change-speed lever, pull the lever inwards through the gate and pull it backwards into the reverse notch, then very carefully release clutch pedal and accelerate cautiously until you feel that you have the car completely under control.

BRAKES.

The hand brake should *always* be put on when the car is stationary.

In going down long and steep hills, the hand and foot brakes should be used in conjunction, as the braking strain is thereby divided and there is less likelihood of the brakes running hot. On known dangerous hills or particularly long and steep descents such as are met with in Scotland, the engine forms an excellent brake. The engine speed-setting device is set until the throttle is almost shut (the current switched off), and the gear lever brought back to 2nd speed, or even 1st for very steep grades ; the car is then easily kept in check with very slight application of either the hand or foot brake. This method of braking is not only very efficient, but is easy on the car and tyres, and, moreover, helps to cool the engine ; but the engine speed should not be allowed to get too high—keep it down with one or other of the brakes.

SKIDDING.

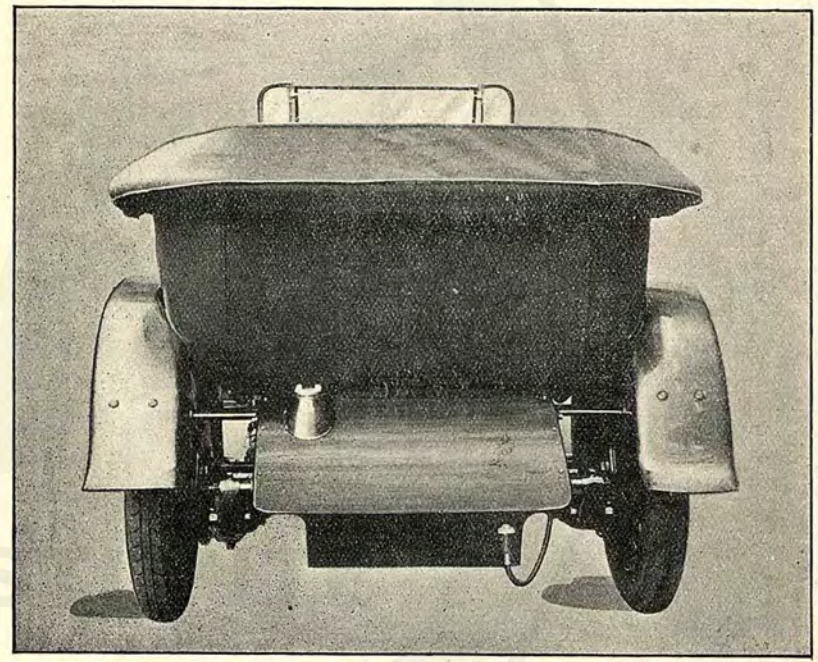
If the brakes are applied suddenly, especially on slippery roads or when turning corners, the car is apt to skid. The only way to avoid skidding is to drive slowly, but when a skid does occur, release the brake momentarily and turn the steering wheel in the direction the car is skidding, but keep the clutch in gear.

GOOD DRIVING.

Consideration for passing vehicles and pedestrians.
Quiet and easy acceleration.
Minimum use of brakes.
Slowing down when taking corners.
Not over-lubricating.

BAD DRIVING.

Racing the engine unnecessarily.
Jamming on the brakes at the last moment.
Driving on the clutch.
Using the brakes instead of slowing down when taking corners.
Moving steering when car is standing.



PETROL TANK.

CARBURATION.

PETROL SUPPLY (AUTOVAC FEED SYSTEM).

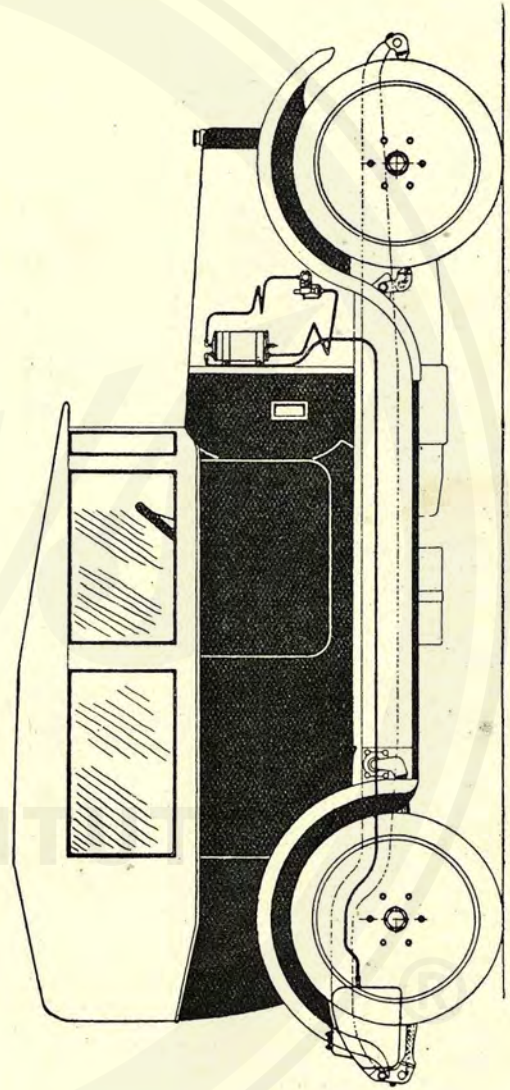
This consists of a storage tank of 12 gallons capacity practically built in to the chassis frame at the rear of car and fitted with inlet plug with filter, and filter over outlet pipe; air ventilator and copper piping to AUTOVAC tank under the bonnet, with piping connections to carburetter fixed direct on the engine block. The petrol passes through three filters before reaching the engine. The arrangement is very simple, and there is no chance of anything getting out of order. The chief thing is to see that all the joints are tight, and to examine regularly the filter fitted to the storage tank and the filter on the AUTOVAC tank, and keep them clean.

This tank is connected up to the AUTOVAC Petrol Feed system small tank installed under the bonnet (*see* pages 23 and 24).

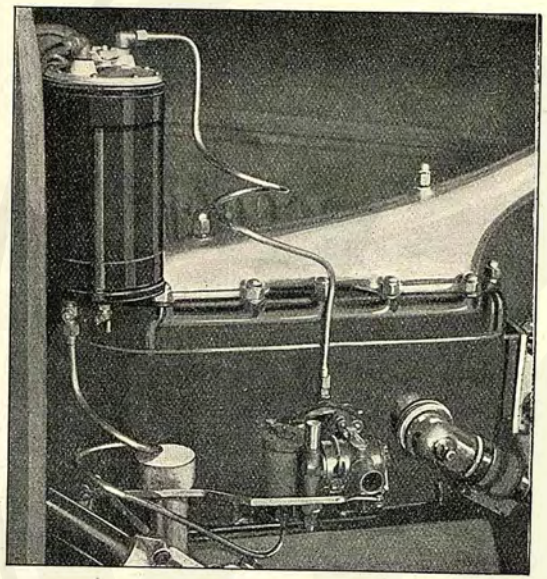
A descriptive booklet of this system is supplied with each car. This booklet contains the necessary information for installing and the working of the system, with numerous illustrations shewing in detail the working parts and their adjustment, with instructions when and how the various details should be cleaned.

CARBURETTER.

A Cox "Atmos" carburetter is specially made for the car, and is so arranged that the mixture flows from the carburetter through the passage in the centre of the cylinder block to the inlet valves, thus ensuring the mixture being heated up before it enters the cylinders.



20 H.P. TYPE "E."
ARRANGEMENT OF CAR, SHOWING AUTOVAC PETROL FEED SYSTEM.



AUTOVAC PETROL FEED TANK

The makers' booklet is supplied with each car, and contains a full description of the design and working of the carburetter, with instructions for setting, in order to obtain the most economical results from the engine, but it is advisable to leave adjustment of carburetter as delivered from our Factory.

All joints in connection with the carburation system must be perfectly air-tight, to ensure easy engine-starting and slow running.

The accelerator lever, fitted on the steering wheel and connected to the carburetter barrel throttle valve, regulates the quantity of mixture admitted to the cylinders and is arranged to give a fine control for slow-running, allowing at the same time sufficient travel to open the throttle to its maximum.

Benzole can be used in place of petrol, with slight adjustments, but it is recommended that a mixture of not less than 25% benzole and the rest petrol be used to give the best results.

The main storage tank is fitted with a filter contained in the filler. In addition, the AUTOVAC tank is also fitted with a filter; thus the fuel is filtered three times before its entrance into the engine.

The filter fitted to the inlet of the storage tank, and the filter in the AUTOVAC tank, can readily be removed for cleaning purposes.

IGNITION.

The ignition is by a British high-tension clockwise magneto mounted on the near side of the crankcase

immediately behind the dynamo, driven by an extension of the dynamo shaft through a SIMMS-VERNIER coupling.

The magneto and throttle control rods are carried up the centre of the steering column, the operating handles functioning on a quadrant bracket carried on an extension of the column inner tube. The lower ends of the rods are fitted with levers for the rods coupling up to the magneto and carburetter.

Make and Break.

The platinum points when correctly adjusted are half a millimetre apart, or the thickness of the spring portion of special spanner.

A booklet dealing specially with the magneto is supplied by the makers. It is recommended that this booklet be carefully read through in order to familiarise the owner with the working parts of the magneto and its correct setting, as also with the necessary care to be taken to keep it in good order.

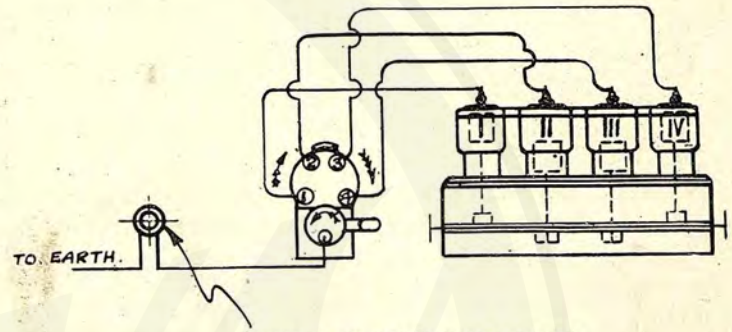
Ignition is controlled by the left-hand lever fitted to steering wheel, thus enabling the driver to advance or retard the time of ignition in the cylinders. When going full speed the ignition should be advanced (*i.e.*, outwards to its full limit).

SWITCH.

A two-way switch of the Plunger type is fitted to the instrument board for operating the magneto. When the switch is in the "PULLED OUT" position the magneto is functioning; in the "PUSHED IN" position, it is out of action.

WIRING.

If dismantled for any purpose, the wires should be carefully marked to ensure their being replaced in proper sequence; otherwise the engine will not run



WIRING DIAGRAM. SEQUENCE OF FIRING—1, 2, 4, 3.

correctly. The order of firing is as follows :—1, 2, 4, 3. No. 1 cylinder is nearest the radiator (*see* illustration).

BRAKES.

Both hand and foot brakes are compensated, and operate on the large drums of the rear wheels; each drum being fitted with two brakes, one operated by hand and one by foot.

The drums are rigid malleable castings of large diameter.

The brake shoes of cast-iron are lined with die-pressed Ferodo. No lubrication is necessary.

The brakes can be adjusted by means of the turn-buckles under the floor-boards of the rear seat.

The back axle should be raised from the ground occasionally by means of lifting jacks and the brakes adjusted so that they act equally on both wheels.

To Remove Brake Drums.

Jack up the car clear of the ground.
Remove the wheels and hub cap.
Remove the locking wire and slack off the axle nut.
Fit wheel puller, screw home the centre pinching pin.
If stiff, tap the end of the pin sharply with a hammer and the drum will ease off.

CLUTCH.

A petrol 4-stroke engine cannot be started under load; therefore the engine is connected up to the driving mechanism by means of a friction clutch operated by a foot pedal.

The clutch is of the single plate type functioning in the flywheel, and consists of a steel driving plate working between two Ferodo-lined plates, automatically kept in gear by six helical springs, the clutch being actuated by foot pedal.

Oil or grease MUST NOT BE ALLOWED to get on the discs. The driving shaft bearing only requires a few drops of oil every 500 to 1000 miles through special oil-hole in coupling.

Slipping Clutch.—Provided the slipping is not due to oil having got on to the discs, this can be taken up by means of the screw plugs (*see* illustration, page 29).

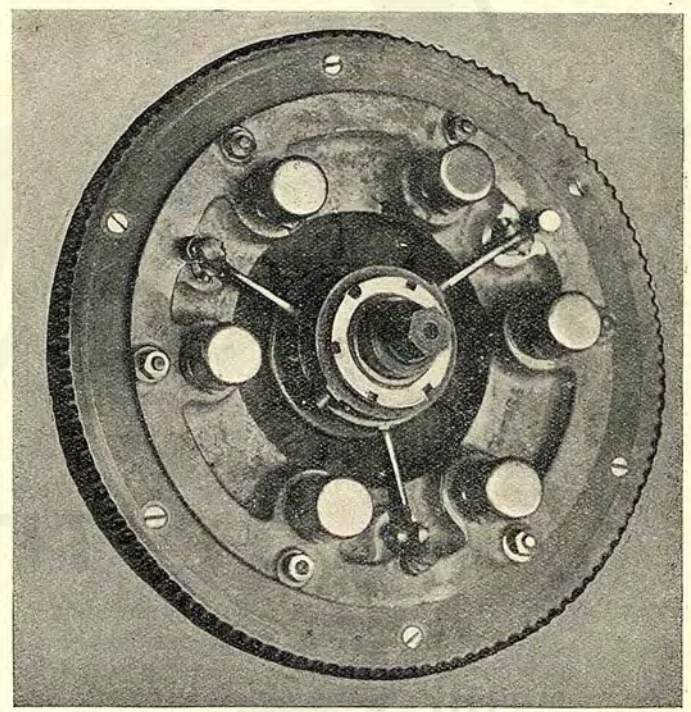
To ensure the clutch operating properly, care must be taken in screwing up the plugs that the pressure is applied equally all round.

If oil or grease has got on the discs, the clutch must be dismantled and the grease washed off.

To Adjust the Clutch.

If the clutch is worn and will not function—

(1) Adjust the three withdraw levers so that the point of the set screws strike the dowels on the fulcrum



LOOKING ON FACE OF CLUTCH.

plate at the same time. This is done by means of the set screws at the end of the levers.

(2) Adjust the three set screws so that when the clutch is in its normal position there is a space of 1 m/m between the points of the set screws and the dowel on fulcrum plate.

(3) Lock the three set screws in place by the locking device arranged for that purpose.

(4) The clutch pedal when properly adjusted should allow of a travel of about $1\frac{1}{2}$" before it commences to function or the pressure is appreciably felt.

SPEEDOMETER.

The speedometer registers the speed of the car in travelling, and also the total mileage run.

The speedometer drive is taken from the drive shaft immediately behind the universal joint through a pair of spiral gears, and connected by a flexible shaft to the speed dial fixed to instrument board.

The spiral gears are lubricated through the small plug fitted on the upper side of the torque tube immediately above the gears.

DETACHABLE WHEELS.

ROAD WHEELS.

Detachable steel spoke wheels are fitted as a standard equipment.

It is most important that the wheels should be in correct alignment, otherwise there will be undue wear on the tyres, and the steering will be affected.

The front and rear wheels should "track" correctly, *i.e.*, they should both run in the same line.

FRONT WHEELS.

To assist the steering and to counteract the tendency of the wheels when running to close in at the top, the wheels are "cambered," *i.e.*, the wheels are set so that the distance between the bottom of the wheels touching the ground is $2\frac{1}{8}$" less than the distance measured between the tops of the wheels, equal to an angle of 2 degrees 18 minutes.

The wheels are also "splayed" inwards to counteract the tendency of the wheels to splay out when running: the wheels are so set that the distance measured from centre to centre of tyres at the front half-way up is about $\frac{3}{16}$" less than the distance measured at the back. This splay can be regulated by the track steering rod, which is made adjustable for that purpose.

If the wheels are not set correctly, there will be undue wear on the tyres.

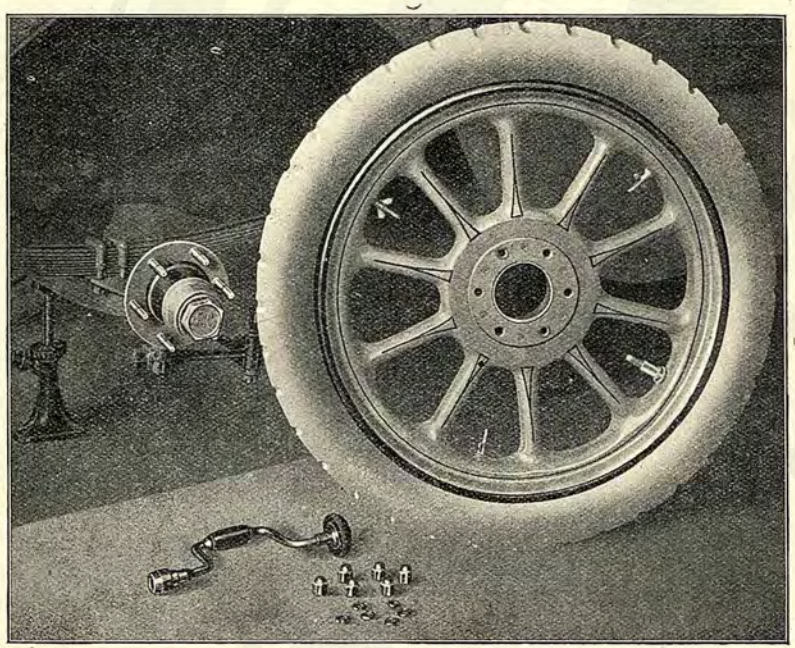
The wheels are interchangeable, and are attached to the hubs by means of six studs and nuts (*see* illustration).

The fitting and detaching are simplicity itself. The only tools required are a special brace box spanner,

and special lever, which facilitates the fitting of the wheel. These tools are supplied with the wheels, and are to be found in the tool tray.

To Change Wheels.

Jack up axle until wheel is clear of the ground.
Unscrew nuts by means of special brace provided.
Pull off wheel.
Fit spare wheel.
Replace and tighten nuts, taking care that these are screwed well home.
Grease hubs to ensure easy fitting.



DETACHABLE SPOKE WHEEL AND FITTINGS.

ENGINE.

Four cylinders cast *en bloc*, of the internal combustion type on the 4-cycle system.

The cylinders are set to fire in the following order, viz. :—1, 2, 4, 3, cylinder No. 1 being nearest the forward end of the car.

Each cylinder has an inlet and exhaust valve operated by a camshaft through tappets working on hardened steel rollers. The upper end of tappet is arranged with an adjusting nut—the adjusting nut being locked in position by a split coned nut which binds on tappet adjuster.

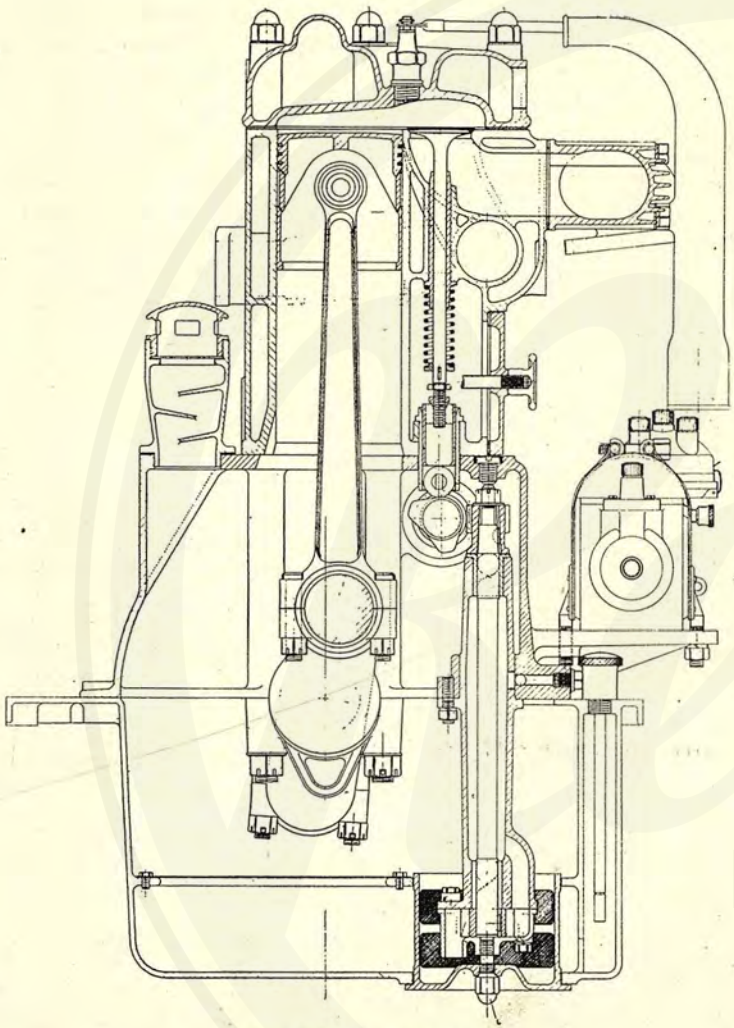
The tappets are of large diameter, working in bushes, readily accessible for removal or adjustment.

The tappet guide bushes are lubricated from crank-case and are held in place by strong yokes.

PISTONS.

Aluminium pistons are fitted of special design, fitted with three split rings arranged to exert a constant pressure against the side of the cylinders.

By fitting this type of piston, vibration is lessened and the engine "picks up" more quickly, conducts the heat away more rapidly, less carbon is formed on the piston top, and there is less friction between the cylinder walls and the pistons, causing less wear and tear on the cylinder walls. As aluminium pistons expand more quickly than cast-iron pistons, these require more clearance.



CROSS SECTION POWER UNIT,
SHOWING VALVE MECHANISM AND OIL PUMP.

This extra clearance makes the engine easier to turn when cold, but has a tendency to cause a slight "slap" when started up first from cold. Once heated up, however, this "slap" disappears.

REMOVING CARBON.

After the first 3000 miles, the combustion chamber and piston heads should be decarbonised. A rich mixture, or too much lubricating oil, will form a carbon deposit, an excess of which has a tendency to become incandescent and ignite the charges before the piston has finished its compression stroke, resulting in a knock in the engine.

CYLINDER HEAD.

Detachable, water jacketed—arranged to take the sparking plugs, and containing the combustion chamber.

VALVES.

These should be ground in periodically, as any defect in the seating of the valves means loss of power.

To remove valves :—

Remove detachable head, which is supplied with lifting lugs for easy handling.

Insert valve lifting tool to compress spring.

Withdraw cotter and remove collar.

Lift valve clear of cylinder.

To grind valves :—

Smear face of valve with emery compound.

Replace valve, and, with screwdriver engaging slot of same, rotate backwards and

forwards. Continue until a bright continuous line appears on the valve and seating. Do not continue to grind after this.

Thoroughly clean with paraffin so as to remove all grit.

Re-insert valve and fit spring, &c.

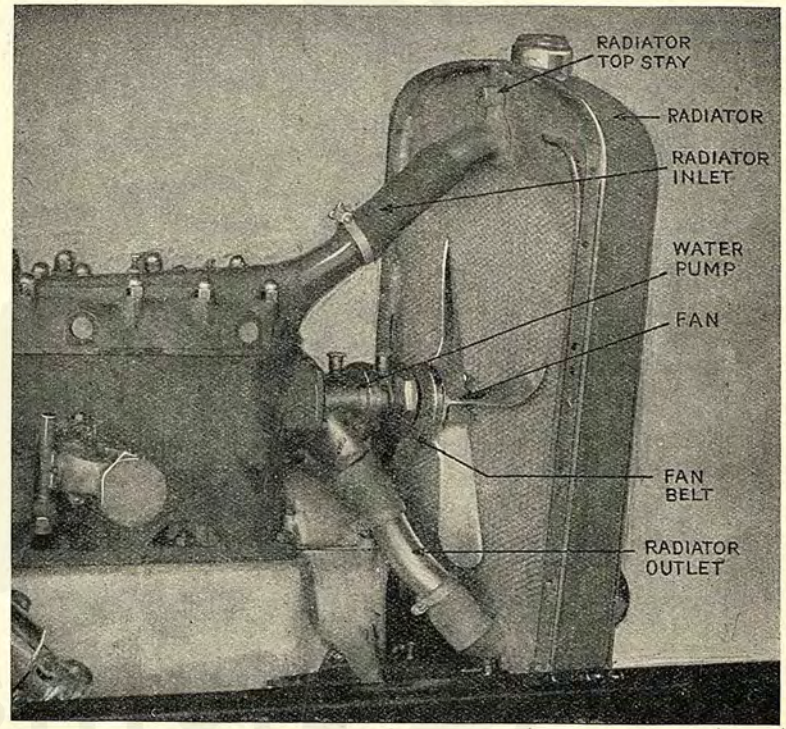
Replace cylinder head. Make sure that the gasket is in good order and that the faces of the cylinder block and head are quite clean. Tighten down the nuts equally all round, paying special attention to the studs running up the centre of the head. Run the engine slowly until the cylinder block and head are thoroughly heated up, and again try all the nuts, tightening them down hard.

After a day or two's run, say 200 miles, again go over the nuts. It is advisable that the nuts should be tried regularly by the owner, as the vibration of the car in service has a tendency to slack back the nuts—hence the necessity of testing them.

VALVE TAPPETS.

These are adjustable, and should be periodically examined.

After engine has been running, test clearance between end of valve stem and face of tappet. The correct clearance between the face of the valve stem and the tappet should be 3-thousands of an inch for the inlet valve and 4-thousands of an inch for the exhaust valve.



ARRANGEMENT OF COOLING SYSTEM.

Excessive clearance reduces free intake and exhaust of gases, with resultant loss of power and increased noise.

Insufficient clearance may mean that valves are not closing correctly, with resultant loss of power and burnt valves.

EXHAUST.

Consists of exhaust manifold, exhaust pipe, and silencer. The silencer consists of a sheet-metal box fitted with baffles, perforated to direct the exhaust gases to travel the longest course, and impinging on the plate before finally leaving through the outlet pipe carried out to the back axle. This silencer should be taken down and cleaned once per year.

COOLING SYSTEM.

The cooling is effected by means of a radiator, a centrifugal pump, and fan mounted on the same spindle, and driven by belt from an extension of the dynamo drive.

The centrifugal pump delivers the water through the cylinder jackets to the cylinder head (the water passages being of large area at all points), and thence to the top of the radiator (*see* Power Unit at end of book).

The radiator, fitted in front of the engine, is secured to the cross member of the chassis frame by spring bolts, and the top stayed to the dash, and provides a substantial support for the front end of the bonnet.

To prevent overheating, see that the radiator is filled with clean water, the fan belt tight, and the water connections in good order.

The radiator is of cellular construction, having extra large surface to ensure efficient cooling under all conditions.

The aluminium fan is fitted immediately behind the radiator, providing a continuous circulation of cool air.

The "V" driving pulley on the pump and fan spindle is made in halves, and is adjustable to allow the belt slack to be taken up.

To empty the radiator, open the small tap fitted in the lowest part of the suction pipe.

The correct water level is just below the level of the filler cap.

GEAR BOX.

Internal combustion engines develop power in ratio to the speed—the higher the speed the more H.P. The change-speed gear is designed to take advantage of this, inasmuch as at times a car requires more power at low speeds than at high speeds, the gear box being used so that the high speed of the engine may be ratio'd down to the speed of the rear wheels in proportion to the gear ratios of the gear box.

When the change-speed lever is in the neutral position, the constant speed mesh wheels are in gear only; hence the main (or secondary or sliding) shaft will not turn.

1st SPEED.

When the change-speed lever is moved into the 1st speed notch, the low speed wheel on the secondary shaft meshes with the low speed wheel on the layshaft and the car will move forward slowly.

2nd SPEED.

When the change-speed lever is moved into the 2nd speed notch, the 2nd speed wheel is moved forward and meshes with the 2nd speed wheel on the layshaft (the 1st and 2nd speed wheels on the secondary or main shaft are riveted together).

3rd SPEED.

The 3rd speed wheel on the secondary shaft is moved backwards, and meshes with the 3rd speed wheel on the layshaft.

TOP SPEED.

The 3rd speed wheel on the secondary shaft is moved forward, and engages with the studs on the end of the primary shaft.

REVERSE.

When the change-speed lever is moved into the reverse position, the reverse pinion slides into mesh with the 1st speed wheel on the secondary shaft, which again meshes with the 1st speed wheel on the layshaft.

TRANSMISSION.

The transmission comprises all those parts, commencing with the change-speed gear box to the rear road wheels. The drive is transmitted from the gear box through the universal joint to the back axle by a drive shaft enclosed in a steel torque tube, and thence through a spiral bevel pinion and wheel.

UNIVERSAL JOINT.

This provides the flexible connection between the power unit and the drive shaft, and is placed immediately behind the gear box.

Is of the split-ring and stud type, the four stud bearings being fitted with hard steel bushes. The hexagon jaw fits on the gear box secondary shaft. The splined jaw fits on the forward end of the drive shaft, the joint being enclosed in a dust-proof cover provided with an oiling plug for the purpose of lubricating the stud bearings.

DRIVE SHAFT.

The drive shaft transmits the power from the universal joint to the driving gears of the differential and is entirely enclosed in a steel torque tube, the forward forked end of the tube swinging on the universal joint housing, compensating for the rise and fall of the road wheels.

The rear end of the shaft is carried on TIMKEN bearings fitted in a separate housing contained in the flanged end of the torque tube.

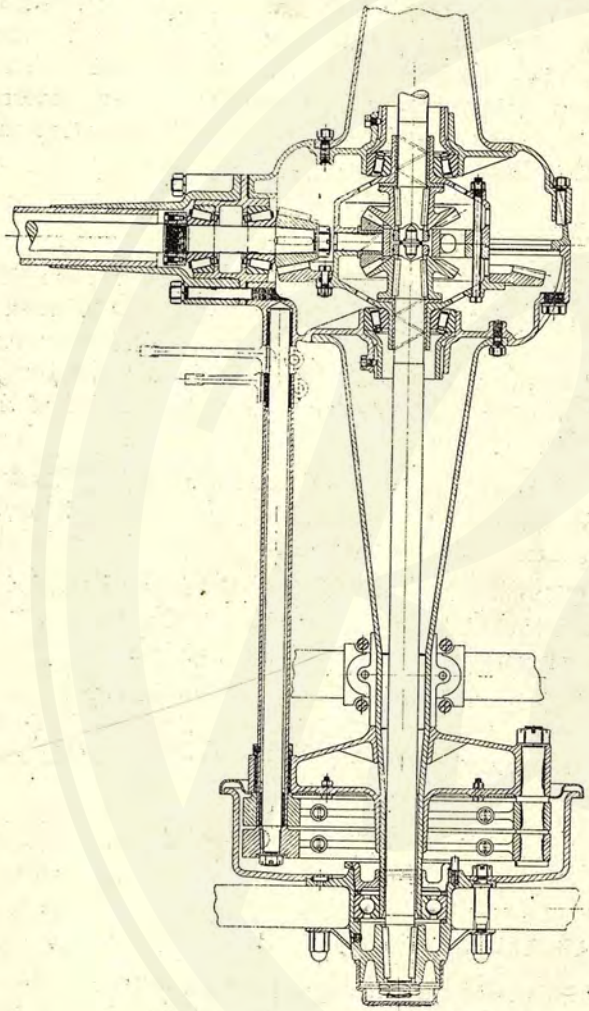
This shaft is of special steel, the forward end being splined to fit into the universal joint, the rear end with tapered cone for taking the driving pinion.

To adjust the depth of the mesh of the crown pinion with the crown wheel, the joint of the torque tube flange to the axle casing must be slacked back and a thin shim added or removed as required.

This adjustment should be made by an experienced mechanic.

REAR AXLE.

This is of the three-quarter floating type, and consists of a malleable cast centre casing with steel tube



20 H.P. TYPE "E" CAR.
GENERAL ARRANGEMENT OF REAR AXLE.

extensions for carrying the weight, the outer ends of the tubes strutted up to the forward end of the torque tube to counteract the tendency of the casing to twist round from the reaction of the driving shaft and to stiffen up the unit for service on heavy, rough roads. The outer ends of the tubes run on ball bearings. The axle centre casing contains the differential and special bevel gears for transmitting the power through the axle shaft to the road wheels.

The differential is an automatic device which allows the road wheels to revolve at variable speeds although both are driven by the engine; hence the rear axle consists of two separate shafts, the differential being placed between the inner ends.

The differential casing consists of a steel stamping mounted on TIMKEN bearings, carried in housings screwed and locked in the malleable cast axle casings.

The crown wheel is bolted to the outside of the differential and meshed with the crown pinion on the end of the drive shaft. Inside the differential case is a set of three bevel gears meshing with the bevel pinions fixed on the ends of the axle shafts.

The wheel hubs are fixed on the outer ends of the axle shafts by means of cones and keys and house single ball bearings for carrying the outer ends of the axle casings. The weight of the car thus being carried by the housing, the axle shafts take the thrust and transmit the driving power.

The bearings are arranged to be lubricated through a filler hole in the hub. Oil deflectors are also fitted to prevent oil working over from the differential casing into the brake drums.

To adjust the crown wheel in relation to the crown pinion and driving gears, the housing carrying the TIMKEN bearing can be screwed inwards or outwards as may be desired. Both housings must be turned exactly the same amount, and in the same direction, to prevent end-play in the bearings.

This adjustment should be made by an experienced mechanic.

The crown wheel runs in a continuous oil-bath, ensuring ample lubrication to the differential gears and the crown pinion.

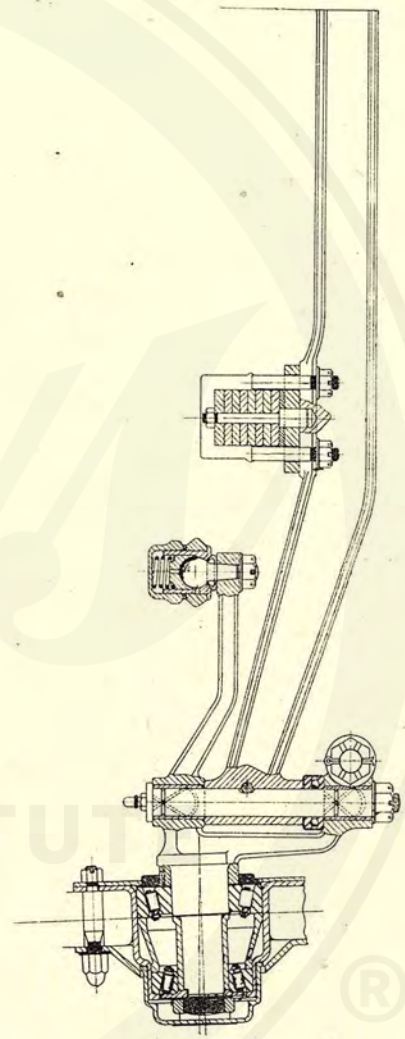
FRONT AXLE (*see* illustration).

The front axle is a special steel forging " H " section. The stub axle is a one-piece drop forging of special steel. The swivel pins have extra large bearings case-hardened; the centre is drilled out to form an oil reservoir, which connects up to spiral grooves in the bearing surfaces. The hole in the top end of the spindle is closed with a screwed nut, which in turn has a snap cover to allow of filling the oil reservoir and to keep out the dirt.

STEERING GEAR.

The steering wheel is attached to a long tube forming the steering column—the lower end carrying a single thread worm engaging in a worm sector in the steering gear box ; the sector shaft carrying the drop lever, to which is attached the drag-link connecting up to the steering yoke of the front axle.

The lower ends of the steering and column tube are carried on ball bearings, the end movement being taken up by a thrust washer. The steering wheel



20 H.P. TYPE "E" CAR.
GENERAL ARRANGEMENT OF FRONT AXLE.

should not have more than about $1\frac{1}{2}$" movement at the rim before commencing to operate the gear.

The steering rods are fitted with ball and socket joints, part of the hollow steering rod forming an oil reservoir automatically lubricating the joints.

The oil reservoir is filled through the screw-plugs (*see* illustration).

FRONT SPRINGS.

The front springs are semi-elliptic, long and very elastic, mounted above the axle.

The centre of the springs is attached direct to the axle by spring clips; the forward ends to the dumb iron, the rear end to the chassis frame by shackle links and swivel pins, with large bearing surfaces.

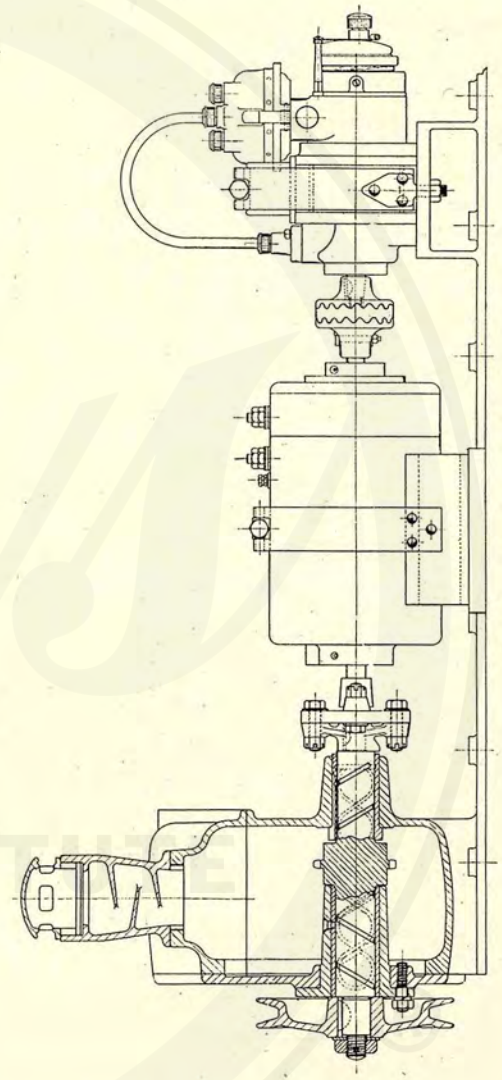
REAR SPRINGS.

Semi-elliptic underslung, long and very elastic. The centre of the spring is attached direct to the axle by spring clips. Both ends are secured to the frame through strong box shackle links, with large bearing surface for the swivel pins.

The springs are carefully designed to give easy riding at all speeds, and are fitted with leather gaiters to exclude dust and water.

SPRING CLIPS.

In the case of a new car, tighten up the clips after the first 500 miles, and afterwards examine them occasionally. Loose clips and bolts are almost invariably



20 H.P. TYPE "E" CAR.
ARRANGEMENT OF MAGNETO AND DYNAMO DRIVE.

the cause of broken spring leaves; hence the necessity of making sure that the cap nuts are tight in place.

ELECTRICAL EQUIPMENT.

Starting and Lighting are separate units, both supplied by the C. A. V. Co. (For full particulars, *see* separate booklet.)

The Dynamo and Magneto are fitted in line on the left-hand side of the engine, driven direct through the timing gear. The forward end of the dynamo shaft is fitted with a flexible disc coupling, the magneto driving shaft being fitted with a SIMMS-VERNIER coupling arranged to allow fine adjustments to be made (*see* Instruction Card supplied by makers).

The Starting Motor is a separate unit, located on the engine bedplate, gearing direct to a toothed ring fitted on the rim of the flywheel, and is coupled up direct to the accumulator.

There are two sets of cables—one for the Lighting System and one for the Starting Motor. All cables in one length without joints or splices.

All cables are carefully clipped to chassis frame to prevent whipping.

CIRCUIT DIAGRAM.

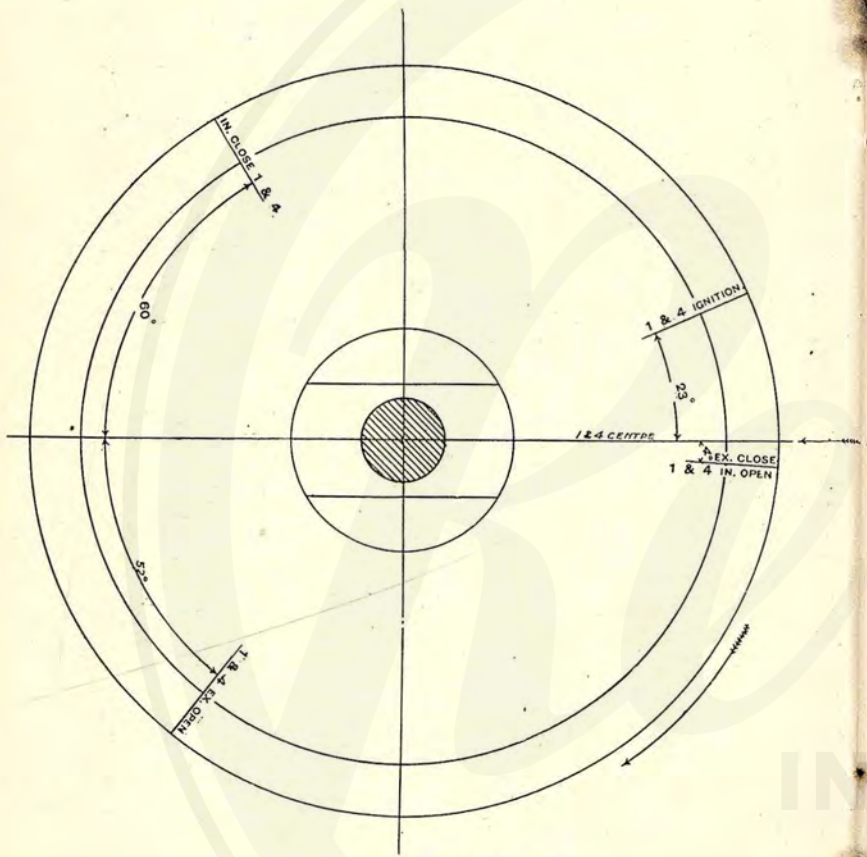
The internal wiring circuits of the electrical equipment are shewn on the circuit diagram. Disconnect the lead from the storage battery terminals before attempting to change any connections at the back of the lighting switch box.

AMMETER.

This instrument allows the owner to check the efficiency of the electrical system. It registers the nett amount of current generated by the dynamo when the engine is running and delivered to the storage battery, and also registers the amount of current the battery is furnishing to the lights when the engine is out of action.

BATTERY.

The Battery is enclosed in a box fixed on the near-side footboard, and connected up to the Dynamo and the Electric System by insulated cable.



FRONT VIEW OF FLYWHEEL.
ORDER OF FIRING, 1, 2, 4, 3.

TIMING.

ENGINE.

It is sufficient to time No. 1 cylinder, *i.e.*, the cylinder next the radiator.

(1) Remove the sparking plugs.

(2) Turn the engine clockwise until No. 1 crank is on the top centre.

(3) Adjust the tappets so that there is 3 thous. clearance between the end of the inlet valve and tappet rods, and 4 thous. between the exhaust valve and tappet rods.

(4) Turn the engine round slowly. With the crank 13 m/m over the top centre (measuring on flywheel rim), the exhaust should be just closing and the inlet opening, the magneto firing when the crank is 75 m/m (measuring on the flywheel rim) before top centre.

The diagram shews the standard valve timing, and, although it is not always possible to get the exact setting, it is imperative that the setting should be as near to standard as possible (*see* illustration).

On the face of the flywheel next the engine, the positions of Nos. 1 and 4 cranks are marked.

When marking the flywheel be careful to turn the engine one way only, *i.e.*, clockwise.

The tappets are fitted with adjusting nuts and locking device, so that once the correct clearances are obtained the tappet is locked in place.

MAGNETO.

Be careful to turn the magneto in its direction of rotation when setting distributor rotor to No. 1 terminal.

Examine the valves to be certain that No. 1 cylinder is on its firing stroke.

Turn the engine slowly by hand until the crank of No. 1 cylinder as marked on the flywheel is 75 m/m before top centre.

The timing lever of the magneto should be fully advanced and the magneto armature revolved in the proper direction until the fibre heel on the contact breaker touches the cam and the platinum points are just about to open.

The magneto driving shaft is fitted with a SIMMS-VERNIER Coupling, arranged to allow fine adjustments to be made.

(1) If it is desired to alter timing of magneto with engine, remove bolt and slide engine half coupling out of engagement with rubber clutch.

(2) Rotate magneto spindle together with rubber clutch a distance of one tooth in the desired direction; mesh rubber clutch with engine half coupling and rotate magneto spindle only a distance of one tooth in the opposite direction.

Rotating the magneto spindle to the right, in respect to the engine, retards it on a R.H. magneto.

Ditto to the left, advances it on a R.H. magneto.

Rotating magneto spindle to the right, in respect to the engine, advances it on a L.H. magneto.

Ditto to the left, retards it on a L.H. magneto.

The half couplings have 19 and 20 teeth respectively, and the adjustment is therefore $1/19 - 1/20 =$ 1/380th part of a revolution, or rather less than 1°.

(3) Bring up both rubber clutch and engine half coupling to mesh with magneto half; mesh and bolt up as before.

(4) Allow 0·5 m/m total play in Rubber part of Magneto coupling.

The spark should always be so regulated that the engine will not knock or lose power. With a retarded spark and running for any length of time, the engine will heat up.

All cars are supplied with a copy of the magneto makers' instruction book, which details clearly the working parts and the method of handling and upkeep of same.

SPARKING PLUGS.

The correct gap between the plug electrode is ·030".

"ENOTS" HIGH-PRESSURE LUBRICATING SYSTEM.

Attention to regular and systematic lubrication is absolutely necessary to ensure comfortable riding and car efficiency. The "ENOTS" system comprises a grease gun, flexible tube, and lubricating nipples to all shackle pins and to the rear spring swivel bearings.

Charging the Gun.—Unscrew the knurled cap from the barrel; withdraw the plunger (a strong pull is necessary). Spin the cap down the screw to its utmost limit until it covers the cup leather plunger. Fill the gun with grease, packing as solid as possible. The cap should be replaced and screwed down by hand only until it is tightly home. The grease gun is then ready for use. Soft clear grease is essential, and is more efficient than heavy grease.

The flexible tube allows easy access to lubricating points, which ordinarily are somewhat difficult of access and thus are liable to be forgotten or overlooked.

Before applying the gun, make sure that the nipples are quite clean, and that no dirt of any kind is forced into the bearings.

The patent Quick Detachable Pressure-tight Coupling at the end of the tube is attached to the connection nipples. The handle of the gun is given a few turns, as required, at each part to be lubricated. Use hands only in operating gun. A pressure of 600 lbs. can be exerted on the bearings if required, and all old, dirty grease expelled.

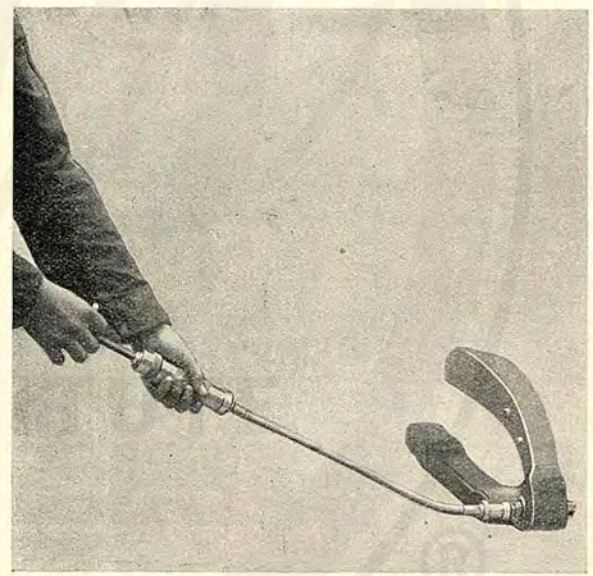
Immediately the patent coupling is disconnected, the grease flow is instantaneously stopped, and no matter what pressure be then put on the gun the extrusion of grease becomes impossible.

The flexible tube should always be kept as straight as possible; it should not be bent round unduly sharp corners.

All flexible connections are tested to pressure of 1000 lbs. per sq. inch before being despatched from the Works.

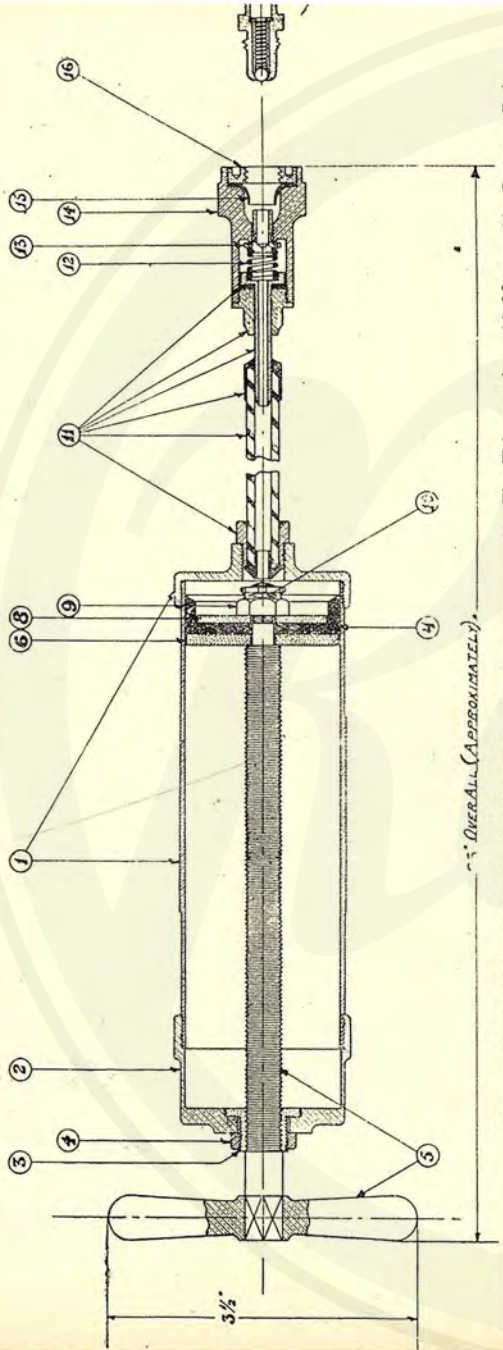
In the event of the valve leaking, remove nut immediately behind Connector Body (14), remove spring (12) and valve (13), carefully clean seating of each, and replace. Leakage will not occur if clean grease is always used.

All spring shackle pins and the rear spring swivel bearings are fitted on this system.



OPERATING "ENOTS" GREASE-GUN.

Detailed Drawing of GREASE GUN and CONNECTOR VALVE



1—Barrel.
2—Cap.
3—Flange Nut Bush.
4—Hexagon Nut for Flange Nut Bush.
5—Handle and Screw.
6—Plunger Washer.
7—Plunger Cup Leather.
8—Cup Leather Supporting Washer.
9—Hexagon Castle Nut.
10—Split Cotter Pin.
11—Flex Tube complete with Mounts.
12—Control Valve Spring.
13—Control Valve.
14—Connector Body.
15—Leather Seating Washer.
16—Steel Connector Nut.

When ordering spare parts please quote whether large, medium, or small size gun.

GENERAL LUBRICATION.

This subject is of the utmost importance to the owner-driver, and by adhering strictly to the following instructions he may rely upon efficient running, absence of wear in running parts, and all-round general comfort and efficiency.

Referring to the Diagram at the end of the book, the following summary will readily be grasped :—

ENGINE.

The ARROL-JOHNSTON system of forced feed engine lubrication has been the subject of special attention for many years, and has been improved and developed until it is undoubtedly the most satisfactory system in present-day use.

A full charge of oil, amounting to 12 pints, is first poured through the filler breather into the crankcase. A gear pump enclosed in a filter and driven from the crankshaft is fitted in the lowest part of the crankcase, and circulates the oil continually through a combination of pipes and through the drilled crankshaft and crankpins to the main bearings and connecting rod big ends.

An ample supply of oil escapes from these bearings to thoroughly lubricate the cylinder walls, gudgeon pins, tappet rod rollers and guides.

The CAMSHAFT, DYNAMO, and MAGNETO Driving Gears are arranged to run constantly in oil (*see* Power Unit print at the end of book).

The front and rear spring shackle pins and the rear spring swivel bearings are arranged for the " ENOTS " grease-gun system.

LUBRICATION.

The oil, after passing through the different bearings, falls into the crankcase and finds its way into the oil

sump, in which is placed the oil pump, and, passing through the filter, is again pumped through the system, the oil being used over and over again. With a new car it is advisable to drain off the oil after running about 2000 miles, and replenish with new oil.

The pressure in the system depends upon the quality of oil and its temperature. On first starting up in cold weather with thick oil, the pressure may be 140/150 lbs. per sq. in. Once the engine is warmed up, the pressure will average from 10 lbs. to 30 lbs. per sq. in.

The filter may be removed by simply unfastening nut " L " shewn in diagram. The filter which surrounds the oil pump is so used as to exclude foreign matter from the oil circulation, and should be thoroughly cleansed with paraffin before replenishing the crankcase with oil.

To Adjust Oil Circulation.—The oil pump forces the oil through a combination of pipes and drilled holes, through the crankshaft and crankpins to the main bearings and connecting rod big ends.

The volume of oil passing through the system is regulated by a spring-loaded bypass valve. To increase the flow, screw down the nut, compressing the spring. To decrease the flow, slack back the nut. Once the volume is settled, the spindle should be carefully locked in place.

All the oil drains back into the timing chain end of the crankcase, and must pass through the pump filter before it again circulates through the system.

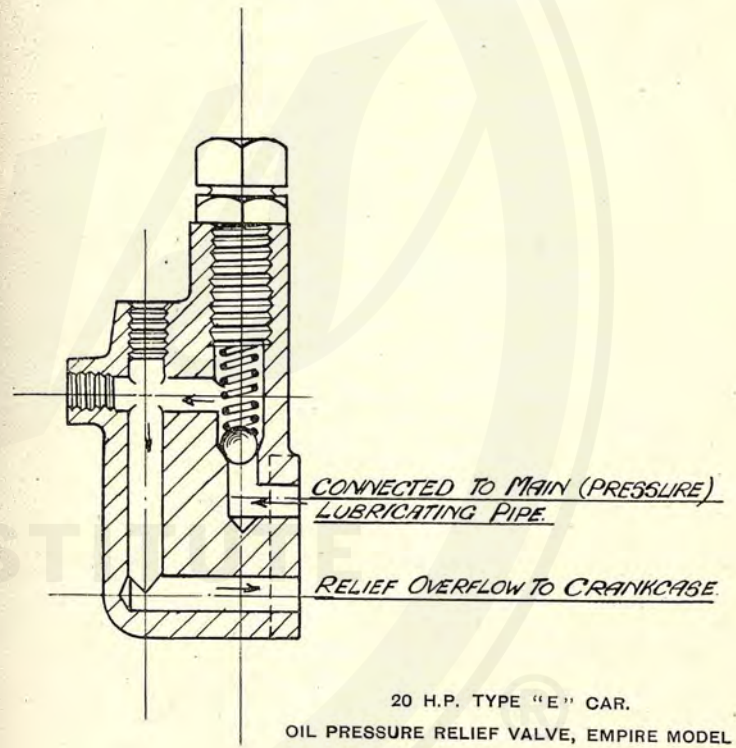
Tighten locknut after making adjustments.

Excess lubrication will cause smoky exhaust, and will probably give rise to sooty sparking plugs.

Insufficient lubrication may cause the bearings to " run " or the pistons to seize in the cylinders.

CRANKCASE.

To check the level of the oil, unscrew the oil gauge rod situated on the near-side at the end of the crankcase just behind the magneto and in front of the flywheel. The rod is provided with a knurled head for ease of handling, and is marked shewing the correct depth of oil in the crankcase (*see* page 34). If the oil level is found to be below the graduated mark, add sufficient oil until it reaches the mark, *but not higher*.



20 H.P. TYPE "E" CAR.
OIL PRESSURE RELIEF VALVE, EMPIRE MODEL

To drain the crankcase, slack off the nut marked "L" (*see* Power Unit plate at end of book) ; this allows the oil pump filter to be removed, and gives a free outlet for the dirty oil.

The crankcase should be drained when the oil is hot, immediately after a run, in order to draw off all foreign matter which may be in suspension in the oil. Draining the crankcase when cold allows foreign matter to separate and adhere to bottom and sides of sump.

When all the oil is drained out of the crankcase, replace the oil pump filter and pour into the crankcase half-a-gallon of paraffin. Motor the engine round for about 30 seconds with the self-starter, the engine switched off. Give a few turns of the starting-handle and motor round a second time for a further 30 seconds. Afterwards drain off the dirty paraffin and replace the oil pump filter, and pour into the crankcase a quart of lubricating oil. Motor the engine round about a minute, and then drain off the oil and paraffin. Replace the oil pump filter, and fill up the crankcase with oil.

Valve Spindles.—A little oil drawn in through the carburetter occasionally will effectually prevent sticking valves. Introduce the oil through the carburetter air intake pipe, using the oil-can for this purpose.

CLUTCH.

The clutch plates must not be lubricated.

The clutch withdrawal gear joints and pins should be given a few drops of oil regularly.

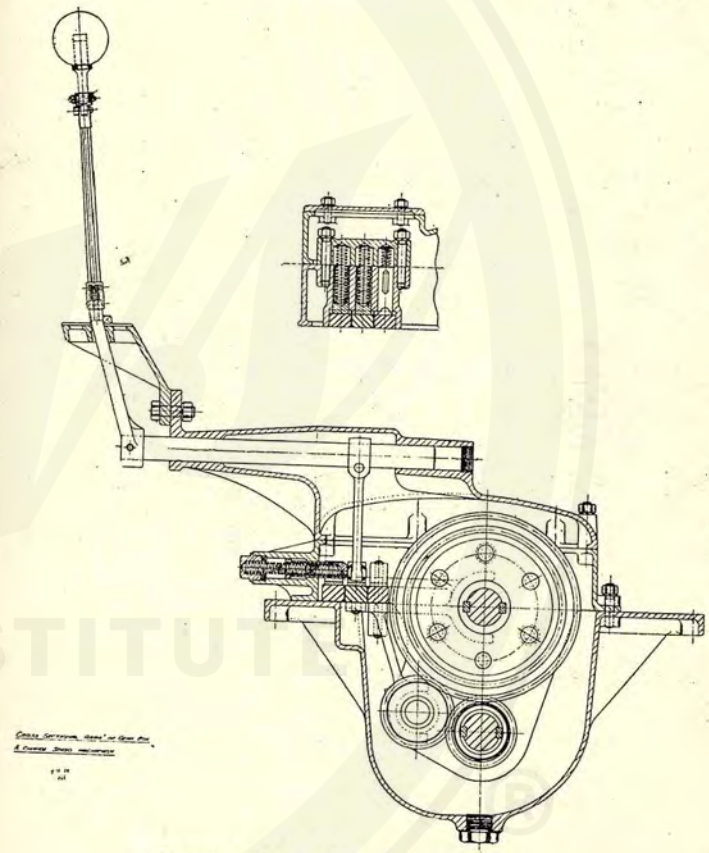
GEAR BOX.

A full charge of oil amounts to 8 pints.

The correct oil level is $7\frac{1}{2}$" from the face of the inspection cover. To ascertain level, remove inspection cover and insert dipper.

If the oil is found to be below this level, add the requisite quantity to bring it to the correct level, *but not higher*. (*See* illustration at end of Instruction Book.)

Every six months, or after three thousand miles' running, the old oil should be drained off by removing plug



CHANGE GEAR BOX AND CONTROLS.

at the bottom of casing. Clean out with paraffin and fill in new oil.

UNIVERSAL JOINT—MAIN DRIVE.

When first assembled, the space is filled in with grease and the joint encased in a leather jacket. Provision is made for adding gear oil when required.

REAR AXLE.

A full charge of thick oil for the axle casing is 4 pints.

The correct depth of oil is marked on the dipper housed inside the casing (*see* page 34).

To replenish the axle casing, remove the rear seat cushion and lift up the hinged seat; remove the cover of the oil filler immediately beneath the seat.

To ascertain if additional oil is required, screw out the dipper and note if the oil level is below the mark. Add sufficient oil to bring the level up to the mark, *but not higher*.

The correct time to check the oil level is after a run, when the oil is warm and in a freely liquid state.

Be careful to screw the dipper hard home when replaced.

Drain the rear axle every 3000 miles; wash out with paraffin and refill to the correct level. Gear oil is easily poured by warming before use.

SPEEDOMETER GEAR (*see* Chart).

HAND-STARTING BRACKET.

Examine regularly, and fill the lubricator with grease when required.

Occasionally apply a few drops of oil to keep the celluloid grip from binding on the starting handle.

FRONT AXLE.

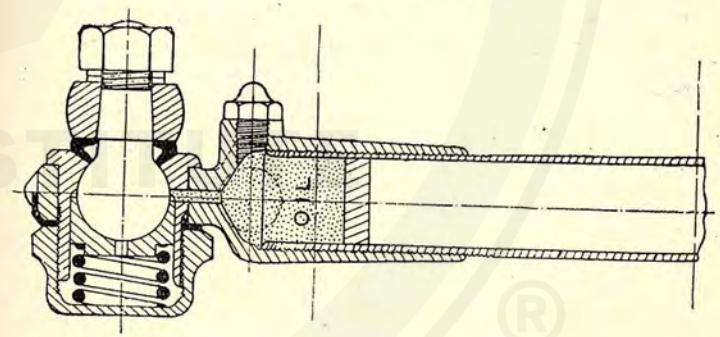
Thin grease should be well packed into the hubs and the hub cap filled, so that, when screwed into place, the grease will be forced well back into the inner bearing.

This should be done monthly in order to prevent possible ingress of mud and dirt into the delicately adjusted ball bearings.

The vertical swivel pins are drilled through the centre to form oil reservoirs, the top end fitted with a screwed nut with automatic flap for lubrication, and should be examined and refilled after 500 miles' running.

STEERING RODS.

The ball and socket joints are automatically lubricated from the oil reservoir contained in the end of the hollow rods (*see* illustration), and should be examined and refilled after 500 miles' running.



STEERING RODS

SPRINGS.

The leaves of the springs are well greased when assembled, and being completely covered in by gaiters, do not require to be re-greased until after 5000 miles on the road.

By jacking up the frame, slacking back the box shackle pins and the clip bolts securing the spring to axle, the springs can be taken down, and the leaves separated and re-greased.

STEERING GEAR BOX.

Should be replenished with thick oil (*see* Chart)

The operating spindle should occasionally be given a few drops of oil through a small hole drilled just above the footboard and covered with a spring clip.

BRAKES.

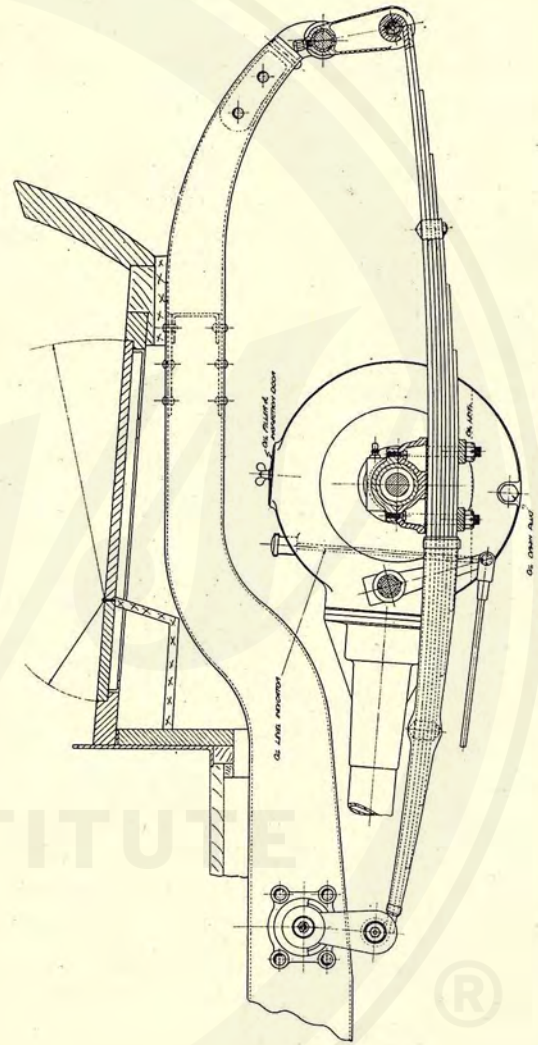
The cross-shafts, fitted under the chassis frame and carrying the intermediate brake levers, run in oil-less bearings.

The brake lever pins should be given a few drops of oil occasionally.

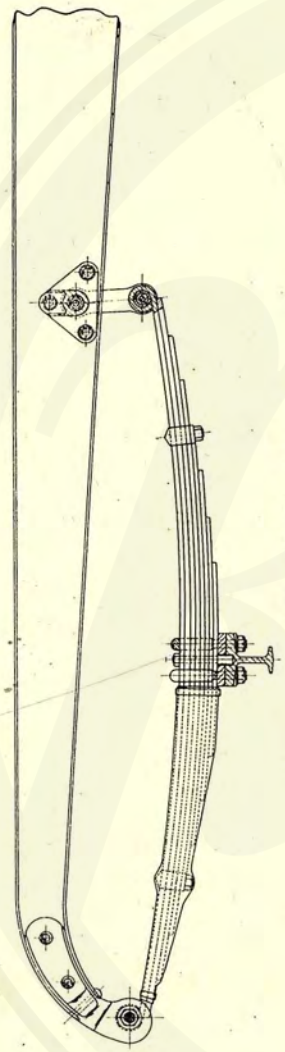
It is most important that the lubrication of the brake-gear parts should be carefully and methodically attended to.

FAN.

A screwed lubricator is fitted to the fan bearing, and should be attended to daily and kept packed with grease.



20 H.P. TYPE "E" CAR.
GENERAL ARRANGEMENT OF REAR SPRING.



20 H.P. TYPE "E" CAR.
GENERAL ARRANGEMENT OF FRONT SPRING.

PUMP—WATER.

A screwed lubricator is fitted to the pump bearing and should be attended to daily and kept packed with grease.

CONTROLS—MAGNETO AND CARBURETTER.

A few drops of oil occasionally are necessary on the joints and pins.

EXHAUST BOX.

This should be examined for obstructions every twelve months, taken down, and thoroughly cleaned.

MAGNETO.

Depending upon the make of magneto.

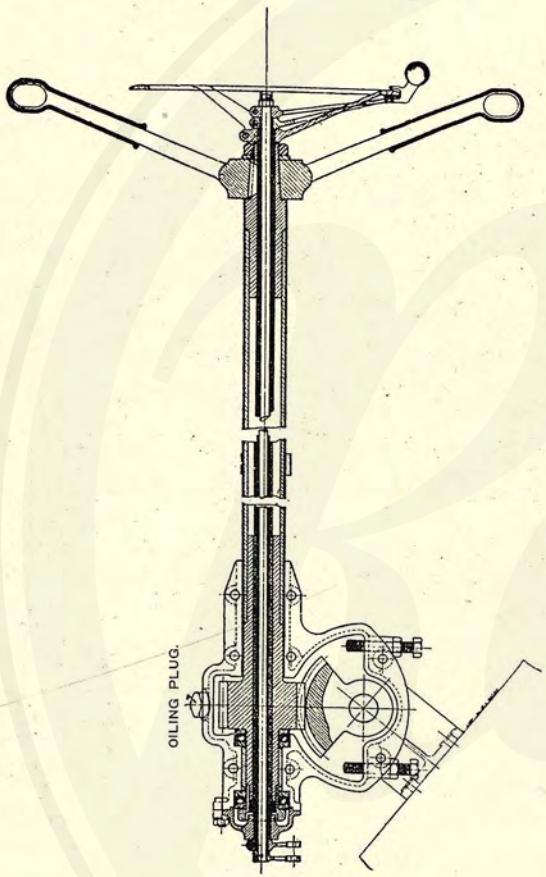
DYNAMO.

When the machines are first assembled the bearings are packed with grease, which lasts for a long time.

There is a lubricator at each end of the machine.

STARTING MOTOR.

To the end of the motor is fitted a grease cup (*see* Chart).



STEERING GEAR AND CONTROLS.

DOOR HINGES.

A few drops of oil monthly.

DOOR LOCKS.

A few drops of oil monthly.

WINDOW AUTOMATIC LIFTERS.

A few drops of oil monthly.
(Saloon Cars only.)

HEAD.

A few drops of oil monthly on head frame hinges.
(All-Weather Cars only.)

"VACUUM" OILS SUITABLE for LUBRICATION of ARROL-JOHNSTON CARS.

ENGINE.

Gargoyle Mobiloil "BB" for Summer.
Gargoyle Mobiloil "A" for Winter.

GEAR BOX AND BACK AXLE.

Gargoyle Mobiloil "C."

HUB—FRONT.

Vacuum Transmission Grease (Light).

HUB—REAR.

Engine Oil.

SPRINGS—FRONT AND BACK.

Gargoyle Graphite Grease (Medium).

OTHER PARTS.

Vacuum Transmission Grease (Light).

IMPORTANT.

OWNERS OF ARROL-JOHNSTON CARS REQUIRING ADJUSTMENTS OR OVERHAULS ARE STRONGLY ADVISED TO HAVE THESE CARRIED OUT, WHERE POSSIBLE, BY ACCREDITED ARROL-JOHNSTON AGENTS.

TOOLS AND ACCESSORIES

FOR

20 h.p. ARROL-JOHNSTON CAR, TYPE "E."

One "Enots" Grease-Gun.
One Lifting Jack.
One Tyre Inflator and Adaptor.
One Pair of Pliers.
One Screwdriver.
One Valve Lifter Lever and Bracket.
One Large Adjustable Spanner.
One Spanner for Front Hub Nut.
Two Sets D.E. Spanners ($\frac{1}{8}$" × $\frac{3}{16}$"); ($\frac{1}{4}$" × $\frac{5}{16}$").
Two Sets D.E. Spanners ($\frac{3}{8}$" × $\frac{7}{16}$"); ($\frac{1}{2}$" × $\frac{5}{8}$").
One Magneto Spanner.
One Combined Rear Hub Nut and Cap Spanner (cranked).
One Combined Clutch and Cylinder Nut Spanner.
One Combined Fan Hub Cap and Adjusting Bush Spanner.
One Tubular Sparking Plug Spanner.
One Tubular Spanner and Tommy Bar ($\frac{1}{4}$" × $\frac{5}{16}$").
One Tubular Spanner for Cylinder Holding-down Nuts.
One Oil Can (under bonnet, o/s).
One Screwed Oil Dipper (in crank case).
One Brace for removing Detachable Wheel Nuts.
One Hand Hammer.
One Tool Box (under rear seat footboard).
One Built-in Tool Box (rear seat) for taking Lifting Jack Handle and Tyre Inflator.
Three Tyre Levers.

TERRITORIAL DEALERS.

Aberdeen	Claud Hamilton (Aberdeen), Ltd., 254 Union St.
Aberfeldy	A. Mackerchar, Bank Street.
Altrincham	J. Richardson & Son, Unity Garage, Dunham Road.
Ayr	Claud Hamilton, Ltd., King's Garage.
Belfast	Leslie Porter, Ltd., 24-30 Great Victoria Street.
Bexhill-on-Sea	L. Russell & Co., Station Road.
Birmingham	John Chilton & Co., 71 Broad Street.
Blackburn	Crompton & Davies, Ltd., Simmons Street.
Blackpool	King's Hall Motor Co. (Blackpool), Ltd., Rigby Road.
Blairgowrie	John Harper & Sons, 27-29 Perth Street.
Bolton	The Bolton Motor Co., Ltd., 3 Marsden Road.
Bournemouth	The Westover Garage, Ltd., Poole Road, Branksome.
Bradford	Central Garage, Ltd., Town Hall Square.
Bristol	Welch & Co., Ltd., Redcliffe Garage.
Burnley	W. H. Harrison (Burnley), Ltd., The Motor House.
Cambridge	Herbert Robinson, Ltd., 2 Regent Street.
Cardiff	J. Parsons & Co., Dalcross Street, Roath Park.
Carlisle	The County Garage Co., Ltd., 14a Botchergate.
Carnforth	Carnforth Cycle & Motor Co., 7 Scotland Road.
Channel Islands	Central Garage, Guernsey.
Cheltenham	H. G. Norton & Co. (1917), Ltd., High Street.
Chester	Gamon, Hardwick & Co., 52 Bridge Street.
Church Stretton	The James' Garage, Ltd., High Street.
Crieff	Harold Barrington, Motor Agent.
Derby	Andrews' Garage, London Road.
Dorchester	E. Channon & Sons, High Street East.
Dumfries	The Dumfries Motor Co., Ltd., 101 English St.
Dunfermline	Fife Motor Co., Halbeath Road.
Dunleer	B. Gannon, Main Street.

Edinburgh	Scottish Automobile Co., Ltd., 43-45 Lothian Road.
Egremont (Cumb.)	J. F. Stout, Market Place.
Elgin	Nicholson & Dalgarno, The Northern Garage, 41 High Street.
Exeter	Gould Brothers, Ltd., 4-6 Southernhay.
Forres	Morayshire Motor & Engineering Co., Ltd., Vulcan Works.
Glasgow	Claud Hamilton, Ltd., The Garage, Smith Street, Hillhead.
Grantham	Whipples, Ltd., 17 High Street.
Grimsby	Fred Lloyd, Strand Street.
Gullane	Arthur Stoddart & Co., Motor Engineers.
Hawick	Croall & Croall, Ltd., Motor Agents.
Hay (Herefordshire)	T. J. Madigan, Garage.
Helensburgh	Macfarlane & Gilmour, Ltd., 1 West Clyde St.
Hull	J. B. Simpson, Ltd., 71 Prospect Street.
Ipswich	Egertons (Ipswich), Ltd., Northgate.
Isle of Man	Athol Motor Garage, Ltd., Hill Street, Douglas.
Isle of Wight	Percy C. Alford, York Avenue, East Cowes.
Kendal	H. J. Croft, 90 Highgate.
Lancaster	Ashton Motors, Market Square.
Leeds	J. Mortimer, 9 Aire Street.
Leicester	Norman Coates, Ltd., Market Street.
Lerwick	Zetland Motor Engineering Co., Commercial Rd.
Liverpool	Tom Garner, Ltd., 20-22 Hardman Street.
Llandudno	Llandudno Motor & Garage Co. (Red Garages).
London	The Leverett Kearton Co., Ltd., 79-85 Davies Street, Oxford Street, W. 1.
Manchester	Tom Garner, Ltd., 10-12 Peter Street.
Middlesbrough	Fred Burr & Co., Ltd., 52-58 Corporation Road.
Monmouth	George Webb, Ganarew.
Nairn	Knowles & Cumming, 9-11 Bridge Street.
Newcastle-on-Tyne	Rossleigh Ltd., Olympia Garage, Northumberland Road.
Newcastle (Staffs)	Thomas Johnson, Ltd., Bagnall Street.
Newport-on-Tay	John T. Young, Ltd., The Motor House.
Norwich	Howes & Sons, Ltd., Chapelfield.
Nottingham	R. Cripps & Co., Ltd., Lower Parliament Street.
Old Colwyn	Llandudno Motor & Garage Co., Olympia Red Garage, Abergele Road.

Oswestry (Salop)	E. H. Longney, Bailey Street.
Perth	Macfarlane & Sons' Motor Depot, 11 York Place.
Peterborough	Brainsbys Ltd., Broadway.
Preston	Loxham's Garages, Ltd., Charnley Street.
Rhyl	Auto Marine Engineering Co.
Sheffield	Sheffield Motor Co., Ltd., 218-224 West Street.
Stirling	Henderson Bros., 29 Barnton Street.
Sunderland	Grimshaw, Leather & Co., Ltd., Union Street.
Truro	Taylor's Transport Co., Ltd., Lemon Quay.
Wellington (Salop)	Ensor & Shaw, Bridge Road.
Wigan	H. H. Timberlake, Ltd., King Street.
Wrexham	Wrexham Motor & Electrical Engineering Co., Chester Street.
York	Gibbs & Co., Fawcett Street, Fishergate.

LICENCE APPLICATIONS.

The following information is necessary when applying for a licence :—

Type of Body :	Touring, All-Weather, or Saloon.
Colour :—	
Engine :	Internal Combustion.
Make :	ARROL-JOHNSTON.
Description of Car :	"EMPIRE" Model, 20 h.p., TYPE "E."
Number of Engine :	See number stamped on left-hand side of crankcase.
Number of Cylinders :	Four.
Bore of Cylinders :	89·75.
Stroke :	130.

COMMON CAR TROUBLES.

Difficulty in Starting will be experienced under any of the following conditions :—

(1) Petrol is not turned on, or not sufficient in tank.

(2) Switch is not " on."

(3) Throttle insufficiently open.

(4) Throttle open too far.

(5) Carburetter flooding.

(6) Sparking plug points too far apart, or points dirty.

(7) Valves sticking in guides—due to using bad oil.

(8) Contact maker on magneto sticking—see that this works freely.

(9) Induction pipe joints drawing air.

(10) Switch wire to magneto " shorting "—disconnect this and try again.

The remedies for some of the above are obvious, and in the next few paragraphs the more common troubles are dealt with at length.

The sparking plugs may be put out of action by carbon deposits on the electrodes. Plugs in this condition should be washed in petrol.

Ignition Fails Suddenly.—Usually due to a permanent short circuit brought about by the earthing cable from the terminal coming permanently in contact

with the frame. To test this, remove the wire from the terminal on magneto. If this does not cure the fault, remove the distributor disc, inspect the distributor carbon brush and make sure the brush is in good order.

Irregular firing may be due to incorrect working of the contact breaker. Remove the cover, see that the locknut of the contact breaker is well tightened up, that the bell crank lever moves freely on its pivot (from which it is insulated by a fibre brush), and that the platinum points are ·5 m/m apart when the bell crank lever is rocked by one of the segments of the steel cam. If necessary, the contacts should be carefully cleaned, and any oil or grease removed. If the examination has not led to the discovery of the fault, and it is impossible to start the engine, the timing of the ignition should be verified. If the timing is correct, the magneto should be returned to the MAKERS ; no further dismantling is advisable.

All the rubbing contacts and collecting brushes should be examined and carefully cleaned once a month.

Popping into Carburetter.—This is usually caused by (1) shortage of petrol, but may also be due to (2) pre-ignition from carbon deposit, (3) defective sparking plugs, (4) a wrongly connected wire on the magneto, or to (5) sticking valves. Examine petrol tank to see if petrol has run short, also the float chamber of the carburetter to see if water has got in—this is a very frequent cause of popping on cars not fitted with a petrol filter between tank and carburetter. The petrol filter should be cleaned once every week at least—petrol should never be put into the tank except through the fine gauze strainer.

Knocking.—If intermittent, may be due to pre-ignition caused by a small particle of carbon on the pistons or cylinder heads becoming incandescent. If continuous, when the engine slows down on an upgrade, may be overcome by changing at once to a lower gear. The engine should never be allowed to knock, the change to a lower gear being effected before it has a chance to labour.

Loss of Compression.—A frequent source of loss of power is faulty compression; this is especially marked on hills, as the efficiency of the engine is greatly reduced. Loss of compression is generally due to leaky valves. The easiest method of locating faulty compression is to switch "off" the ignition, open the throttle-control lever on the steering wheel to its fullest extremity, and then turn the engine round slowly. If the compression of one cylinder is "easier" than the others the trouble is here, and it should be at once rectified. The offending valve should be located, and then make sure that there is the correct amount of clearance between the valve stem and the adjustable tappet when the latter is at the lowest point of travel; if this is correct, the valve spring and cotter should be removed and the valve bodily removed from the engine. Carefully clean the valve and its seat with petrol, and then proceed to grind in the valve as per the foregoing instructions (page 34). It is also advisable to test all joints on the carburetter and inlet system by the same means when looking over the valve gearing.

Another source of loss of compression or power is sometimes the piston rings, which may possibly have turned round, allowing the slots to come in line, thus

allowing the gas to leak past the pistons, or become stuck in their slots, due to too much oil. The remedy for this is to fit new ones. It will take some little time for the rings to become gas-tight; so, even if after fitting new ones the compression is not great, it will probably increase as the rings wear in.

BODY.

Consists of a wooden frame covered with steel panels, and is bolted down to the chassis frame. The holding-down bolts should be examined regularly and tightened down if required. By so doing, body squeaks are prevented.

WINDSCREEN.

The top half of the windscreen is of V-shape in Saloon and All-weather Cars, and adjustable by swinging the glass outwards, thumbscrews being fitted to hold the glass at any desired angle.

CARE OF THE CAR.

Frost.—If frosty weather is expected and the car is not kept in a heated garage, always drain the water off if it is to be left standing for any considerable time.

Split Pins and spring washers should always be replaced after dismantling any part. This is most important, and should any be forgotten or left out, serious damage may result. If any part has to be taken down, all nuts and washers should at once be screwed loosely on their respective bolts, and, together with the other parts, placed carefully away in boxes to avoid any chance

of loss. Nuts should always be slackened by means of the spanner provided, and NOT WITH A HAMMER AND CHISEL. Paraffin oil freely applied and allowed to soak into the threads, at the same time gently tapping with a hammer, will often help to loosen a nut that is jammed or rusted up.

Care of Tyres.—Reckless use of the brakes or clutch, and rounding corners at a high speed, bring severe strain on the tyres, thereby greatly shortening their life. Remember that to get the best results from your tyres it is absolutely essential to have them inflated to the correct pressure. (Each tyre manufacturer specifies scales of pressures.) They should be frequently tested by a tyre pressure gauge, which can be bought from any of the large tyre manufacturers at a reasonable price.

A punctured tyre must be attended to immediately, even though the car is a few yards from home ; otherwise the cover, tube, and perhaps the rim, will be irretrievably damaged. The tread of the tyres should be examined from time to time, any stones embedded therein removed with the point of a knife, and the damaged place vulcanised or temporarily stopped with one of the various compositions made for the purpose, thus preventing wet getting in and rotting the canvas of the cover. Further information about tyres is given in the pamphlets issued by the various tyre companies.

Care of Coachwork.—There is no reason why a motor car cannot be maintained in a similar condition to a horse carriage. The secret of success in this respect is to use an abundance of clean water till every speck

of dust and mud is removed. It is most important that the car should be hosed down before mud has time to dry on hard and cake, as nothing tends more to scratch paintwork and ruin the varnish. After hosing down carefully, wash the body over with one of the special sponges sold for the purpose, using plenty of clean water. The car should then be dried with chamois leathers which have previously been well soaked and wrung out. When the car is new the varnish may be slightly sticky and easily marked ; nothing is better for hardening the varnish than plenty of clean cold water. The upholstery should be washed with a clean sponge every time the car is cleaned, and carefully dried with a chamois in the same way as the coachwork. A little paraffin may be used for removing grease or oil from the wheels, but should be sparingly employed, as it tends to take off the gloss. When cloth and lace are fitted they should be brushed with a good quality brush, having a short point to get into the corners.

Care should be taken that both the Touring Hood and the All-Weather Hood be carefully lowered and stored properly. Envelopes are provided for this purpose.

Never fold a hood when it is wet ; see that it is thoroughly cleaned and dry before folding.

Modus Operandi for Opening and Closing Head of All-Weather Car.

(1) Let down the rear windows.

(2) Release the press buttons attaching the head to the side frames.

(3) Slack back the two wing nuts at the top of the near and off sides of the windscreen, and the two wing nuts at the top of the centre swivel frame carrying the head, one on the near and one on the off side.

(4) Raise up the head by means of the two handles on the side rails and lower carefully.

(5) See that the head fabric folds outwards—not inwards. If the latter, the fabric will chafe.

(6) To close the head, reverse the above operations.

(7) To stow away the head, be careful to pull the folds well out so that same will lie evenly, as per illustration on page 7 of catalogue.

In Conclusion.—The time and work spent in keeping a car thoroughly clean and in spick-and-span condition will be more than compensated for by the pleasure and pride of owning such a vehicle, and by the smallness of depreciation which such care must inevitably entail.

We shall at any time be pleased to place the services of our technical staff at the disposal of any of our clients who experience any difficulty not covered by the foregoing instructions.

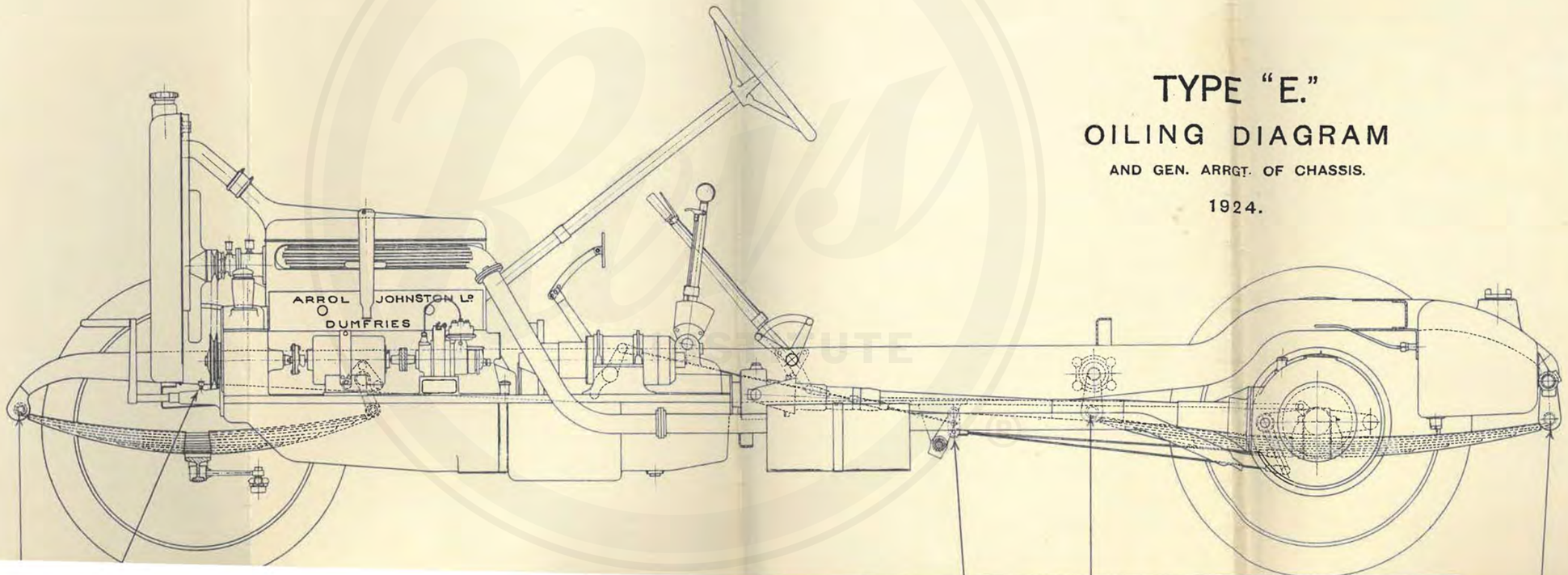
1. **Engine.**	Gargoyle Mobiloil "BB" for Summer Gargoyle Mobiloil "A" for Winter. Fill through the breathers to the mark on the screwed dipper. A full charge is 12 pints. Drain oil from crankcase after first 1500 miles, and replace with fresh oil every 3000 miles.
2. **Gearbox.**	Gargoyle Mobiloil "C." A full charge is 8 pints. Fill through the inspection door to 7½" from door face. Refill with fresh oil every 3000 miles.
3. **Rear Axle.**	Gargoyle Mobiloil "C." A full charge is 4 pints. Fill through the inspection door to depth marked on dipper rod.
4. **Clutch Spigot Bush.**	Engine oil. A few drops daily.
5. **Universal Joint.**	Engine oil. Remove plug and add oil.
6. **Torque Tube.**	Engine oil. Remove plug and add oil.
7. **Torque Tube Pins.**	Engine oil.
8. **Rear Wheel Hubs.**	Gargoyle Mobiloil "C." Remove the counter-sunk screws and add oil.
9. **Front Wheel Hubs.**	VACUUM light transmission grease. Remove the hub cap and pack with grease.
10. **Steering Column.**	Engine oil. Slack back the spring clip covering oiling hole and add oil occasionally.
11. **Steering Gearbox.**	Gargoyle Mobiloil "C."
12. **Brake Pins and Connections.**	Engine oil. A few drops occasionally.
13. **Stub Axle Pins.**	Use "ENOTS" Greasc-Gun.
14. **Steering Gear Rods.**	Engine oil. Remove the brass plug and add oil
15. **Shackle Pins.**	Use "ENOTS" Grease-Gun.
16. **Rear Spring Swivel Bearings.**	Use "ENOTS" Grease-Gun.
17. **Starting Motor.**	Light grease.
18. **Magneto.**	Light grease or Engine oil.
19. **Dynamo.**	Engine oil or Sewing Machine oil.
20. **Water Pump Shaft.**	VACUUM light transmission grease. Keep full.
21. **Fan Shaft.**	VACUUM light transmission grease. Keep full.
22. **Starting Handle Shaft.**	VACUUM light transmission grease. Keep full.
Magneto and Carburetter Control Links.	Engine oil occasionally.

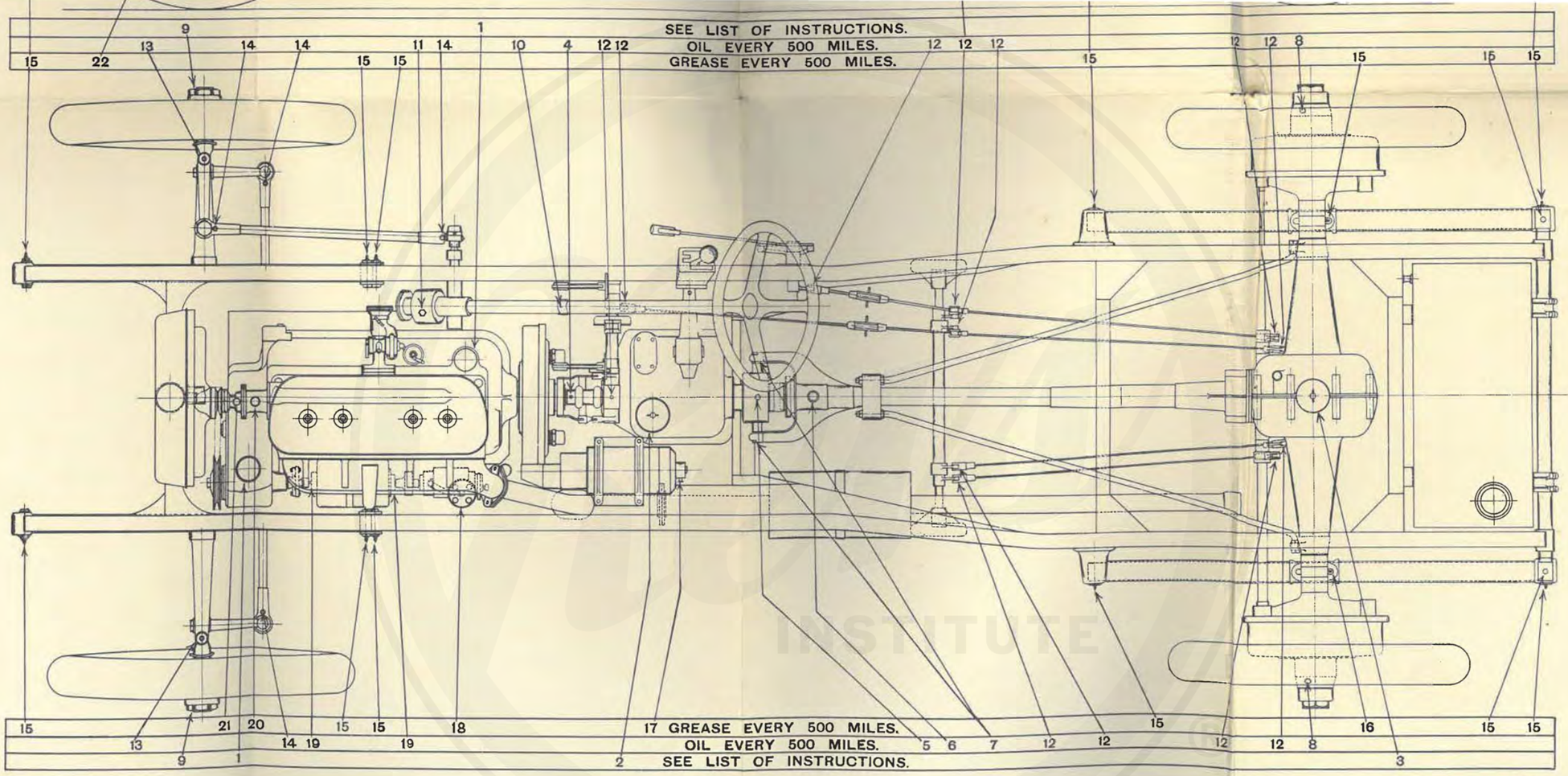
TYPE "E."

OILING DIAGRAM

AND GEN. ARRGT. OF CHASSIS.

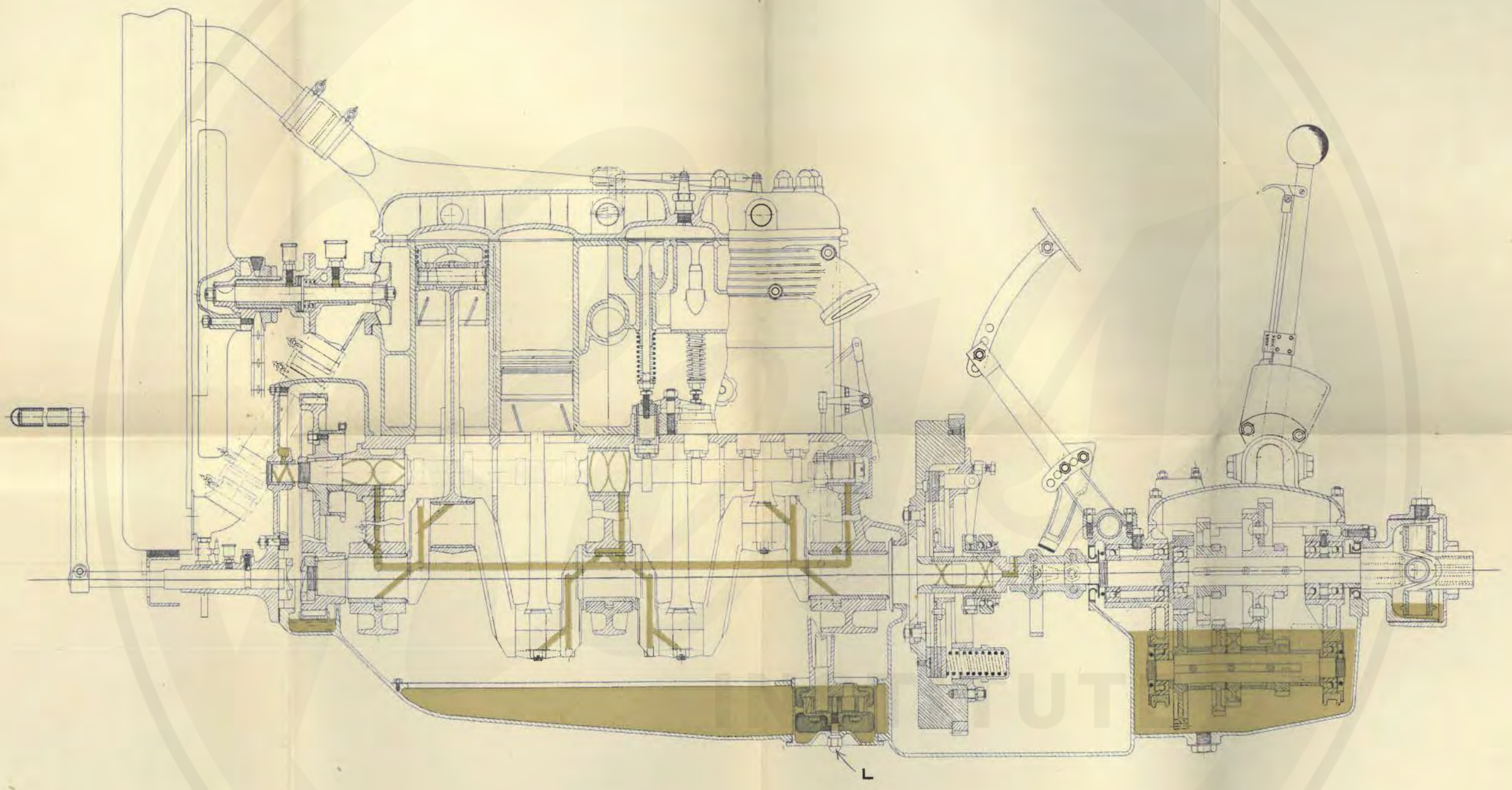
1924.





970 A.

Arrol-Johnston



SECTIONAL VIEW OF COMPLETE POWER UNIT.

20 H.P. TYPE "E" CAR.

1924.

970 A.

Arrol-Johnston