INSTRUCTIONS
FOR · MANAGEMENT
& · CONTROL · OF

"DENNIS"
Turbine
Motor Fire Engines

DENNIS
BROS. (1913)
LIMITED

CONTENTS

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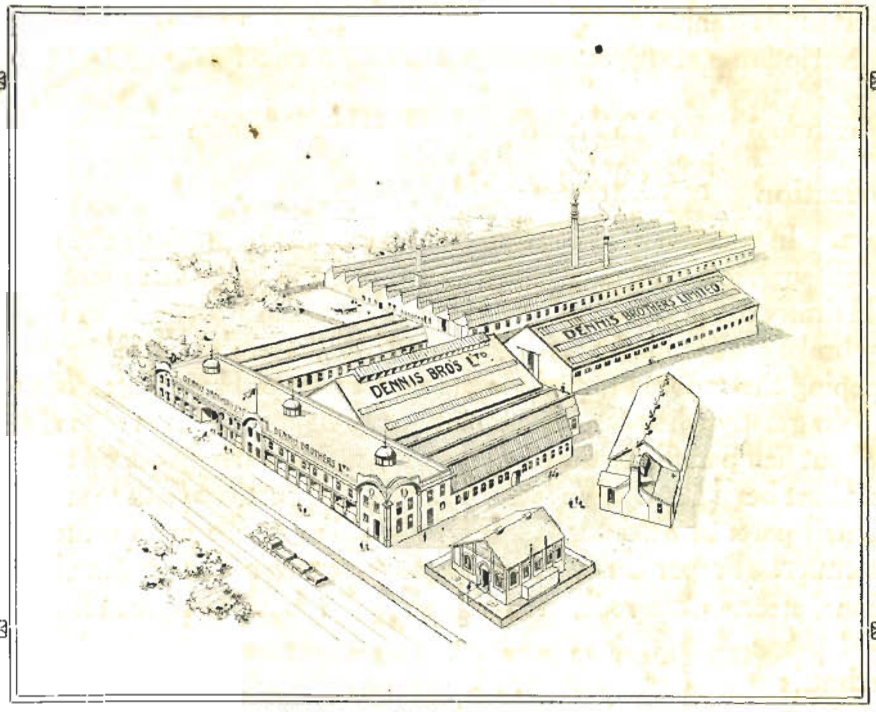
DENNIS "TURBINE" MOTOR FIRE ENGINES



A General View of the Woodbridge Factories

DENNIS BROS (1913) LTD.

Motor Manufacturers

GUILDFORD

Telegrams: "Dennis, Guildford" **Telephone: 129 Guildford**

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INTRODUCTION

Our Aim These few hints are given with a view to helping the users and drivers of " DENNIS " FIRE ENGINES.

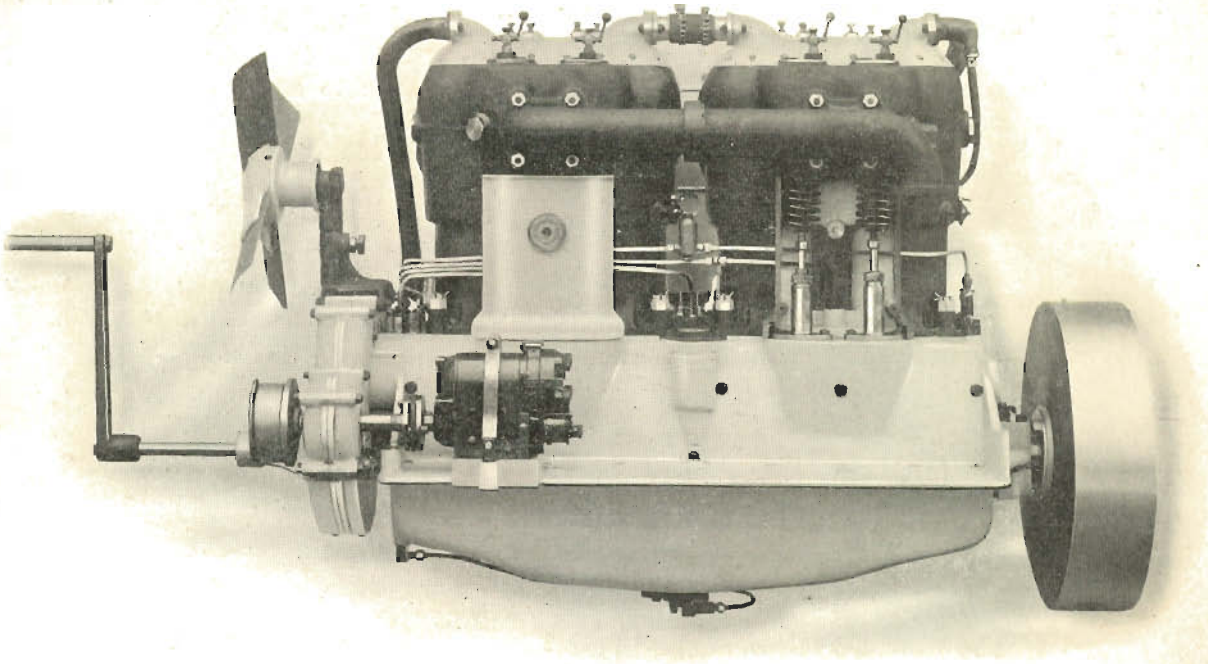
We wish to point out, however, that in a treatise of this description it is practically impossible to cover all the points and difficulties that may arise while operating any motor vehicle, but the intelligent driver who wishes to take an interest in his Vehicle and obtain the best results therefrom will, we hope, find the description and diagrams of considerable service.

Importance of Lubrication We think it worth while mentioning here that one of the most important details contributing towards success in running a Motor Vehicle is that of paying **strict attention to Lubrication.** In addition to seeing that the Engine, Gear Box, Axle and other parts are well supplied according to the instructions in the subsequent pages, we would draw attention to the necessity of going round with an oil can and oiling every brake connection, etc., in fact, every place where movement occurs ; also of keeping the exposed thread for the adjustment of brakes, etc., oiled. This will help greatly when the adjustment has to be made. It is a good thing to add about half paraffin to the oil in the can, as this will help the oil to penetrate should rust be present. We look upon these instructions with regard to oiling the detail parts of a Motor Chassis, in addition to the main units, as MOST IMPORTANT. Proper Lubrication will do a lot towards preventing brake connections, steering, tie rods, etc., getting into a loose, noisy condition.

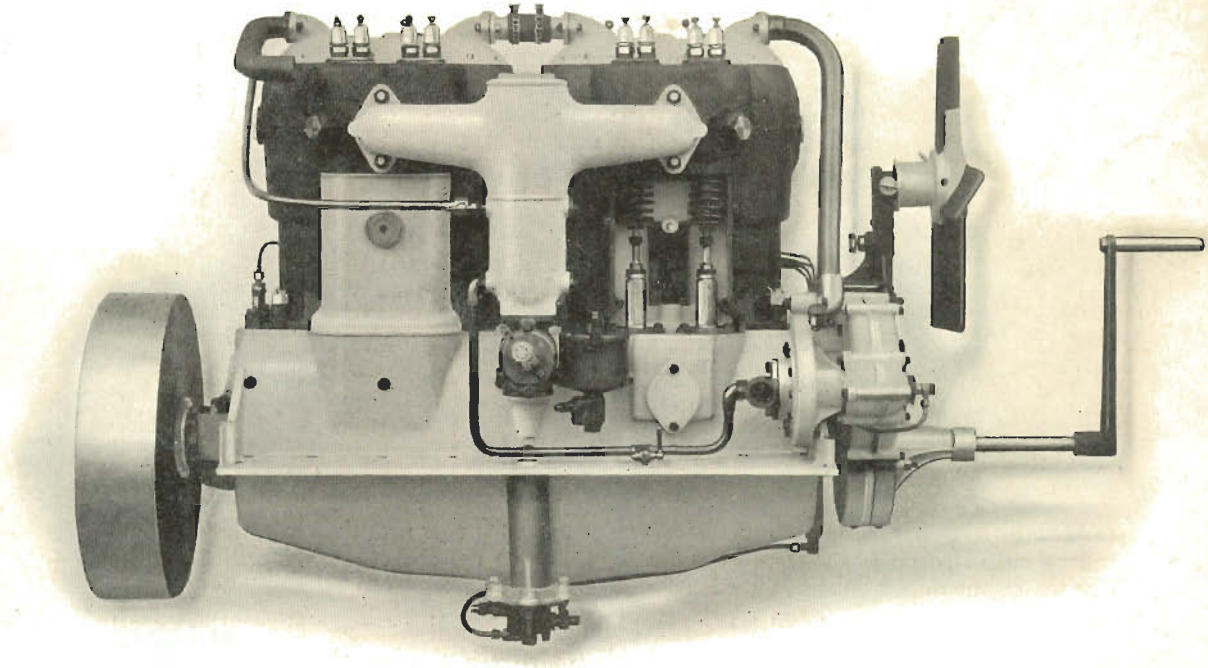
Overhauls Another very important advantage in keeping the Chassis well oiled " **all over** " is that when adjustments and replacements have to be made, the parts come to pieces with half the trouble than would be the case where brake shafts, shackle pins, etc., have been allowed to rust up tight.

Study your Vehicle Every driver should take a studied interest in the running of the Vehicle under his control. In this way he will learn to recognise when any detail requires attention. Then, by seeing to the job at once, the consequent evils of a neglected repair or adjustment will be avoided.

"DENNIS" 60 h.p. Engine



"Exhaust" Side

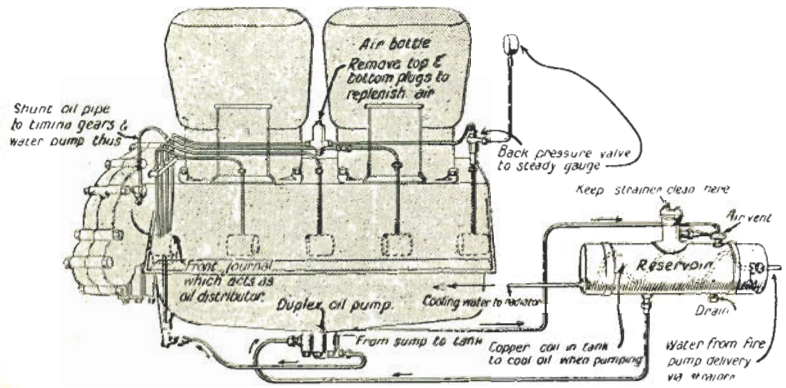


"Inlet" Side

General Care of Machine

Engine This will require very little attention beyond seeing that it is kept well supplied with Lubricating Oil, and for this purpose we recommend VACUUM A. Great care must be taken to ensure that an inferior oil is not used. AN OIL CIRCULATING PRESSURE GAUGE is provided on dash, visible from the Driver's seat and the habit of looking at this gauge at frequent intervals should be cultivated. Any sign that it is not recording a steady pressure should be investigated at once.

Description of Engine Lubrication Diagram. At the bottom of the crank case a Duplex pump gear driven from the Inlet Camshaft draws the oil from the oil tank and delivers it under pressure to the front journal bearing, it is then split up and delivered evenly to each of the four oil pipes by the rotation of the crankshaft.



The complete lubrication system on the engine of the Dennis motor fire pump.

The oil drains back to the sump after a predetermined level has been attained in the bottom of the crank chamber, it is then pumped back to the oil tank by the upper part of the oil pump through a strainer fitted in the tank filler cap.

Should the pressure valve be dismantled, care must be taken to see that this is correctly assembled, which is clearly shown in small sketch. The function of this valve is to release excessive pressure of oil by acting as a bye-pass.

The oil pipes should be cleaned out with paraffin every six months, also the oil tank in the same way. It is a good plan to drain off a gallon of oil from the tank and replace with new after six to eight hours' pumping.

NOTE.—If the distributor is removed from the engine, together with the shaft, the oil pump will be out of action as the pump is driven by a dog on the end of distributor shaft, in this case the engine must not be run until it has been replaced.

The Valve Covers should be removed occasionally to see that all the oil pipes and connections between cylinders are tight, also that valve springs and tappets are in order, and for any adjustment that may be necessary.

General Care of Machine—*Continued*

Adjustment of Tappets This adjustment is best made when the engine is warm so as to be sure of allowing the proper clearance. This is most important as too little clearance causes the engine to run badly and may cause the valves to overheat if the clearance is too great and excessive wear will take place.

INCORRECT CARBURETTOR ADJUSTMENT, allowing of too rich a mixture (noticeable by the pungent smell at the exhaust outlet), may cause excessive carbon deposit in the combustion chamber. This state of affairs will cause the Engine to lose power, and probably " clank " or " knock " when pulling with a fairly open throttle. This trouble can be reduced by injecting two or three tablespoonfuls of paraffin into each cylinder while the Engine is warm, preferably by removing the valve caps so that the paraffin can be well sprayed over the surface. Some hours should subsequently be allowed to elapse before starting up the Engine.

If the Engine is not pulling up to standard it may be due to LOSS OF COMPRESSION. To test this, crank the Engine round by the starting handle ; an even, springy resistance should be felt when each piston comes under compression. If this is not the case, find out which cylinder is at fault by opening three compression cocks at a time and cranking round to try the compression on the cylinder with the closed cock.

The trouble may be due to a valve not seating properly, either through incorrect adjustment of the tappet or through carbon deposit. The state of the valve seat will show any trouble in this respect ; it should be clean and smooth. If the valves are adjusted and are seating correctly, then the trouble may be due to a leakage taking place through a valve cap or sparking plug joint. This can usually be heard when the Engine is being cranked round. A leak past the rings of the piston is unusual and will require expert attention, including the removal of the cylinders.

Oil Pipe from Tank to Oil Pump It is very important that the connection from the bottom of the oil tank to the oil pump be kept tight as in any other pump, if the suction pipe is not air tight the full quantity will not be delivered.

Valve Setting.—In our four cylinder 127 m/m bore 180 m/m stroke Engines the :—

Exhaust opens 18 m/m before bottom.
Exhaust shuts 1 m/m over top.
Inlet opens 8 m/m down.
Inlet shuts 5 m/m up.

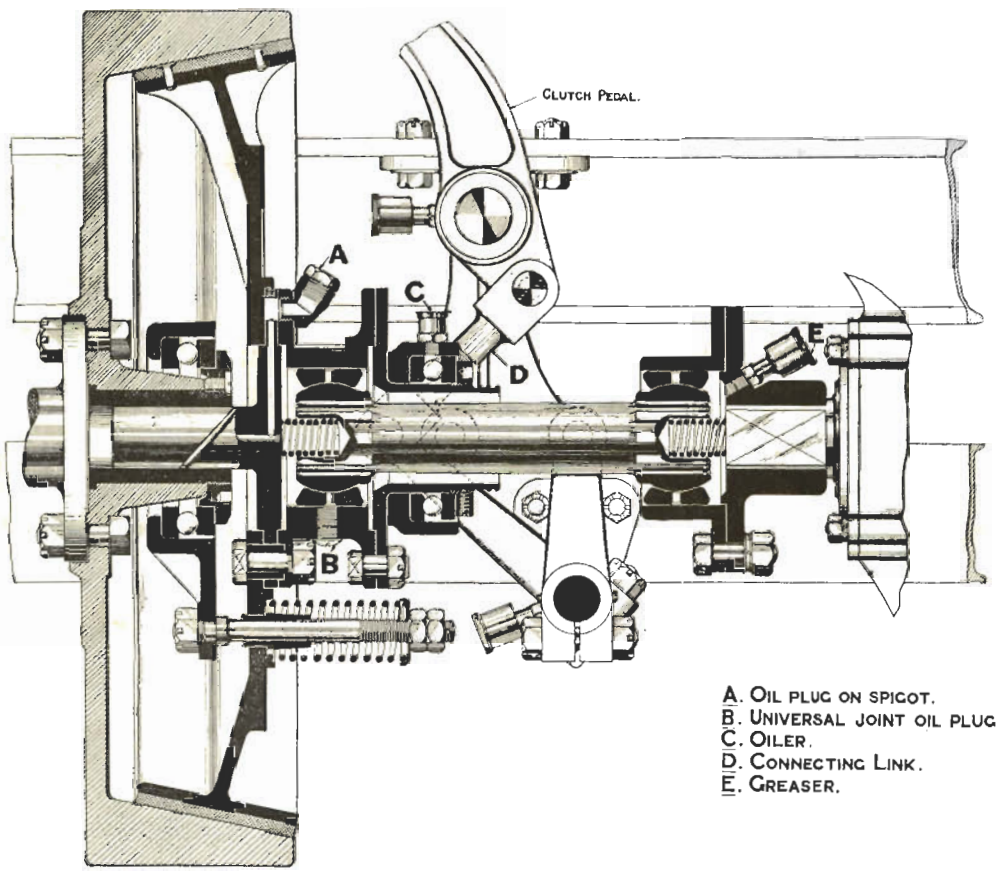
Care of the Clutch

THE CLUTCH is of the composition-lined cone type. A careful study of the illustration will show the method of operation.

It is most important to see that this detail is kept in proper working order. To begin with, on the foot pedal being pressed hard down, the clutch should soon come to rest to allow of the gears meshing quietly. CLUTCH STOP indicated on the illustration, see page 28, is provided for this purpose, and should be kept adjusted up to its work. Keep the clutch clean and all working parts well lubricated, paying special attention to the INTERNAL SPIGOT, which is lubricated through the plug marked "A." If the spigot is allowed to "seize" or get dry, there will be difficulty in getting the male portion of the clutch to stop. Do not drive with a "FIERCE" CLUTCH, but tone it down with a little oil at once. Should the clutch show signs of slipping, wash it out with paraffin and see that the adjustment of the foot pedal is not preventing the male portion from going "home" into its position. This is the most frequent cause of a SLIPPING CLUTCH, for as the composition face wears, so the clutch goes further in, and the connecting link "D" must be lengthened, otherwise the stop on the pedal holds the clutch partly out.

When all pressure is removed from the clutch pedal, there should be a little "play" in the connections, that is, it should be possible to pull the pedal up from the foot boards about $\frac{1}{4}$in. THIS WILL MEAN THAT THE PEDAL CONNECTION WILL NOT BE INTERFERING WITH THE PROPER ENGAGEMENT OF THE CLUTCH.

The outside spring adjustment may require attention, and a little more pressure can be put on the clutch faces by tightening the three nuts on the ends of the spring studs, taking care to ADJUST ALL THREE ALIKE as regards number of turns. See illustration below.



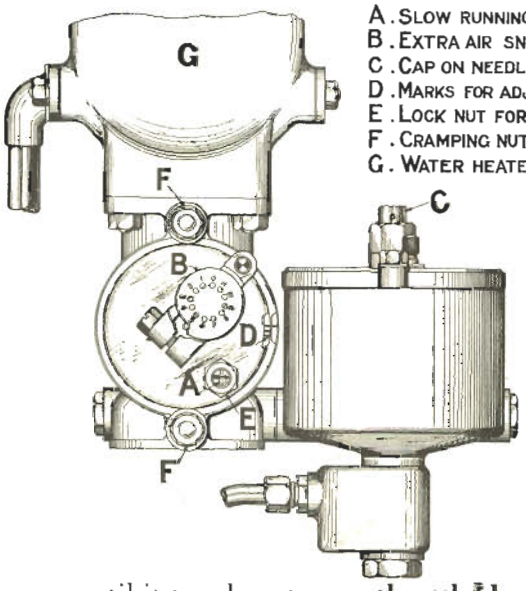
A. OIL PLUG ON SPIGOT.
B. UNIVERSAL JOINT OIL PLUG.
C. OILER.
D. CONNECTING LINK.
E. GREASER.

General Notes on the Petrol Feed and Carburettor System

Petrol Tank The petrol tank is situated immediately under the driving seat, and its holding capacity is 20 gallons. The petrol is fed to the carburettor by gravity.

Petrol Filter The petrol is supplied from the tank to the filter, and it is necessary that the bowl of the filter should be cleansed daily and note taken that a good stream of petrol is available when filter bowl is detached. It must be remembered that the petrol pipe feeding the filter and also the petrol tap immediately under the tank are liable to become choked with foreign matter and so to starve the petrol supply to the float chamber.

Float and Needle Valve Both the float and needle valve may be removed occasionally for the purpose of cleaning the float chamber, but on no account should either float or needle valve be dropped, damaged, or strained whilst performing this operation ; damage here will materially interfere with the accurate working of the carburettor.



A. Slow running stop.
B. Extra air snail on throttle lever.
C. Cap on needle valve.
D. Marks for adjusting air sleeve.
E. Lock nut for slow running stop.
F. Cramping nuts for air sleeve.
G. Water heated inlet pipe.

The Carburettor is bolted direct to the inlet pipe in which is embodied a water-heated jacket. It may be found an advantage when pumping in hot weather to reduce the circulation of hot water round the jacket by partly closing the tap.

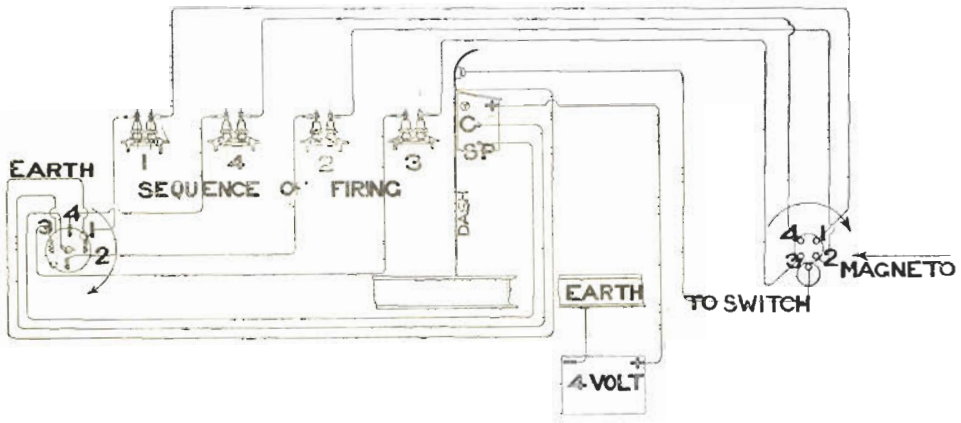
A. **Slow running stop.** An eccentric screw engaging with a pin in the end of the throttle drum—the widest point of the eccentric screw is marked with an arrow. To adjust, start engine and after the correct position of the air disc has been found, slow the engine down to the required speed. Slacken the lock-nut E, then turn the screw A round until it touches stop on throttle drum—if it is turned too far the throttle will be opened by its pressure, causing the engine to run too fast. Be sure the lock-nut E **is quite tight** before opening the throttle by the accelerator pedal.

B. **Extra air regulating disc.** By this means air can be admitted to the mixing chamber through the hole in the throttle spindle. By turning the disc to the right or left the amount of air can be varied so as to obtain the correct mixture.

D. **Scale on air sleeve for the main adjustment of the Carburettor.** To strengthen mixture slacken the two cramping nuts F and turn air sleeve to the **left** (anti-clock) about half a division, which as a rule will be found sufficient.

C. **Cap over needle valve.** This should be always in place as the cause of carburettor flooding is generally grit working down between top of float chamber and needle.

Ignition Wiring Diagram



Magneto and Accumulator Ignition Wiring

INSTRUCTIONS FOR "TIMING" MAGNETO IGNITION.

The engine must be turned round until the No. 1 cylinder piston is at the top of the firing stroke. To find this open compression cock 2, 3 and 4 and as soon as compression is felt, which means No. 1 is approaching dead centre, open compression cock and turn slowly until the mark on the fly wheel is vertical. The magneto can then be fixed. First turn the magneto spindle until the carbon brush in H.T. distributor touches No. 1 segment then couple up leather disc coupling.

If it has been necessary to dismantle the magneto drive it will require to be re-adjusted so that the break in magneto will occur when the piston is at the top dead centre with the rocker at full retard. In re-assembling place the differential collar on driving bolt and slide through the hollow magneto pinion shaft until the collar is within $\frac{1}{4}$" of the end of hollow shaft.

Turn engine until No. 1 piston is at the top dead centre also magneto so that carbon brush is entering No. 1 segment, then turn magneto until the platinum points just break.

The castellated differential collar should be turned round so that the teeth will mesh in both driving flange and shaft, then slide together, place nut on fan pulley and tighten up.

Care of the Magneto & Ignition System

The Distributor The distributor cover should be removed occasionally and any carbon dust wiped away which may have accumulated owing to the normal wear of the carbon brush. There is a possibility that this carbon dust might cause " shorting " to take place from one brass segment to the other, the result of which would be that the spark would occur in one of the cylinders not under compression, with consequent misfiring.

After cleaning the inside of the distributor in this way, it is advisable to lubricate the rubbing surface slightly with a little oil, in order to prevent the carbon brush from sticking.

Lubrication The armature of the magneto is fitted at both ends with ball bearings which require only very little lubrication. Excessive oiling should be carefully avoided. Nothing but the best oil should be used, not too thin, and the magneto should be lubricated at regular intervals. The distributor gear wheel is provided with a plain bearing which is oiled by means of a felt wick, and requires, of course, more lubrication than the ball bearings of the armature.

The two oil holes noticeable under the oil cover at the distributor end of the magneto are of different sizes, the larger one being for the distributor gear wheel. If the motor is used daily, this oil well should be filled every 8 to 14 days according to the size of the two oil holes. When the magneto is new, it can be lubricated a little more frequently, although filling up the small oil well three times will always be sufficient.

Important It is of the utmost importance that no oil shall get on the platinum surfaces of the contact breaker, oil being a non-conductor and so tending to insulate the platinum contacts from each other, and causing excessive burning on the points.

The Switch When the switch is closed or in " OFF " position, the primary winding is short circuited, as a result of terminal and screw being " Earthed ; " that is to say, in contact with the frame. This renders the action of the contact breaker ineffective.

Safety Spark Gap A safety spark gap is fitted on the magneto to provide against excessive strain being imposed on the insulation of the windings. If any of the cables become disconnected from the sparking plugs, or if the electrodes of the latter are too far apart, the current will be discharged across the safety gap. This must not be allowed to continue for any length of time.

Care of the Magneto & Ignition System

(continued)

Contact Breaker The most delicate part of the magneto is the contact breaker. It is advisable to inspect it occasionally, and to do this it is only necessary to remove the fibre disc which is held on to the timing lever by an expanding spring. The contact breaker is then accessible for examination, and if necessary the gap between the platinum points can be adjusted. When these contacts are separated by the fibre block of the bell crank lever striking the steel cams fitted in the timing ring, the platinum contacts must not be more than 0.4 m m (about 1/64th of an inch) apart. This distance can be regulated by means of the adjustment provided on the platinum screw. If the points should be uneven, BUT ONLY THEN, they should be filed flat with a smooth file, and subsequently adjusted.

Special attention should be given to the easy movement of the bell crank lever, the pivot of which works in a fibre bush in order to render lubrication unnecessary. On new magnetos it may happen occasionally that this bell crank lever becomes stuck up owing to the swelling of the fibre, but by slightly increasing the bore of the fibre bush by means of a reamer, this defect can easily be remedied.

If, after carrying out the foregoing instructions, the running of the Motor is not satisfactory, the timing of the magneto should be verified.

If the timing of the magneto is found to be correct, but ignition is still unsatisfactory, it is advisable to return the magneto at once to the makers as any further dismantling of it would probably result in the eventual repair being more complicated and more expensive. Apart from this, the makers can only guarantee magnetos which have not been tampered with beyond the instructions given in this booklet.

Misfiring If one cylinder misfires continually, the trouble will probably be due to the sparking plug, the changing of which will prove an immediate remedy. The usual troubles experienced with sparking plugs can be dealt with as follows :—

Care of Sparking Plugs

1.—Short circuiting between the electrodes and the body of the plug, caused by small metallic beads which are sometimes formed as a result of the strong magneto spark melting the electrode.

This fault can be quickly remedied, as the beads are easily removed.

Care of the Magneto & Ignition System

(continued)

2.—Too wide a gap between the electrodes and the body of the plug. The correct gap is 0·5 to 0·6 m/m (about 1/50th of an inch), and anything much larger or less than this will tend to make the ignition to work unsatisfactorily. The electrodes can easily be bent until they are the correct distance from the body of the plug. If the gap is much too great, the spark produced by the magneto will be discharged across the safety gap. When plugs are removed from the cylinders, they might appear, of course, to work satisfactorily even if the gaps are excessive, but it must be remembered that they will not necessarily work correctly under compression where the resistance to the spark is very much greater than in air. The fact that the sparks jump regularly across the plugs, when the latter are removed from the cylinders, gives no guarantee that the electrodes are set correctly, as such an experiment is only of value if the plugs are working under compression.

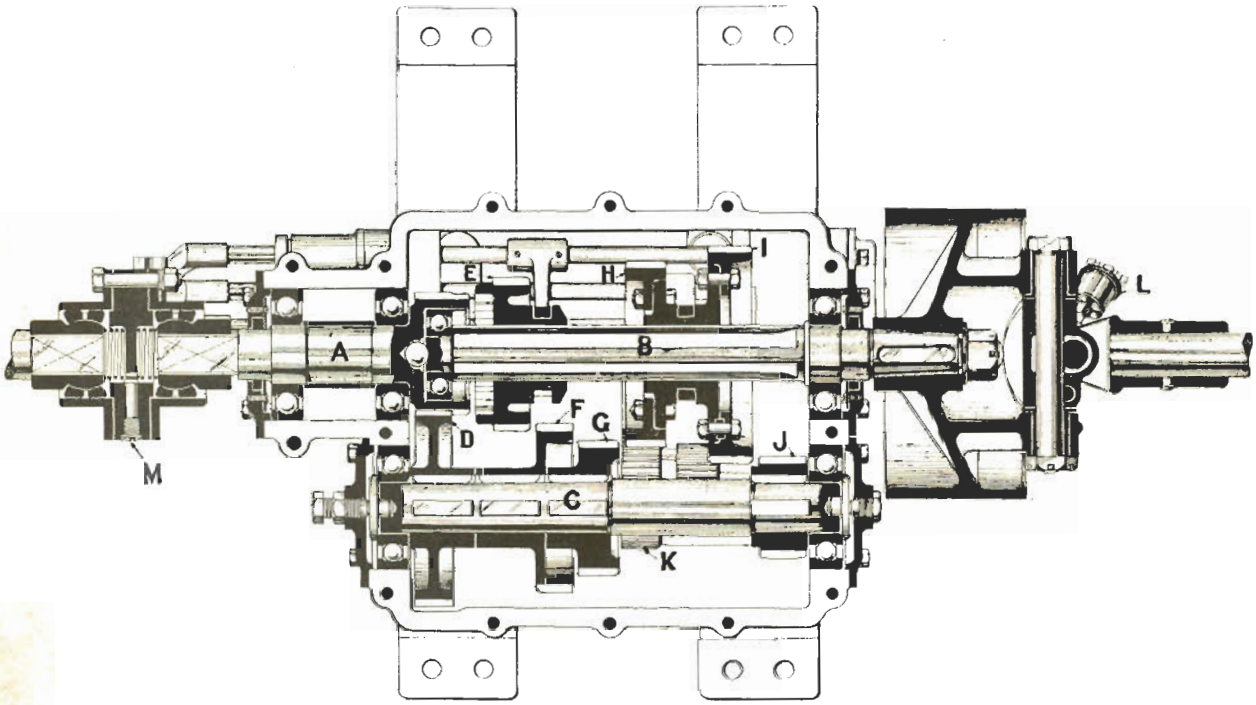
3.—Sooting up of the plugs. If sooting up should occur, the portions which are exposed to the explosive gasses can easily be cleaned by means of a little petrol.

If the ignition fails completely and suddenly, it may be concluded that the connection for short circuiting the magneto is faulty and a short circuit is being accidentally caused. This can easily be ascertained by removing the switch cable from the magneto terminal, but if this does not remedy the trouble, the cause must be sought elsewhere.

Accumulator Ignition A single tremble coil with a high and low tension distributor. This should be treated in the same way as the magneto with the exception that the make and brake will require more attention and should be inspected every two or three months and adjusted if necessary. The same gauge should be used as for the break in the magneto, about 0·5m/m. As the wear takes place the duration of the contact becomes longer so that in time the contact would be continuous and cause back firing when starting.

Accumulators should always be charged up every four weeks whether they have been used or not. It is a good plan to discharge the spare one through a 4-volt lamp for a few hours before re-charging. Always keep the top of the plates covered with acid, replace with new any that may be spilled, but on no account should fresh acid be used to replace any that may be lost through evaporation, only add distilled water or sulphating will result.

"DENNIS" Fire Engine Gear Box



A. FIXED SPEED PINION.
B. FIRST MOTION SHAFT.
C. SECONDARY SHAFT.
D. FIXED SPEED WHEEL
E. 3RD SPEED WHEEL
F " " PINION ON SECONDARY SHAFT.
G. 2ND SPEED PINION ON SECONDARY SHAFT.
H. 2ND SPEED WHEEL 1ST MOTION SHAFT.
I. 1ST " " " "
J. 1ST " PINION " SECONDARY SHAFT.
K. IDLE WHEEL FOR REVERSE.
L. U.V. JOINT GREASER.
M. GREASE PLUG.

PUMP GEAR BOX.

The Pump gear box which transmits the power from the engine to the pump, is of the ordinary sliding type and will not require any special attention except lubrication. It is very important that only the right quantity of oil be used. Too much lubrication will only cause heating up and waste of oil.

To ascertain the correct level, take out oil level plug and fill up until the oil reaches the bottom of hole.

A thick gear oil or grease and oil should only be used.

Description of Gear Box and Change Speed Mechanism

The gear box is of the four-speed and reverse sliding pinion type, with direct drive on fourth gear. Ball bearings are used throughout, and all wheels are mounted on splined shafts. A careful study of the line-drawing on previous page should be made, so that the functions of the various parts may be understood.

LUBRICATION — Gear oil, such as Vacuum C, is the best lubricant for both these boxes. All that is required is that the wheels just touch and should never be nearer than 1¼ inches from the bottom of the splined shaft. Oil working out of the breather on gear box cover is due to too much oil.

THE GATE CHANGE—The various positions of the hand lever for the four forward speeds and reverse are clearly marked. It is most essential to keep all the moving parts of the change speed operating mechanism well lubricated and working freely.

Gear Changing

CLUTCH BRAKE The first essential point in gear changing is to note that the clutch has plenty of downward movement, and that the clutch brake pad comes into operation before the pedal plate reaches the footboard.

STARTING AWAY To engage first Gear or Reverse, the throttle lever should be moved back. Then, fully depress the clutch pedal and wait a second for the male portion to stop spinning. The gear should then be pushed forward into the first gear notch.

"CHANGING UP" Before changing from first to second gear, the engine should be run moderately fast on first gear. Then de-clutch, and move lever to neutral, pause a second, and finally bring the lever into second gear.
In changing to the third and fourth gears this operation will be repeated except that from second to third gear no pause should be made because of the extra time taken for the lever to traverse the gate.

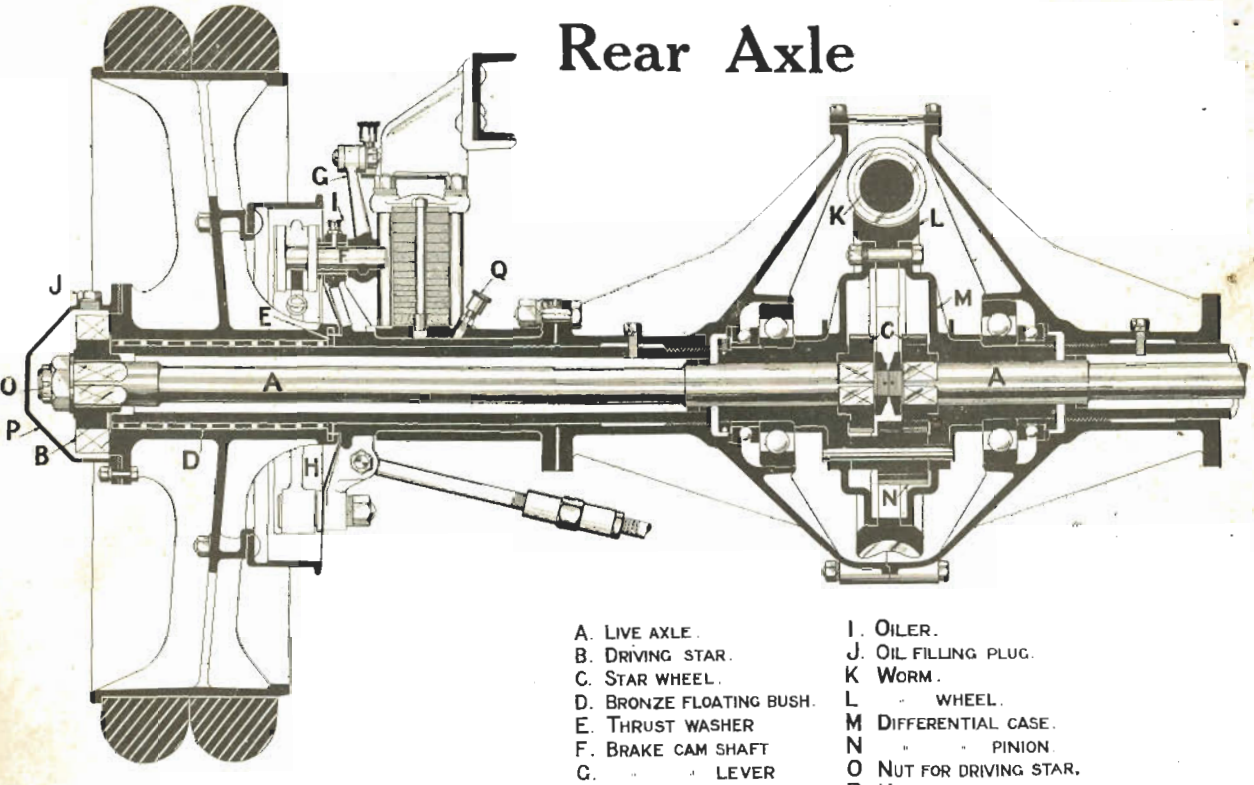
"CHANGING DOWN" In changing down, the clutch pedal slightly depressed, and the gear lever moved to the neutral position. The clutch should then be re-engaged for a second, and at the same time slightly accelerate, the clutch pedal should again be depressed, the gear lever being slipped into the lower gear with the last clutch movement. This is known as "double" clutching, the object being to speed up the male portion, making the ratio of speeds correct for the engagement of the lower gear.

"DOUBLE CLUTCHING"

Of course the gears may be changed by clashing the edges of the pinions together, but it should be every driver's ambition to change the gears without the slightest noise or damage. A little practice in the above is all that is necessary.

A point to bear in mind is that the clutch cone should not stop spinning too quickly. Should this be the case the stops should be adjusted a little further away from the cone, and a little grease put on them.

Rear Axle

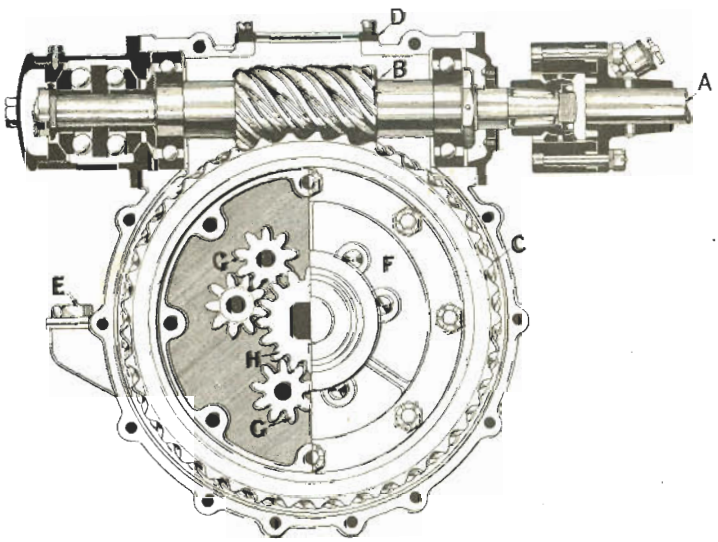


A. LIVE AXLE.
B. DRIVING STAR.
C. STAR WHEEL.
D. BRONZE FLOATING BUSH.
E. THRUST WASHER
F. BRAKE CAM SHAFT
G. " " LEVER
H. " SHOES.
I. OILER.
J. OIL FILLING PLUG.
K WORM.
L " WHEEL.
M DIFFERENTIAL CASE.
N " " PINION.
O NUT FOR DRIVING STAR.
P. HUB CAP.
Q. GREASER.

The Rear Axle is of the worm and wheel driven type. A study of the line drawings will make the detail quite clear.

It is very important that great care be taken when replenishing the oil and grease, to see that no dirt or grit gets into the axle.

Should it be necessary to take any of the gearing to pieces, great care must be taken to see that the parts are correctly re-assembled, careful attention being paid to the mounting of the worm and wheel, seeing that the parts are central and in line and that the worm takes its proper bearing on the worm wheel. Also see that there is no "end-play" in any of the thrust bearings—these must be adjusted tight.



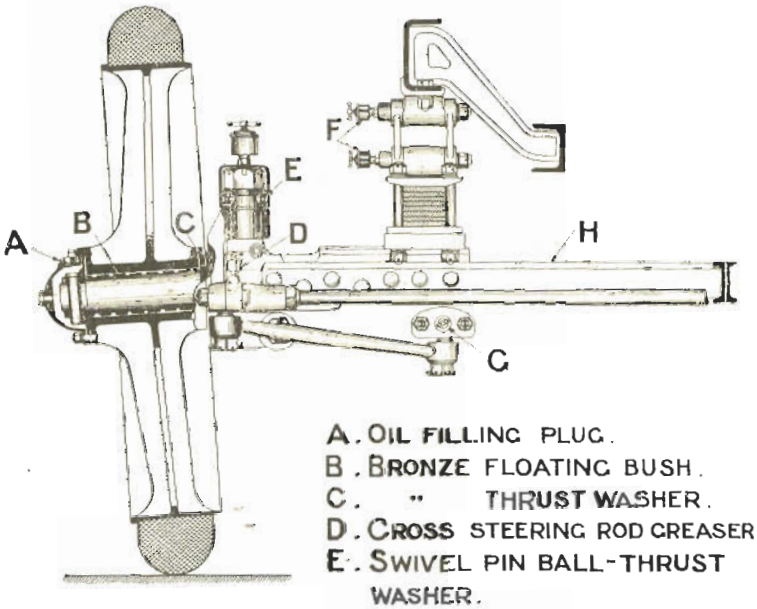
A. PROPELLOR SHAFT.
B. WORM SHAFT.
C. BRONZE WORM WHEEL.
D. INSPECTION COVER.
E. OIL FILLER.
F. DIFFERENTIAL CASE.
G. " PINION.
H. " WHEEL.

LUBRICATION It is very important that the right kind of lubricant be used. A medium thickness gear oil should be used and kept up to the oil level plug "E" shown on drawing.

Front Wheel Hub and Steering Swivel

The front wheel hub runs on a " floating " bush and plain stub axle bearing, and strict attention must be paid to see that it is well lubricated at regular intervals.

The steering swivel moves on a ball thrust bearing and plain vertical pin. Large sized grease lubricators are provided on the tops and bottoms of these pins, and grooves are arranged to convey the grease to the various parts. These, together with all ball steering joints, must be carefully attended to, and on no account allowed to be short of sufficient lubricant.



Front Wheel Hub, etc.

A. OIL FILLING PLUG.
B. BRONZE FLOATING BUSH.
C. " THRUST WASHER.
D. CROSS STEERING ROD GREASER.
E. SWIVEL PIN BALL-THRUST WASHER.
F. SPRING PIN GREASER.
G. SIDE STEERING ROD GREASER.
H. FRONT AXLE.

Steering Gear

The steering gear is of the " worm and segment " design. Great care should be taken to see that the proper lubrication of all parts is not neglected. At the top of the pillar will be found a small but important grease lubricator, which should be regularly attended to. The steering gear box must be supplied with grease through the plug hole provided for the purpose. In addition the numerous grease lubricators fitted to the steering connections and axle swivel must also be kept well supplied.

While attending to these instructions a careful inspection of all nuts and connections should be made : see that none are loose, and that all split pins are in position.

Brakes

FOOT BRAKE This Brake is of the slipper type and it is necessary to keep it in proper adjustment. Also it is important that ALL MOVING PARTS and CONNECTIONS should be well LUBRICATED and WORK FREELY.

ADJUSTMENT The main adjustment is made from the turn buckle under the driver's footboards. Care should be taken not to take up the rod too much—one turn will be found enough at a time.

Brakes—(*Continued*)

When the lever on the cam-shaft at the top of brake goes too far forward through wear of shoes, the turn buckle adjustment should be unscrewed so that the lever on brake goes right back to the stops. The nuts "G" on plan view of chassis, page 28, should be screwed up, pushing the levers holding the shoes nearer the drum—adjust so that the brake will come into action when the pedal is one inch from foot-boards.

GREAT CARE MUST BE TAKEN THAT THE SHOES ARE ADJUSTED EVENLY.

The set screws through the side levers are provided to ensure the shoes clearing the drum when brake is "off" and should be adjusted so as to tilt the shoes until they are quite clear.

HAND BRAKE Acting direct on to the rear wheels. Always keep both sides adjusted evenly by the turn buckles A.A, page 28, so that the levers on the cross shaft hang straight down when the brake is hard on. For adjusting in the ordinary way to take up wear, use the turn buckle B, page 28. When the levers on the cross shaft come too far forward, unscrew B and take up AA evenly. THE BRAKE SHOULD BE HARD ON WHEN HAND LEVER IS HALF-WAY UP QUADRANT.

ALWAYS KEEP ALL KNUCKLE JOINTS AND BEARINGS WELL LUBRICATED.

Breaking rods are caused by rusty knuckle joints. It is a good plan to go over all joints with a little paraffin before applying the lubricating oil, as it will penetrate any rust that may have formed.

UNIVERSAL JOINTS Special attention should be paid to the lubrication of all the Universal Joints on the driving shafts, especially on the propellor shaft behind the foot brake and on the worm shaft.

CLUTCH STOP should be kept well adjusted to facilitate gear changing—it should touch the clutch cone when the pedal is half-way to the foot-board.

ROAD WHEELS Both front and rear wheels will require to be adjusted for end play from time to time and care should be taken not to overdo this or heating up will result.

FITTING WHEELS After the parts have been thoroughly cleaned try the floating bush both in the hub and on the axle, making quite sure there are no burrs or rough places anywhere. Thoroughly oil thrust washer, bush and wheel hub and place on axle in rotation, using gear oil for this purpose. The driving star should then be placed in position together with washer and nut.

CARE MUST BE TAKEN NOT TO SCREW THE NUT UP TOO TIGHT.

Screw up just tight, then slack nut back one-third of turn and place split pin in position.

LUBRICATION Half fill hub cap with gear oil.

A Few Hints and Tips

To Start Engine

1.—Partly open throttle by means of hand lever on steering column.

2.—See that petrol is turned on.

3.—Crank engine round about four or five turns.

4.—Switch on magneto and coil ignitions, making sure that the ignition lever is **retarded** as far as possible.

5.—The engine should then start up by itself as soon as the coil ignition is switched on.

6.—Advance ignition and switch off coil.

If the engine has not been run for a long while or the petrol has been turned off, the carburettor should be slightly flooded by raising the needle valve in the float chamber.

If the float chamber of carburettor floods, look to the following probable causes :—

1.—The float may have been punctured and become totally or partially filled with fuel, and therefore incapable of lifting the toggles which operate the needle valve to shut off the petrol.

2.—There may be a little grit under the needle valve. This can be removed by raising the needle valve off its seat, thus allowing the fuel to flood through and wash away the obstruction.

3.—The needle valve may require grinding in, which should be carefully done, great care being taken when grinding to see that there is no grit on the seating or it will be ruined. The best grinding medium for this is jewellers' rouge or Globe Polish. Emery must on no account be used.

Petrol will not feed to the Carburettor

1.—Disconnect filter bowl, turn on petrol and see that there is a plentiful supply. Should the filter appear starved, disconnect pipe feeding the filter and note if there is a plentiful supply here. If the supply is all in order, then the stoppage is actually in the filter itself—not an uncommon occurrence.

2.—Should there be a poor supply of petrol feeding the filter, it next remains to disconnect the pipe—tank to filter—entirely, and thoroughly cleanse ; at the same time check tap on petrol tank and make certain there is no obstruction here. A petrol tap is just as likely to choke, in fact, more likely, as the petrol feed starts from here. Should everything appear in order, then the next point to receive attention is the feed from filter to the carburettor.

3.—When starting to replace petrol feed system, always start at the tank end and note as you go along that the petrol feeds freely through each pipe.

Popping in Carburettor

1.—Failure to turn on heating tap.

2.—Opening throttle suddenly before engine is thoroughly warmed up.

3.—Ignition too far retarded.

4.—Valve spring broken.

5.—Tappets adjusted too close, preventing valve from seating.

6.—Petrol supply to carburettor choked.

7.—Petrol jet choked.

8.—Water in petrol.

A few Hints and Tips—(*Continued*)

Stoppage of Car or Engine on the road may be due to

1.—Petrol supply choked.

2.—Switch accidentally knocked off.

3.—Petrol tap jolted closed.

4.—Petrol too low in tank.

5.—Over-heating through lack of lubrication to the various bearings.

6.—Brakes adjusted too light.

7.—Bell-crank of contact breaker seized in fibre bush, see "contact breaker"—Magneto notes, page 9.

Engine will not start

If the petrol feeds to the float chamber satisfactorily and Engine will not start, it may be due to—

1.—Choked petrol jet.

2.—Throttle insufficiently open.

3.—Coil Ignition not working.

4.—Switch not being on.

5.—Throttle too far open.

6.—Sparking plug points too far apart. See notes under "IGNITION."

Engine will not accelerate

This may be due to—

1.—Ignition being too far retarded.

2.—Contact breaker points of magneto dirty and out of adjustment. See note under "IGNITION."

3.—One or more sparking plugs missing fire. This should be checked occasionally; to do this, start engine and open compression taps alternately, accelerate engine and note there is no break in the succession of explosions.

Explosions in Silencer

This is probably due to faulty ignition. Check firing.

Over-heating

1.—Insufficient water in radiator.

2.—Fan belt loose.

3.—Unnecessary running of machine on the lower gears.

4.—Engine short of oil.

5.—Tappets badly adjusted, not allowing valves to close.

6.—Ignition too far retarded.

7.—Clutch slipping.

8.—Carburation difficulties, mixture probably being too strong.

9.—Mis-firing.

10.—Petrol too hot from water jacket.

11.—Water circulation at fault.

Engine knocking

1.—Ignition too far advanced. If ignition has been retarded and knocking still continues, it may be due to pre-ignition. In other words, the carbon deposit requires cleaning off the piston heads. Sometimes an Engine will fail to stop when ignition has been switched off. This is also due to pre-ignition or self-ignition through over-heated sparking plug points.

2.—Connecting rod or shaft bearings may be worn.

3.—Missing fire on one or more cylinders.

A Few "Don'ts"

1.—Do not open throttle fully or suddenly when engine is cold, always open gradually until the engine is thoroughly warmed up.

2.—Do not forget to see that heater tap to induction pipe is turned on during the cold weather. See carburettor diagram.

3.—Do not forget to drain the water from radiator, cylinder jackets and water pump nightly during the frosty weather.

4.—Do not forget to fill radiator with water before starting the engine.

5.—Do not fill cold water into an overheated engine. Always wait until the cylinders have cooled down, otherwise there is danger of damaging them.

6.—Do not forget to keep the fan belt adjusted and driving properly.

7.—Do not forget to switch on.

8.—Do not forget to see that oil pressure gauge is registering when engine is running.

9.—Do not let the magneto, wiring, sparking plugs or any part of ignition apparatus get damp.

10.—Do not forget to run with the ignition as far advanced as possible. The engine will run cooler and the petrol consumption will be better.

11.—Do not forget to clean petrol filter after a run.

12.—Do not forget to keep both the foot and side brakes adjusted.

13.—Do not forget that the side brakes should hold when brake lever is half-way along quadrant, also that foot brake should hold well before pedal plate reaches the foot board.

14.—Do not forget to lubricate the hubs of the rear wheels, front wheels, also rear axle, gear box and universal joints, especially those behind foot brake and at the end of arbor shaft.

15.—Do not forget to lubricate every brake rod bearing, also all knuckle and ball joints throughout the car—this is very essential.

16.—Do not forget to lubricate the clutch centre daily.

17.—Do not forget to lubricate the steering swivel pins, also shackle pins of all springs.

18.—Do not forget to lubricate the steering box. A good plan is to first put a little oil in a grease cup and some grease on top and force same well into the joint.

19.—Do not forget to check the compression of each cylinder occasionally. Also the firing of each cylinder by means of the compression cock, to see that it is doing its fair share of work.

20.—Do not tamper with any part of the vehicle unnecessarily.

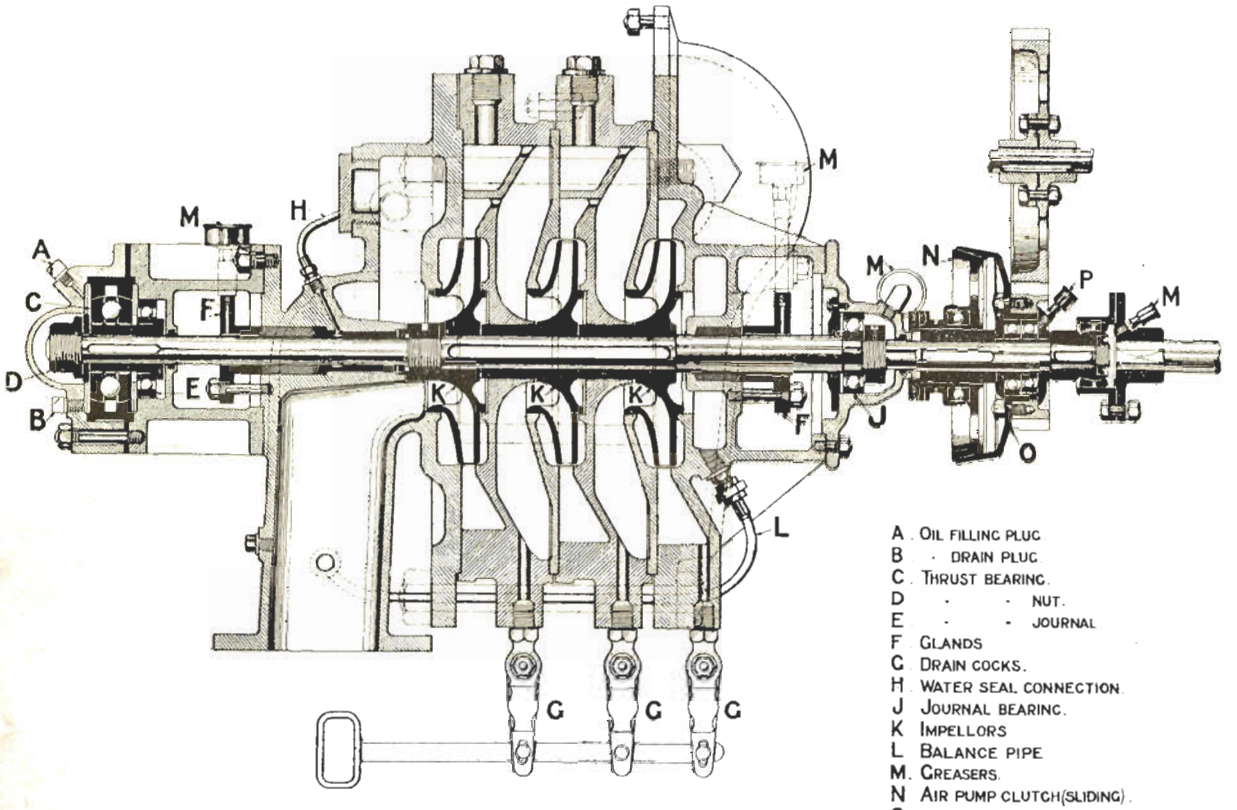
21.—Do not forget that the general performance of a motor vehicle depends largely on the attention given to it by the driver.

22.—Do not forget to keep the engine, gear box and underpan thoroughly clean.

23.—Do not forget to re-set the electrodes of the sparking plugs every 1,500 miles.

24.—Do not forget to use the side brakes whenever possible, reserving the foot brake for traffic work.

25.—Do not open throttle too far or engine will not start.



A. OIL FILLING PLUG.
B. " DRAIN PLUG.
C. THRUST BEARING.
D. " " NUT.
E. " " JOURNAL.
F. GLANDS.
G. DRAIN COCKS.
H. WATER SEAL CONNECTION.
J. JOURNAL BEARING.
K. IMPELLORS.
L. BALANCE PIPE.
M. GREASERS.
N. AIR PUMP CLUTCH (SLIDING).
O. " " " WITH AIR PUMP SPUR WHEEL.
P. " " " GREASER.

Pump

The pump is of the multi-stage turbine type of the usual pattern and requires very little attention beyond keeping the grease lubricators "M" filled and when working give a turn at frequent intervals.

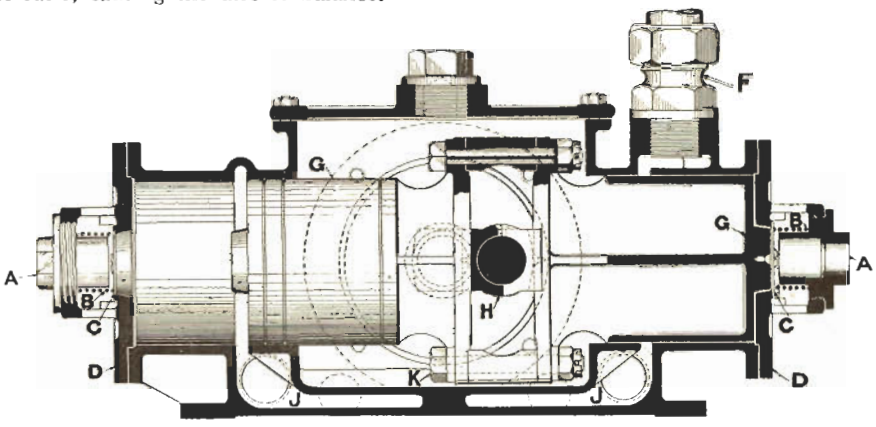
At the rear end of the pump spindle will be found a ball thrust bearing "C" which should be looked after and well lubricated with light machine oil. Care should be taken not to leave too great a quantity in the housing or heating up will result. An oil level screw will be found in the cap and should be removed when filling to ensure the correct quantity being maintained.

The glands at front and rear of pump should be kept up to their work. If the packing is in good condition very little pressure of the cover will be required—they should be just tight enough to be quite air-tight at 27" vacuum.

WATER SEAL The rear gland being on the suction side is water sealed by the connection "H" supplying water from the first stage to the bearing in the pump case under pressure. In this way a small quantity of water is drawn through between the shaft and bush instead of air in the event of the gland leaking.

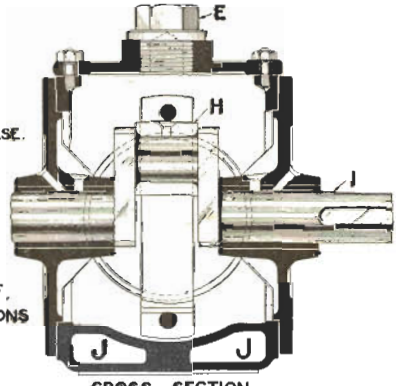
Pump—(*Continued*)

BALANCE PIPE A connection from the suction to the front of the third disc "L"—this is to relieve the pressure from the ball thrust bearing. As the suction head increases the suction through balance pipe "L" on the third disc increases in the same ratio, causing the disc to balance.



LONGITUDINAL SECTION.

A. EXHAUST VALVE CAPS.
B. VALVE SPRING.
C. EXHAUST VALVE.
D. CYLINDER COVER.
E. OIL FILLING PLUG FOR CRANK CASE.
F. CONNECTION FOR AIR PIPE TO PUMP SUCTION.
G. PISTONS.
H. SLIDING BLOCK ON CRANK PIN.
I. CRANK SHAFT.
J. AIR PASSAGE FROM LEFT HAND CYLINDER TO AIR CONNECTION F.
K. BOLTS HOLDING THE TWO PISTONS TOGETHER.



CROSS SECTION

Air Pumps

LUBRICATION The pumps are lubricated throughout from the crank case, which should be filled up level with the top of the pistons, with two parts gear oil and one of grease.

It is very important that the air pumps should not be run too fast—the engine running rather less than half speed will be found to be the most suitable—you will not get any better results by racing them, in fact they will not be quite so quick in lifting water.

TESTING Always test the pumps after use by placing the blank cap on the suction inlet and running the air pump in the ordinary way. If all is in order 27" of vaccum should be reached. If the air pump lever be then pushed back to the out position the hand of the gauge should remain some considerable time without falling back.

If the gauge falls back quickly it shows that there is a leak somewhere which will have to be found out. The best way to do this if the machine is fitted with a collecting-head or direct suction is to connect up to the main when any defective joints or connections will be at once shown. If this is not the case it is necessary to go thoroughly into the matter and make a thorough investigation.

Air Pumps—(*Continued*)

The following are a few points to attend to in rotation:

1.—Inspect air pump exhaust valves and springs to see that they are seating properly.

2.—See that the cylinder cover joints are in good condition and air tight.

3.—Examine crankcase for oil, if nearly empty will cause vacuum reading to be low.

4.—See that all the joints between air pump and air cock are tight.

AIR PUMP CLUTCH For connecting the pump to the air pump—it is mounted on ball journal bearings. The greaser "P" should have frequent attention, also the sight feed at the rear of body should be turned on before the pump is started and should continue to drip all the time it is working.

NOTE.—The Pump should on no account be run dry as the internal bearings are water lubricated. When testing air pump a few gallons of water should be in the pump. After pumping do not drain pump right out, leave a few gallons until you have tested the air pump.

WATER FILTER The water supply from the pump to the radiator passes through the filter situated on the off-side of the chassis: it should be cleaned out by removing the lid and cleaning the wire gauze basket as soon as the flow of water from the radiator overflow is seen to diminish. After passing through the filter the water goes through a coil inside the oil tank thence to the radiator: by this means the engine oil is kept cool throughout long pump runs.

IF THE PUMP WILL NOT START:

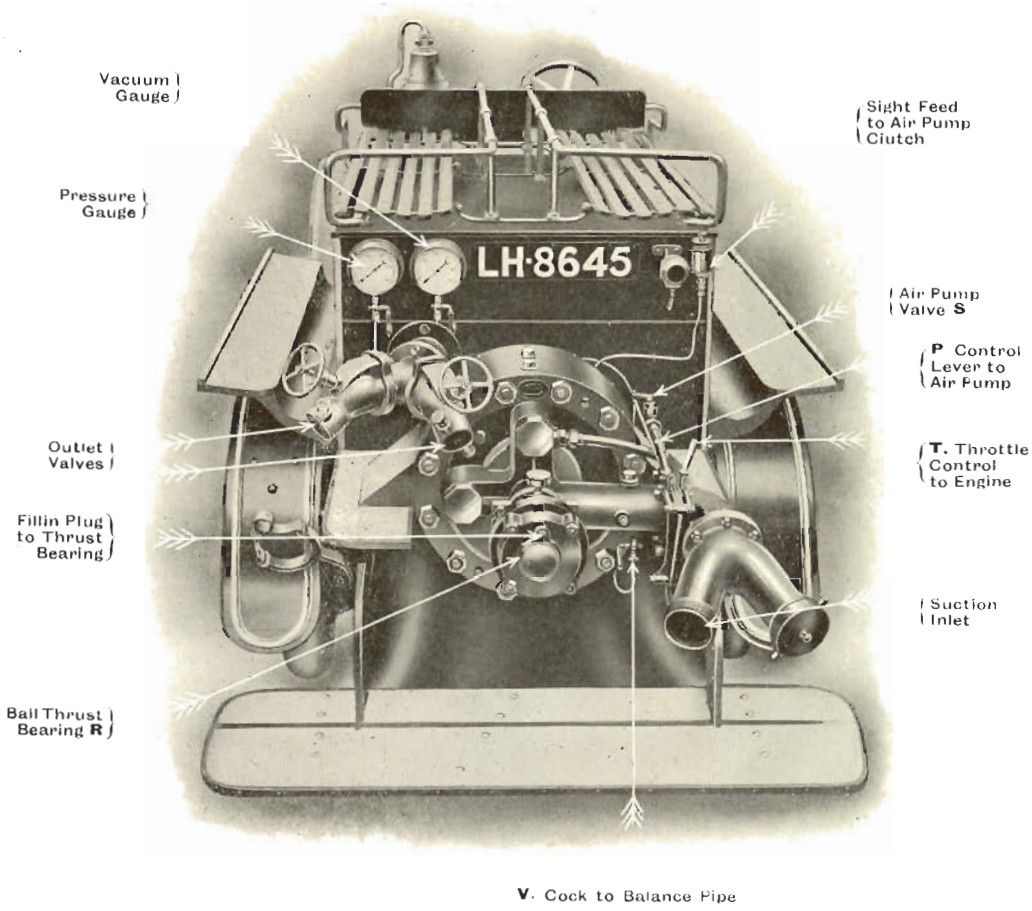
1.—See that the suction strainer is at least six inches under the surface of the water.

2.—See that all the suction hose washers are in good condition and lay flat on their seats when pulled up tight. It is a good thing to grease or dress with oil frequently to keep them in a pliable condition.

3.—Try the outlet valves by screwing down the wheels to see that one or the other is not stuck open.

4.—See that the pump drain and radiator feed cocks are closed.

5.—Inspect the air cock to make quite sure that the cock opens to the full extent when the air pump clutch lever is over to the point marked "IN."



Rear View of Engine.

To Start Pump

1.—See that one or more of the outlets are open.

2.—See that the bye-pass cock " U " is closed.

3.—Turn on sight feed to air pump clutch.

4.—Put pump gear box lever over to the "IN " position and run on one quarter speed.

5.—Pull lever " P " slowly back to position marked " IN," and await arrival of water in the pump, when pressure will be seen recorded on the gauge.

6.—Press lever " P " forward to the position marked " OUT."

7.—Open bye-pass to radiator " U."

Don't forget to open one of the outlets.

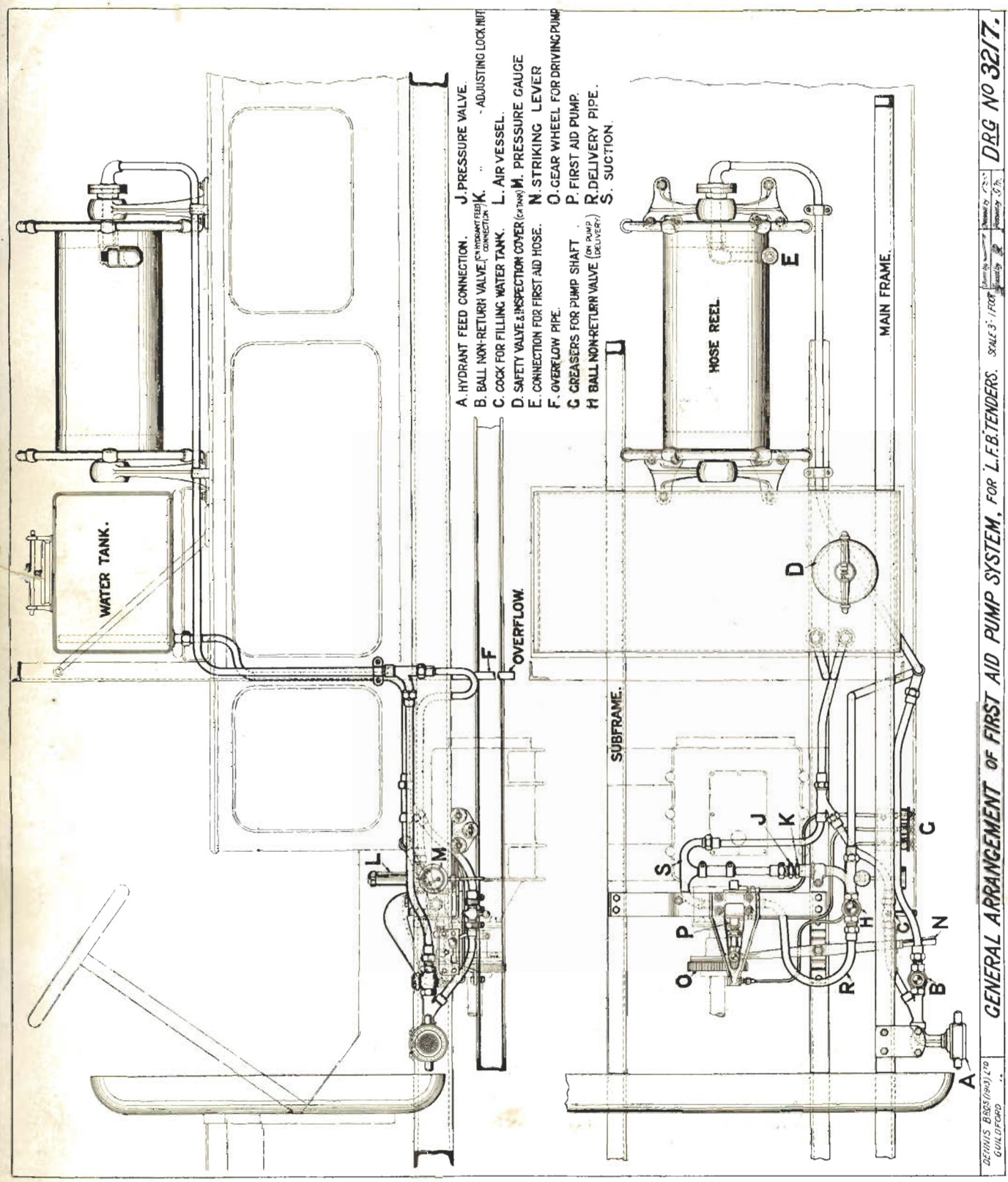
Don't forget to close radiator bye-pass " U " before starting.

Don't forget to close drain cocks on pump.

Don't start pumping until suction hose is in the water.

Don't forget to open bye-pass to radiator directly pump is working.

First Aid


WATER TANK.
A. HYDRANT FEED CONNECTION.
B. BALL NON-RETURN VALVE (ON HYDRANT FEED CONNECTION)
C. COCK FOR FILLING WATER TANK.
D. SAFETY VALVE & INSPECTION COVER (ON TANK)
E. CONNECTION FOR FIRST AID HOSE.
F. OVERFLOW PIPE.
G. GREASERS FOR PUMP SHAFT
H. BALL NON-RETURN VALVE (ON PUMP DELIVERY)
J. PRESSURE VALVE.
K. " - ADJUSTING LOCK NUT
L. AIR VESSEL.
M. PRESSURE GAUGE
N. STRIKING LEVER
O. GEAR WHEEL FOR DRIVING PUMP
P. FIRST AID PUMP.
R. DELIVERY PIPE.
S. SUCTION.
OVERFLOW.
HOSE REEL.
MAIN FRAME.
SUBFRAME.
DENNIS BROS (1903) LTD GUILDFORD
GENERAL ARRANGEMENT OF FIRST AID PUMP SYSTEM, FOR L.F.B. TENDERS.
SCALE 3" = 1 FOOT
DRG No 32/17.

First Aid Pump

Consisting of a double helical pump drawing water from a tank placed in body and delivery to an hydraulical hose reel containing ordinary rubber hose with shut off nozzle.

THE PUMP should not require much attention with the exception of being kept well greased when working—the gland on the spindle tightened up when necessary to prevent water working out. The Greasers " G " should be given about one turn each every few minutes while working, also frequently grease the slippers on the striking lever.

WATER TANK Carried either inside or on top of body, having a large filler cap " D " which may be used for filling when hydrants are not available. The cover is kept in place by means of a spring plunger on cross bar and acts as a safety valve. To remove cover pull plunger marked " Pull " and slide cross bar side-ways until free of lugs.

HOSE REEL Keep the gland well greased and packed so that it is quite tight yet allowing the reel to turn easily. When winding up the hose do not pull it too tight, in fact put it on as slack as possible.

PRESSURE VALVE A spring loaded ball valve which may be set to blow off at any pressure by adjusting the spring tension. It is required to release the pressure when the nozzle is shut off and the pump is kept running. It will be seen from the illustration that it connects the delivery pipe to the suction, acting as a bye-pass.

To adjust, slacken lock nut " K " and turn body of valve round until the required pressure is obtained. The best way to do this is to start pump, turn on nozzle full, then work up the pressure slowly until 100 lbs. per square inch on the gauge " M," which will be found the best working pressure. The nozzle should then be slowly turned off keeping a sharp look out on the pressure gauge. If the valve is set too high the pressure will rise as the nozzle is closed—in this case the body of the pressure valve " J " should be unscrewed until 100 lbs. is reached, then lock the nut " K." If on the other hand the pressure will not go up to 100 lbs. per square inch the valve is too weak and will require screwing up.

The arrangement of the pipes will be clearly seen from the drawing and little explanation will be necessary.

1. When the pump is being used the water is drawn from the tank through the suction pipe " S " and delivered through the non-return valve " H " to delivery pipe " R " to the hose reel —pressure being on delivery pipe " R," non-return valve " B " is kept closed. The tank is fed by connecting hose to hydrant connection and turning on feed cock " C " which should be adjusted to supply about the same quantity as the pump is using.

2. **WORKING OFF HYDRANT** Non-return valve " B " is opened and non-return valve " H " is closed by flow of water to hose reel. When changing over from pump to hydrant feed all that is necessary is to slow engine down and push gear lever out.

TO START FIRST AID PUMP

1.—Slow engine down as slow as possible.

2.—Push gear lever in sharply.

3.—Open throttle until the required pressure is obtained.

To convert pressure in lbs. per square inch into head in feet

Multiply the pressure by 2·307.

Example—150 lbs. pressure × 2·307 = 346 feet head (approx.).

To convert head in feet to pressure per square inch

Multiply head in feet by ·4335.

Example—300 feet head × ·4335 = 130 lbs. pressure (approx.).

To find number of gallons per minute delivered through nozzle

$$\text{Gallons per minute} = \frac{d^2 \sqrt{P}}{2{\cdot}59}$$

When P = Pressure in lbs.

d = Diameter of nozzle in $\frac{1}{8}$th of an inch.

G = Gallons per minute.

Example—Size of nozzle $1\frac{1}{8}$, pressure 140 lbs. at nozzle.

$$G = \frac{d^2 \sqrt{P}}{2{\cdot}59} = \frac{9^2 \sqrt{140}}{2{\cdot}59} = \frac{81 \times 11{\cdot}83}{2{\cdot}59} = \frac{958{\cdot}23}{2{\cdot}59} = 369 \text{ gallons (approx.).}$$

Horse-power represented by jet of water (issuing from nozzle)

$$\text{H.P.} = \frac{W \times P \times 2{\cdot}3}{33{,}000}$$

Where W = Weight of water in lbs. delivered per minute.

P = Pressure of water in lbs. per square inch.

Example—$1\frac{1}{8}$ jet at 140 lbs. pressure

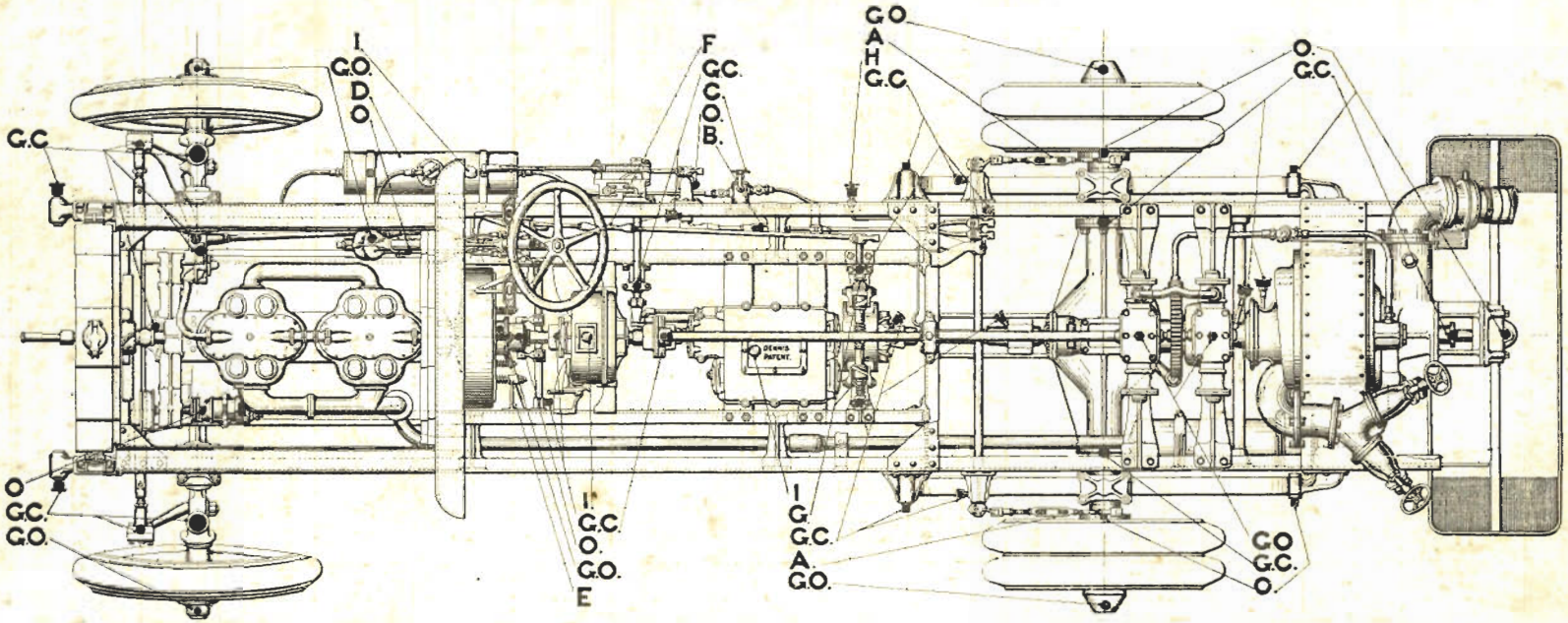
$$\text{H.P.} = \frac{3{,}500 \times 140 \times 2{\cdot}3}{33{,}000} = 34{\cdot}5$$

Approximate Discharge Through Smooth Nozzles.

GALLONS PER MINUTE.

Pressure in lbs. per square at Nozzle	½″	⅝″	¾″	⅞″	1″	1⅛″	1¼″	1⅜″	1½″	1⅝″	1¾″	1⅞″	2″	Head in Feet
5	12	21	30	42	55	70	86	110	125	147	170	195	222	11
10	19	30	43	60	78	99	127	150	177	208	240	276	315	23
15	23	37	53	73	96	124	131	186	217	255	294	338	385	35
20	27	43	62	85	111	142	174	211	250	294	340	390	446	46
25	30	48	69	95	124	167	195	236	278	327	379	436	498	58
30	33	52	76	104	137	173	212	258	305	360	416	478	546	69
35	36	56	82	112	147	186	230	278	338	386	449	515	590	81
40	39	61	87	120	157	198	245	296	350	412	479	550	628	92
45	41	64	93	127	167	210	260	315	372	440	509	585	669	103
50	43	68	98	134	176	222	274	331	391	461	535	615	703	115
55	45	71	102	141	184	233	287	348	410	485	562	645	739	127
60	47	74	107	147	192	243	300	362	430	505	588	674	770	138
65	49	77	112	153	200	253	310	375	445	525	610	700	798	150
70	51	80	116	158	207	262	322	391	462	545	633	727	832	161
75	53	83	120	164	214	271	334	405	478	565	656	753	860	173
80	55	86	124	169	221	280	344	418	495	584	678	778	890	185
85	56	88	128	175	228	289	354	430	510	600	699	800	915	196
90	58	91	131	179	234	297	365	444	525	618	718	824	943	208
95	60	94	135	185	240	305	375	455	538	635	738	848	968	219
100	61	96	139	189	247	312	384	465	551	652	757	870	995	230
105	63	98	142	193	252	319	393	478	565	666	774	898	1020	242
110	64	101	145	198	258	327	403	490	580	683	793	910	1045	254
115	66	103	149	202	264	335	412	500	592	698	810	932	1070	266
120	67	105	152	207	271	342	423	511	608	713	830	955	1090	276
125	69	108	155	212	277	345	432	522	621	730	850	975	1120	289
130	70	110	158	216	282	356	440	532	632	742	865	995	1135	300
135	71	111	161	220	287	363	448	542	645	760	881	1020	1160	311
140	73	114	164	223	293	369	457	552	658	770	898	1030	1180	323
145	74	116	167	228	298	376	465	563	670	785	915	1050	1200	334
150	75	118	170	231	302	382	473	573	681	798	930	1070	1220	346
155	77	120	172	235	307	389	480	583	693	810	945	1082	1240	357
160	78	122	175	239	312	394	489	590	701	825	960	1108	1260	369

A. TURN-BUCKLES FOR MAIN ADJUSTMENT OF SIDE BRAKES.
B. TURN-BUCKLE FOR ORDINARY ADJUSTMENT OF SIDE BRAKES.
C. FILTER FOR WATER FEED FROM PUMP TO RADIATOR.
D. ENGINE OIL TANK.
E. CLUTCH BRAKE STOP.
F. TURN-BUCKLE FOR ORDINARY ADJUSTMENT OF FOOT BRAKE.
G. NUTS ON CAM SHAFT OF FOOT-BRAKE FOR MAIN ADJUSTMENT.
H GREASE CUP CONNECTED TO CENTRE BEARING OF PUMP SHAFT.
I. AIR VENT CAPS.
G.C. GREASE CUPS (FOR LIGHT GREASE.)
O. OILER. (FOR ENGINE OIL)
G.O. PLUGS. (FOR GEAR OIL.)



General Arrangement of Chassis

PLAN VIEW

When at a Working Job

1.—Make quite sure the suction unions are air-tight and that the suction strainer is at least 6" under the surface of the water.

2.—If the water contains leaves or any floating matter use a basket strainer over the copper one or the holes in it will get filled up. You will be able to see by looking at the **vacuum gauge** if this is happening, should the holes in the strainer get filled with dirt, the vacuum reading increases—when this is noted the strainer should be cleaned at once.

3.—When working out of a dam keep the strainer right at the bottom, strap it there if possible and do not let the feeds flow in on the surface—tie the coupling under the surface also. Keep the water just overflowing all the time you are working.

4.—When working with a collecting head care must be taken not to **"over-run"** the water supply. Keep a sharp lookout on the **compound vacuum gauge,** this will tell you what is happening. If pressure is shewn you can open the throttle a little more—if more pressure is required on the delivery valves, keep your eye on the gauge at the same time, do not go past the **zero** on to the vacuum side when feeding with canvas hose or you will draw it flat and at the same time draw air through the hose, spoiling the jet. Close up throttle a little until gauge shows a little pressure. If the delivery pressure is insufficient it will be necessary to use a smaller nozzle as the water supply is not enough for the larger one.

5.—When using the direct suction connection make sure the stand pipe is a good fit and air-tight to hydrant. Connect up suction with direct adapter on the end to stand pipe, then turn hydrant on **full.** Put the pump gear "IN" in the usual way and open throttle slowly, watching the vacuum gauge never goes to more than 18" of vacuum. **Of course when using the collecting head or direct suction you will not require the air pumps.**

6.—If the cooling water through the radiator overflow gets less, slow down for a minute and clean out water filter.

7.—Keep a good look out for the engine oil—**see that the gauge is recording properly** and that there is plenty of oil in the tank. When you have a pumping job it is best to put a little oil in at a time, keeping the tank always three parts full.

8.—Run on the magneto ignition when pumping—keeping it fully advanced.

9.—Do not run with the pump glands too tight—have them slack enough to let a little water run through. When tightening up be sure to take each nut up the same amount, keeping the glands square.

PALETHORPE
& COND. Ltd.
LONDON and
BIRMINGHAM