L TYPE

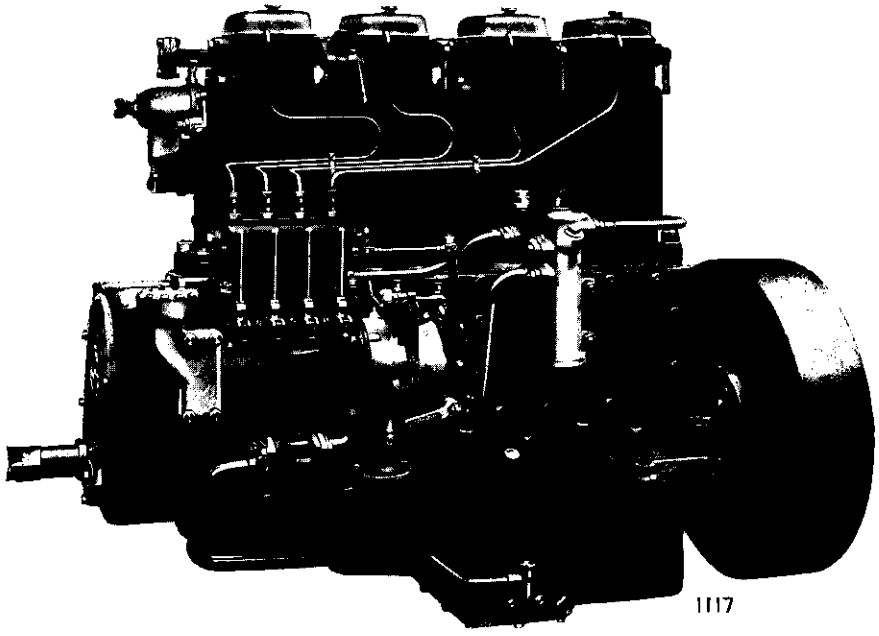
GENERAL DIRECTIONS

for the Management and Care of

GARDNER

HIGH-SPEED OIL ENGINES

Vertical Four-Cycle Compression-Ignition
Cold Starting Airless Fuel Injection



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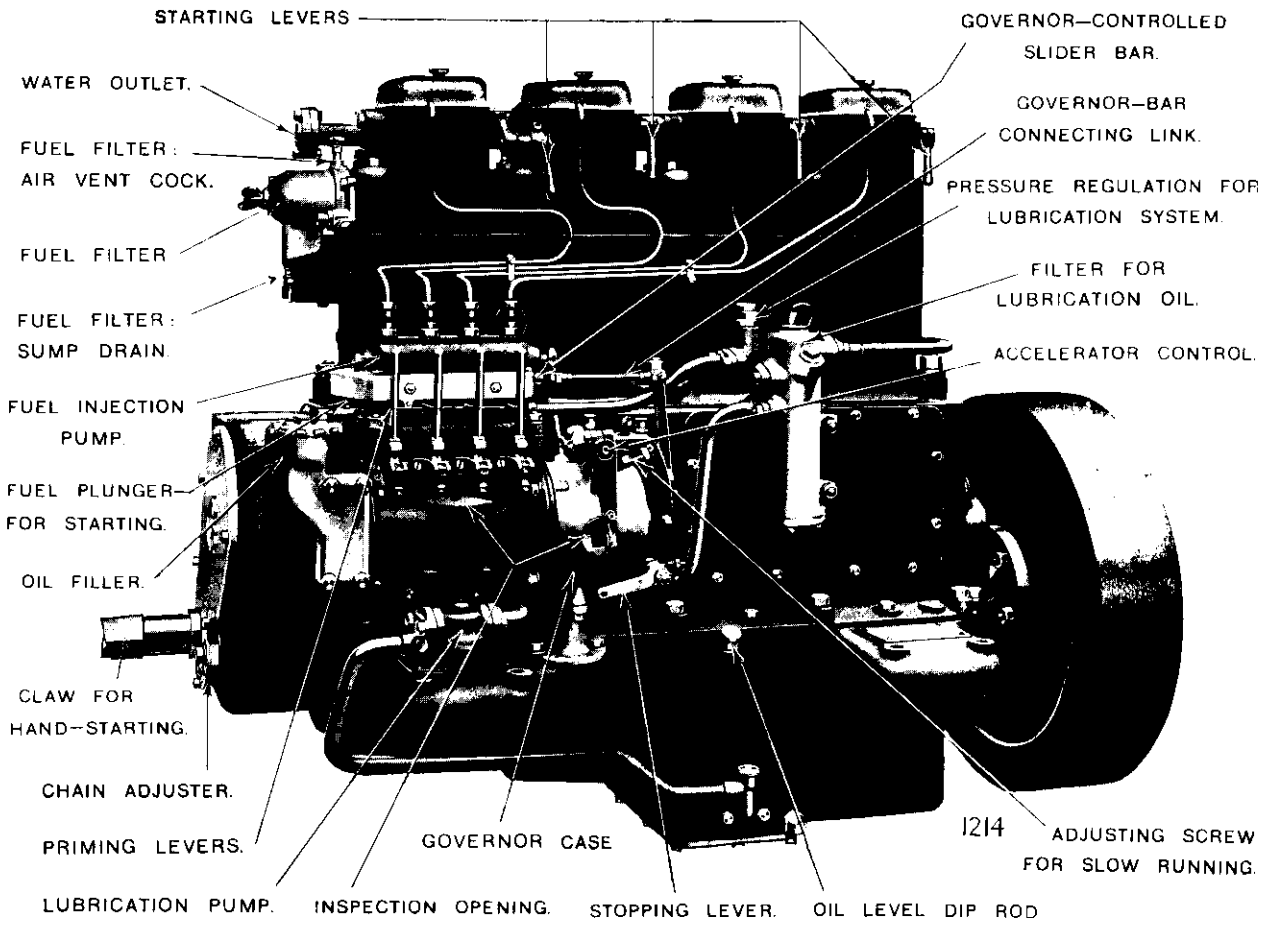
STARTING LEVERS
GOVERNOR—CONTROLLED SLIDER BAR.
WATER OUTLET.
GOVERNOR—BAR CONNECTING LINK.
FUEL FILTER: AIR VENT COCK.
PRESSURE REGULATION FOR LUBRICATION SYSTEM.
FUEL FILTER
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FUEL PLUNGER—FOR STARTING.
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CLAW FOR HAND—STARTING.
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GOVERNOR CASE
1214
ADJUSTING SCREW FOR SLOW RUNNING.
LUBRICATION PUMP.
INSPECTION OPENING.
STOPPING LEVER.
OIL LEVEL DIP ROD

Fig. 1

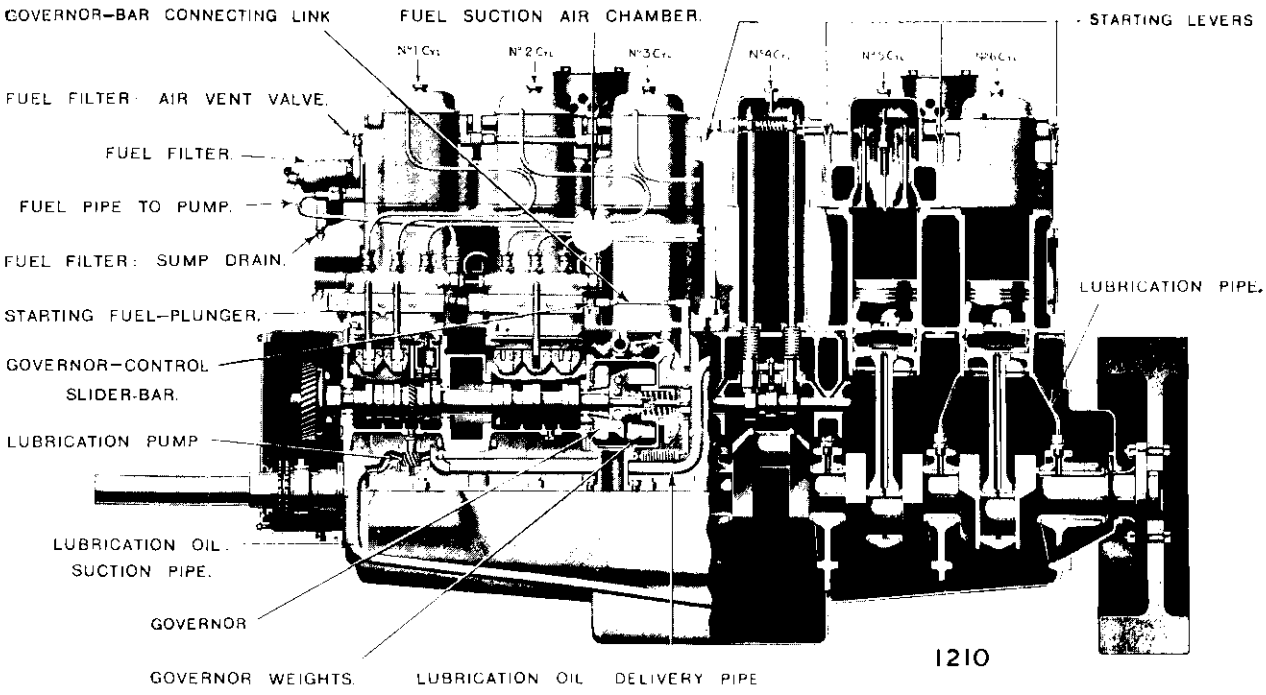
GOVERNOR—BAR CONNECTING LINK
FUEL SUCTION AIR CHAMBER.
STARTING LEVERS
FUEL FILTER: AIR VENT VALVE.
FUEL FILTER.
FUEL PIPE TO PUMP.
FUEL FILTER: SUMP DRAIN.
LUBRICATION PIPE.
STARTING FUEL—PLUNGER.
GOVERNOR—CONTROL SLIDER-BAR.
LUBRICATION PUMP
LUBRICATION OIL SUCTION PIPE.
GOVERNOR
1210
GOVERNOR WEIGHTS.
LUBRICATION OIL DELIVERY PIPE

Fig. 2

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GENERAL INTRODUCTORY NOTES.

1. The complete working cycle of the engine requires four strokes of the piston, that is, two complete turns of the crankshaft. During the first stroke, a charge of air is drawn into the cylinder and is compressed during the second stroke. At or towards the end of this stroke, a charge of fuel is injected into the combustion space in the form of spray which is at once ignited solely by the temperature of the compressed air charge. The resultant combustion causes a rise of pressure and a store of energy to be expended during the third stroke, or the power stroke. During the fourth and last stroke, the burned gases are expelled and this completes the cycle.

2. It is well-known that when air is compressed, its temperature rises, and if the compression be high enough, the resultant temperature suffices to ignite readily the liquid fuel charge. This is the principle of the L type, compression-ignition engine: to repeat, ignition is effected solely by the temperature of the compressed air charge, and this applies equally while the engine is running or while it is being started by hand when all is cold.

3. The injection of the fuel into the combustion chamber is effected by an injection pump, one to each cylinder, which forces the fuel through a sprayer situated at the summit of each combustion chamber. Each fuel charge is accurately measured by the injection pump, the amount of the charge being varied and controlled by the automatic governor to correspond with the load carried by the engine at any given moment.

4. **Fuel Injection Pumps.**—These are built in units each containing as many pumps as there are cylinders on the engine. The 5-cylinder engine, however, has a 2-pump unit and a 3-pump unit, while the 6-cylinder engine has two 3-pump units. Each pump is operated by its own cam on the camshaft, and in addition, is furnished with a hand lever and latch enabling the pumps to be worked by hand for priming the injection system. The latches enable any pump to be put into or out of action.

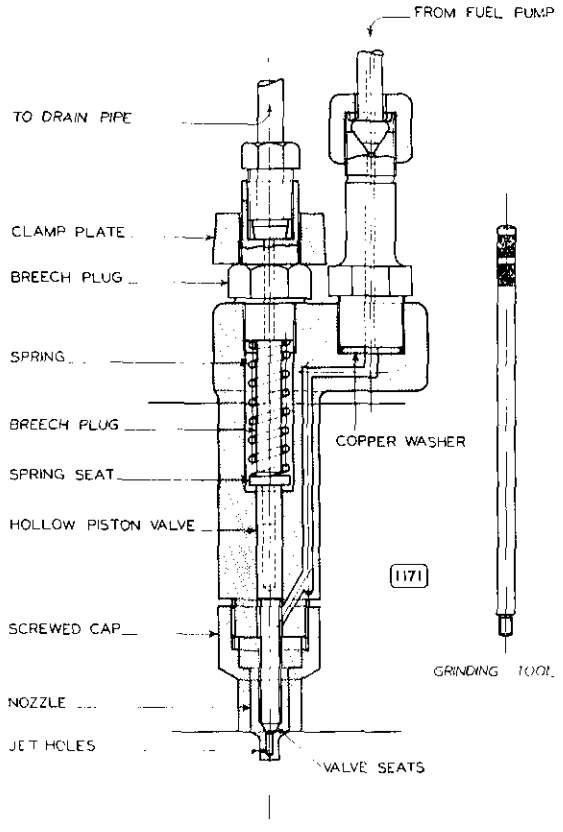

Fig. 3

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GENERAL INTRODUCTORY NOTES- *continued.*

STARTING AND VALVE GEAR.

12. The essential feature of these engines is that the starting is effected by a hand cranking handle just the same as in the motor car engine. Hand starting is the standard form for all the L type engines, but electric starters are supplied at an extra charge when so ordered. As already explained, the ignition of the fuel charge is effected solely by the temperature of compression, therefore all extraneous devices such as pre-heating, cartridges, electric plugs and such like, often used for starting from cold, are entirely dispensed with.

Having regard to the high degree of compression necessary in engines of the compression-ignition type, starting by hand power is quite an achievement and depends among other things upon the Gardner Patented Valve Gear by which (1) the engine is relieved of all compression during the first stage of hand starting and (2) during the second and last stage, the timing of the air valve is altered so as to obtain maximum compression during the slow turning at starting.

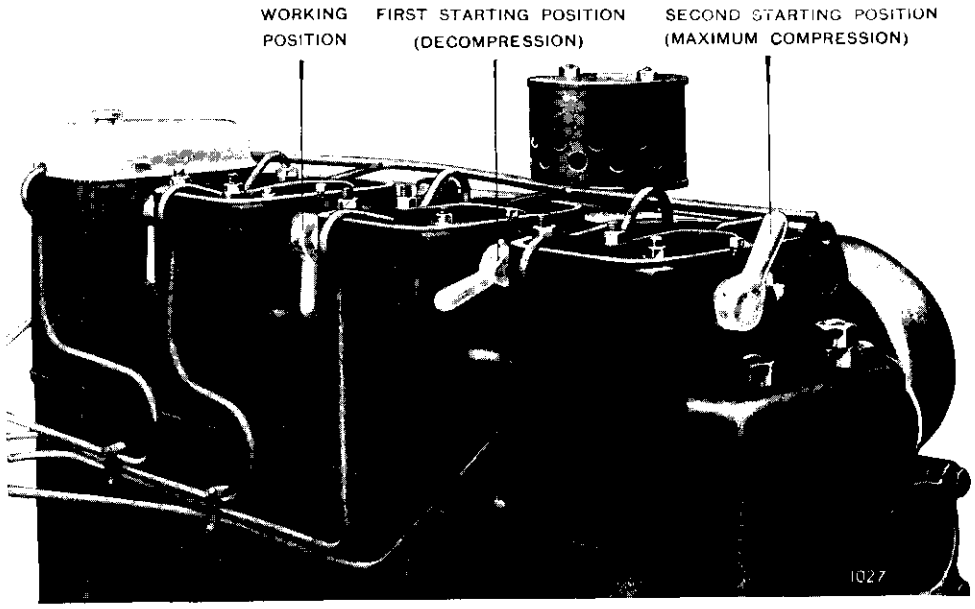

Fig. 5

STARTING LEVERS. SHOWN IN THEIR THREE DIFFERENT POSITIONS.

On the valve gear box of each cylinder head is a small starting lever which normally rests vertically downwards while the engine is running, in which position it is inoperative. In the horizontal position it prevents the air inlet valve from entirely closing and so prevents compression. When the starting lever is turned vertically upwards, past the top centre, it causes the inlet valve lever to slide along the rocker shaft so as to re-engage with the air inlet valve, but now, the time of opening and closing

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GENERAL INTRODUCTORY NOTES—*continued.*

Starting and Valve Gear *continued.*

of the air valve is altered so as to obtain maximum compression while the engine is being turned slowly by *hand*. To recapitulate, the starting levers take in turn the following three positions:

No. 1 First starting position. Horizontal. De-compression.

No. 2 Second starting position. Over the Top. Maximum compression.

No. 3 Running position. Vertically down. Out of action.

The operation of starting is described further on: See 36 and 37.

13. **Starting Fuel-Plunger.** Underneath and at the end of the aluminium box attached to the front of the fuel pumps will be found a vertical spring-loaded plunger which, on being pressed up, as far as it will go, releases the governor-control bar of the pumps and allows it to slide towards the flywheel, in which position the pumps deliver an increased charge of fuel for starting from cold. As soon as the engine is started, the governor-control bar automatically retakes its normal working position in which the pumps cannot give an excessive charge of fuel.

This plunger is to be used only when starting from cold: it must on no account be used when the engine is running, for the purpose of increasing the power of the engine. If the plunger be held or propped up while the engine is working, the pumps may deliver more fuel to the engine than it can burn and serious trouble may occur.

14. **Variable Speed.** The speed of all engines can be varied while the engine is running, from 400 r.p.m. to the maximum running speed including all intermediate speeds by merely turning a knurled knob in a lever on the governor case. It is here to be observed that the engine is under complete control of the governor at all speeds. Apparatus for the remote control of the speed can be added at an extra charge.

ASSEMBLING AND INSTALLATION.

15. **Packing.** Unless expressly ordered otherwise, the engines are packed in their assembled state with only the flywheels removed. Before packing, all bright parts are varnished with a rust preventative which is soluble in paraffin.

16. **Unpacking.** When unpacking, lay out all the loose parts in a suitable, clean place, free from dust and grit and sheltered from the weather. These parts should be at once checked and identified by the Contents List, which is sent by post with the Advice Note of despatch. In case these parts have to lie for any length of time before assembling them, it is not wise to remove the protective varnish.

17. If there is any work being carried on in the neighbourhood of the installation, it is advisable to keep the engine sheeted up as much as possible, and to retain the protective varnish till the last moment.

18. **Assembling.** To remove the protective varnish, use clean, cotton cloths, soaked in paraffin (kerosene). Do not use cotton waste as it is rarely free from dust and particles of fluff. When assembling engines at the Works, we make free use of clean cloths and paraffin baths, and strongly recommend this

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GENERAL INTRODUCTORY NOTES– *continued.*

practice when assembling on site. Clean Gas Oil (from petroleum) is nearly as effective and is, in general, much cheaper than paraffin. Take care that all oil holes and such places are thoroughly cleaned out during assembling.

19. **Fuel Service Tank.**—A suitable service tank is included in the accessories of all stationary engines but not for marine engines or other engines requiring special tanks. Special tanks differ so much in size, shape and construction that they are regarded as coming under the head of installation work.

20. **Fuel Service Tank.**—After piping the fuel tank to the first fuel filter mentioned in para. 7 and from this filter to the second fuel strainer on the engine, and after charging the fuel tank it is advisable to uncouple the union at the engine second fuel filter and allow a copious flush of fuel to pass in order to clear out from the pipes any dirt that may have found its way in. After re-coupling to the filter, open the vent tap on top of the filter and allow another flush of fuel to pass. Do the same at the screwed plug in the flywheel end of the fuel pumps. These last two flushings are to expel all air from the system. This is very important.

21. **Exhaust Pipes.** The exhaust system may be planned on lines similar to those customary in petrol-paraffin engines. Special care should be taken to avoid an unnecessary number of bends and great lengths of pipe which cause undue gas friction and impairs the working of the engine. The normal size of the exhaust pipe is 2 in. increasing to 3 in. at the exit from the expansion chamber or silencer. Sometimes, in Marine Installations, circulation water is injected into the exhaust pipe for cooling: in such cases, the exhaust pipe should be increased all through to 3 in.

PREPARATION FOR STARTING AFTER INSTALLATION.

22. **Lubrication System.**—To charge the pump in the lower crankcase, remove the cover of the oil filter box and pour in lubrication oil until the sump level reaches the maximum mark on the dip rod which will be found in the lower crankcase on the governor side. See Fig. 6, page 11.

23. The **Dip Rod** passes obliquely through a hole in the crankcase and is withdrawn by a knurled knob marked "Oil Level." The lower end of the rod is marked "Max. Level" and "Min. Level."

24. Remove the screwed plug on the suction pipe of the lubrication pump and, by the aid of the large syringe supplied with the engine, fill the pipe with oil until it overflows at the plug hole. The object of this is to prime the pump and suction pipe from the foot valve upwards. This plug will be found on the left-hand side of, and within an inch, or so of the oil pump.

25. After a first run after installation, a certain amount of oil will be used to fill all the oil pipes and to wet all the internal surfaces. This will, of course reduce the oil level in the sump, hence the necessity of an additional make-up charge of oil after a first run.

26. Formed in the crankshaft are oblique ducts which lead lubrication oil from the main bearings to the crank pins and hence to the gudgeon pins by way of a central duct in the connecting rod.

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PREPARATIONS FOR STARTING *continued.*

30. **Lubrication Oil Pressure.** After starting the engine, an interval of ten to fifteen seconds is necessary for the pipe and filter system to become filled by the lubrication pump, consequently, during this interval the gauge will not be expected to record any pressure.

31. **Water Circulation Pump (Centrifugal Type).** See that the grease cup of the gland is fully charged with a light mineral grease and, before starting, give one turn to the cover of the cup.

32. **Liquid Fuels.**- The following are two specifications of typical examples of fuels suitable for these engines :—

	Gas Oil	Diesel Oil
Specific Gravity at 60°F.	·860	·880
Initial Boiling Point	180°C.	200°C.
Distillation Test 10% at	256°C.	280°C.
,, ,, 40% at	304°C.	350°C.
,, ,, 70% at	344°C.	400°C.
Flash Point (Pensky-Martin)	170°F.	180°F.
Sulphur : Not to exceed	·2%	·3%
Water ,, ,, ...	Trace	·5%
Ash ,, ,, ...	·002%	·01%
Calorific Value Gross : B.Th.U.'s/lb.	19,400	19,200
Viscosity : Redwood No. 1	50 secs.	80 secs.

Fuels corresponding to the above specification are readily obtainable and are supplied by :
Anglo Persian Oil Co. Ltd. (British Petroleum Co. Ltd.)
Anglo American Oil Co. Ltd.
Shell Mex Ltd.
Among many others.

33. **To Prime the Fuel System.** It is here assumed that the fuel tank has been charged. See para. 20. It is necessary in a new installation and desirable after dismantling the pipe system for any reason, to allow a copious amount of fuel to wash through the pipes in order to clear them of foreign matter and to rid the system of air. To this end, proceed as follows :

Step No. 1. Uncouple the feed pipe from the filter on the cylinder head to the injection pumps and allow a flush of about half a gallon to flow from the outlet of the filter, then replace the feed pipe.

Step No. 2. Unscrew the brass, spherical, air chamber from the injection pumps and allow another flush of fuel to emerge from the orifice ; then replace the air chamber.

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PREPARATIONS FOR STARTING *continued.*

Step No. 3. Uncouple the unions of the sprayer pipes on the pumps and remove one (any one) of the delivery valve units from the pump. (This unit is Part No. 208, shown on Plate I of the Bosch Pump Booklet). Then allow a further flush of fuel to emerge from the uncovered pump. Replace the delivery valve, not forgetting the valve and spring.

Step No. 4. Taking each pump in turn, work the priming lever *until* fuel emerges from the still uncoupled unions on the pump without the slightest trace of air bubbles. This completes the priming of the system up to the summit of the pumps.

Step No. 5. Work each priming lever until the elastic feeling, if any, has vanished, that is, until a "solid feel" is obtained. This completes the operation of priming. The object of Step No. 5 is to clear out the air from the sprayer pipes. Each stroke of the priming lever forces some of the imprisoned air through the sprayer into the cylinder. When the last vestige of air has been forced out, the "feel" of the lever suddenly becomes "solid." It is important to cease working the priming levers as soon as the "solid feeling" is attained, otherwise, one is liable to inject a harmful amount of fuel into the cylinders.

Note. It is not always necessary to remove Part No. 208 as instructed in Step No. 3, as sometimes Step No. 5 suffices to clear both the pumps and the sprayer pipes of air. Indeed, Step No. 5 is preferable to Steps Nos. 3 and 4 as there is less risk of foreign matter getting into the sprayer pipe and thence into the sprayers.

Caution. Do not inject fuel into the cylinders by means of the priming levers.

34. **Sprayer Pipe Connections.** After the preceding priming operations are complete, make quite sure that the union nuts of the sprayer pipes are tight, particularly at the sprayer end, because any leakage from these unions would fall into the crankcase and contaminate the lubrication oil. This, by the way, applies equally to the unions on the drain pipes of the sprayers. It is easy to inspect for leakage all that is necessary is to remove the valve chamber covers one at a time, while the engine is running and wipe the said unions dry. If there be any leak it shows itself at once.

Note. It is of the utmost importance to avoid such leakage.

35. **Lifting Eye-Bolts.** For convenience of lifting the engine, certain of the nuts which bolt down the cylinder head are temporarily replaced by eye-nuts. Before attempting to run the engine, see that these eye-nuts are removed and replaced with the permanent nuts which will be found attached to their respective studs.

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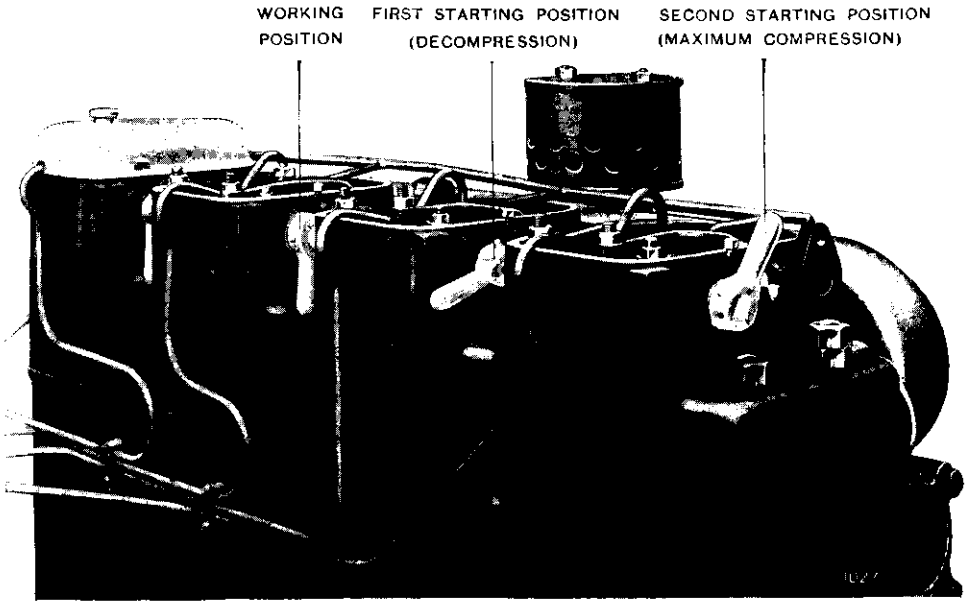
STARTING.



STARTING LEVERS, SHOWN IN THEIR THREE DIFFERENT POSITIONS. Fig. 7

STARTING FROM "ALL COLD."

36. **Step No. 1.** Turn the stopping lever upwards as far as it will go.

Step No. 2. Press up the maximum fuel plunger as far as it will go: this will release the governor-controlled bar and allow it to slide towards the flywheel. If it be sluggish in sliding, help it by pressing on the governor lever.

Step No. 3. Turn up all the starting levers to the horizontal for decompression.

Step No. 4. Crank smartly round the starting handle.

Step No. 5. When maximum speed is attained, turn up quickly any one (the nearest, preferably) of the starting levers as far as it will go, for maximum compression: this cylinder should immediately give power.

Step No. 6. Turn up the remaining starting levers: all cylinders will now be at work.

Step No. 7. Turn all the starting levers vertically downward into the final running position. This completes the operation of starting.

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STARTING.

STARTING A WARM ENGINE.

37. Proceed as in para. 36 but omit Step No. 2.

AFTER STARTING.

38. **After Starting.**—See that the circulation pump and lubrication pump are operative and that the pressure gauge of the latter registers 25 lb./sq. in. at about 1,000 r.p.m., if not, shut down at once and investigate: probably the suction from the foot valve to the pump will need re-priming.

39. **After Starting,** the engine is at once able and ready to take up full load, but a careful engineer will recognise that, in all heat engines, it is better practice to apply the load as gradually as circumstances will permit, especially after starting from cold, in order that the internal parts may become heated gradually and so expand gradually.

STOPPING THE ENGINE.

40. **To Stop.** Turn the stopping lever downwards as far as it will go: in this position the fuel pumps immediately cease to inject fuel and so the engine stops.

41. When the engine stops, the flow of circulation water naturally stops: it is therefore recommended that the engine be allowed to run light for a minute or two just before stopping.

42. The engine may also be stopped by pulling forward all the pump handles to engage with the lifting latches. This puts the pump rams out of action with the cams, but, of course, the use of the stopping lever is obviously preferable.

43. On no account should the engine be stopped by turning off the fuel supply, because this would empty all the fuel pipes and so would necessitate re-priming of the whole fuel system before the next start.

44. It is neither necessary nor advisable to turn off the fuel supply when the engine is standing idle.

GENERAL OPERATIONS AND MAINTENANCE.

45. **Lubrication System.** The lubrication system of any internal combustion engine is of such importance that we would impress upon the users of our engines the necessity of exercising every care in rigorously following the recommendation and instructions set forth hereunder.

46. **Suitable Oil,** as mentioned in para. 28, can be obtained from any of the well-known makers, and should approximate to the viscosities mentioned in para. 28. If any doubt should exist as to the suitability of any oil, we are always pleased to test a sample and report upon it.

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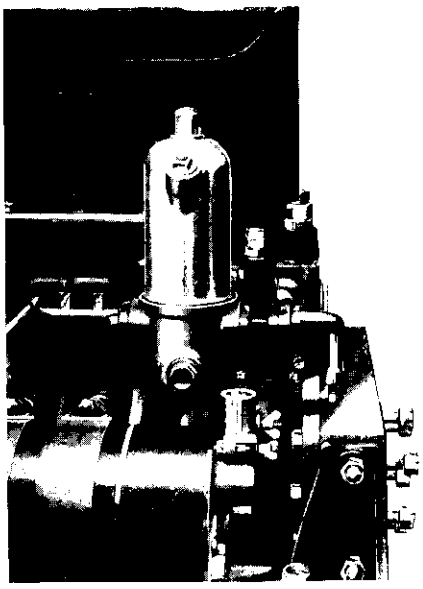
GENERAL OPERATIONS AND MAINTENANCE *continued.*

47. **The Lubrication System** is such that the whole of the working parts of the engine are automatically lubricated from the main pressure system which is maintained by a gear pump carried by the crankcase immediately adjacent to the oil sump. The pump is driven by a vertical shaft from the camshaft. The oil is delivered from the pump to the delivery filter and pressure regulator. It now passes into the feed pipes of the main bearings and thence, by drilled passages, to the crank pins and gudgeon pins. From the same pressure system, oil is fed under pressure to the valve gear in the cylinder heads. The surplus oil rejected by the pressure regulator is separately circulated through the governor unit, the fuel injection pump cams, the tappet mechanism, and finally through the main timing drive of the valve camshaft. This surplus oil pipe is situated on the near side of and external to the engine. It runs along the base of the cylinders from the pressure regulator to the casing of the main drive. This pipe should be dismantled and examined for signs of stoppage every 1,500 hours.

FILTER.

48. **Delivery Filter.** As will be seen, this unit is situated on the near side of the crankcase at the flywheel end. It is of very simple yet special construction, comprising a vertical cylinder in which is a special gauze element instantly detachable by removing the filter cover which is secured by a single nut. In the base of this unit is a sludge sump.
The whole of the lubrication oil passes through this filter before going to its work, so that it is of the greatest importance that the filter be kept clean as in the next paragraph.



DELIVERY FILTER Fig. 8

49. **Delivery Filter, Cleaning of.** This unit **must** be thoroughly cleaned after every 100 hours. To this end, first remove the drain plug of the sludge sump and so drain away the contents. Next remove the filter cover, take out the gauze element and wash it thoroughly in clean paraffin or fuel oil.

50. **Delivery Filter. Reassembling.**— In doing this, it is recommended that the cover of the filter be gently rotated upon the face joint in order to minimise the chance of any foreign matter causing a leak. It is recommended also to replenish the filter with clean oil through the orifice closed by the square headed plug.

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GENERAL OPERATIONS AND MAINTENANCE *continued.*

51. **Pressure Regulation Valve.**—The function of this unit is to maintain within certain limits the pressure of oil in the lubrication system. It consists of a spring-loaded thimble valve with conic seat. The correct amount of spring-loading is effected by an adjusting screw. It will be easily understood that varying the spring-load will correspondingly vary the pressure at which the valve permits the surplus oil to escape through the surplus oil pipe described in para. 47.
The adjusting screw is set during test to 25 lb./sq. in. at about 1,000 r.p.m. with lubrication oil at a temperature of about 130°F. It is well to mention here that, under normal conditions of vehicular work, the oil in the sump does not attain so high a temperature as 130 F., consequently, the pressure usually recorded is about 27 lb./sq. in. Therefore if this regulation valve be dismantled for any reason it should be re-set to give 27 lb./sq. in. when the engine is thoroughly warmed up at normal cruising speed. A useful guide to the setting of the adjusting screw during test is to count and record the number of screw threads that stand above the hexagon lock-nut. This, of course, should be done before dismantling. If correctly counted, this should prove a useful aid when reassembling.
On no account should the engine be run if the oil pressure is less than 20 lb./sq. in.

52. **Oil Pressure Too Low. Possible Causes.**
(1) Delivery filter requires cleaning.
(2) Foreign matter under the seat of the pressure regulation valve.
(3) Fracture of the spring of the regulation valve.
(4) Through use, the lubrication oil has become too thin.
(5) The gauze filter over the sump is choked for want of attention.
(6) Shortage of oil in the sump.
(7) A pipe fracture somewhere in the system.

53. **To Remedy the Above Defects.**
(1) Dismantle, clean and reassemble as in paras. 49 and 50.
(2) If foreign matter prevents the proper seating of the regulation valve, this is usually indicated by the pressure gauge recording normal pressure when the engine is running at maximum r.p.m. and too low a pressure at slow speeds. Sometimes a light tap on the body of this unit suffices to dislodge the obstruction; if not, the thimble valve should be withdrawn, wiped clean and replaced, making the correct spring-load adjustment as described in para. 51.
(3) Replace with spare spring.
(4) Drain the crankcase sump and replace with new oil of the correct grade. In any case, this operation should be carried out after every 300 hours.
(5) The oil level in the sump should not be allowed to fall below the minimum mark on the dipper rod, nor, in passing, should it be allowed to rise above the maximum mark. Read para. 23.

Note. –When leading the small oil pipe from the pressure regulation valve to the pressure gauge on the instrument panel, it is important to secure the pipe from all vibration and consequent possible fracture.

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GENERAL OPERATIONS AND MAINTENANCE—*continued.*

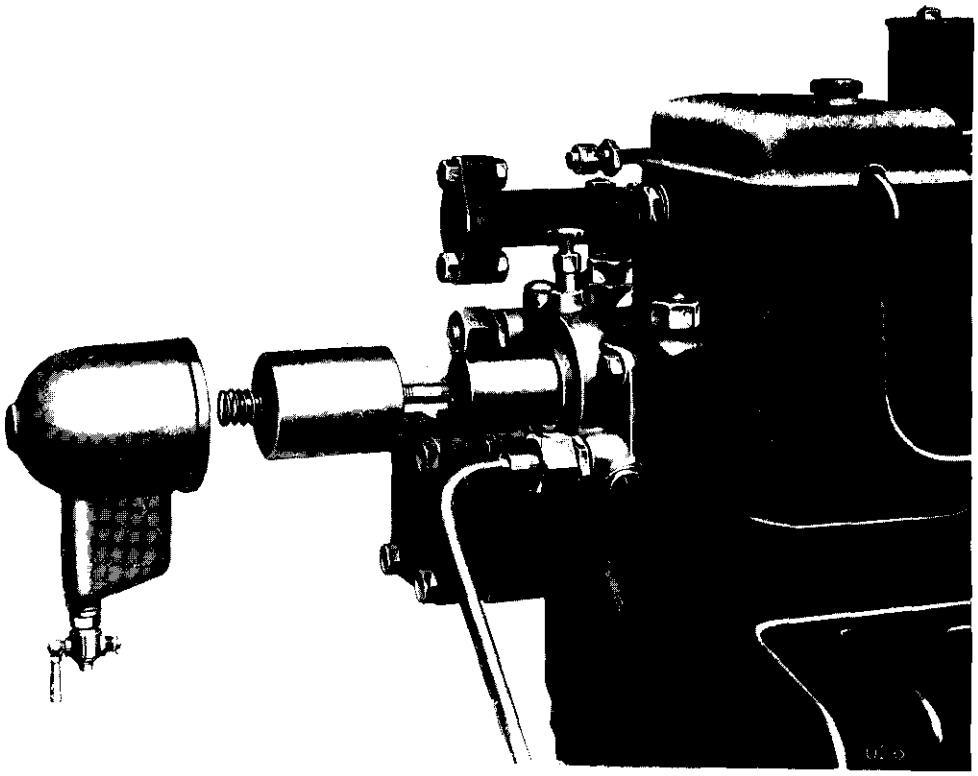
54. **Crankcase Sump. Renewal of Lubrication Oil.**—It is recommended that the sump oil be completely drained off not less frequently than every 300 hours. This should be done after a long run while the oil is warm and fluid. It is not recommended to wash out the sump or crankcase with paraffin as this is liable to disturb particles which might re-enter the lubrication system.

55. **Gauging the Sump Oil Level.** This is described in para. 23.

56. **Correct Oil Level.**—This is indicated on the dip rod which shows the minimum level at which it is safe to run the engine. The maximum level is also shown on the dip rod. This is the level to which the sump should be charged as also the level which should be maintained.

57. **Oil Filler Box.** This is mounted on the main gear or timing case at the forward end of the engine on the near side. The filler box opening to the timing case is protected by a diaphragm in the form of a gauze filter. The sump is charged through the mouth of the filler. If, when charging, the oil does not flow freely, it will probably be found that the gauze diaphragm needs cleaning, which is readily done after removing the filler box from the timing case.

58. **Fuel System. Filters.** Each engine is furnished with two fuel filters, a first filter and a second filter as described in para. 7. The first filter is placed in circuit between the fuel tank and the second filter, due regard being paid, when fixing, to its accessibility for cleaning. The second filter is a patent combination of filter and heater. It is permanently attached with thermal contact to the head of No. 1 cylinder.



SECOND FUEL FILTER

Fig. 9

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GENERAL OPERATIONS AND MAINTENANCE—*continued.*

59. **Fuel Filters.**—These are readily opened for cleaning; they contain an inner and an outer element. The outer element is removable for cleaning, but the inner is not, and for certain reasons should never be taken out. The filters are provided on top with an air vent, and below with a sump fitted with a drain cock.

60. **Cleaning of Fuel Filters.** The frequency of this operation depends among other things on the type and quantity of the fuel used. It is recommended that the outer element in each filter be taken out and examined after 100 hours and replaced if it be found to be almost free from foreign matter. Then re-examine after, say, 300 hours; if it is still found to be clean, the interval can be further increased. Repeated examination will show the user when cleaning becomes really necessary. When cleaning the elements, it is not possible to be quite sure that particles of foreign matter do not get into circulation, therefore, the idea intended to be conveyed by this paragraph is for the user to find by inspection how seldom he may, with safety, clean the elements.
The gauze elements are most conveniently cleaned by brushing them in clean fuel-oil or paraffin.

61. **When Replacing the Filter Covers** gently rotate them on their joint faces so as to minimise the chance of foreign matter causing an unsound joint. Do not use a spanner or hammer to tighten the nut on the cover: hand tightening is all that is needed.

62. **Fuel Filters. Before Starting each Day's Run.**

(1) Open the vent cock on top of each filter in order to make sure that the filters are full of fuel oil.

(2) Open the drain cock of the filter sumps in order to draw off any water or sediment that may have collected during the previous day's run.

63. **Fuel Sprayer.** This is described in para. 5. Efficient running of the engine depends very largely upon the perfect working of the sprayers. They should therefore be inspected not less frequently than after every 300 hours, in order to make sure that the needle valves do not leak and that each jet-hole in the nozzle is delivering the same amount and form of spray, also that none of the jet-holes are stopped up.

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GENERAL OPERATIONS AND MAINTENANCE *continued.*

64. **To Test for Stoppage of the Jet-Holes.**— Remove the sprayer from the cylinder head and re-connect with its sprayer pipe in such a position that the fuel jets are visible while the hand lever of the pump is being worked by hand. See Fig. 11. The jets of fuel emitted from the jet-holes should all travel the same distance and should appear alike. If they do not, take the sprayer to pieces and prick and clear the jet-holes by means of the prickers supplied with the engine, and at the same time clear out the central bore of the nozzle. The size of these jets **is of the utmost importance,** therefore it is imperative that prickers of the correct diameter be used. In case of loss or damage of prickers, the makers will be glad to supply new ones at a nominal charge.

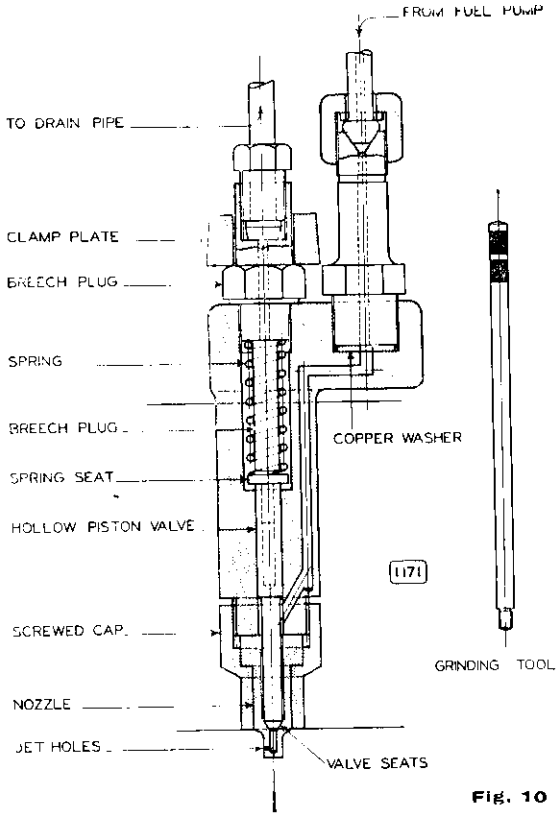
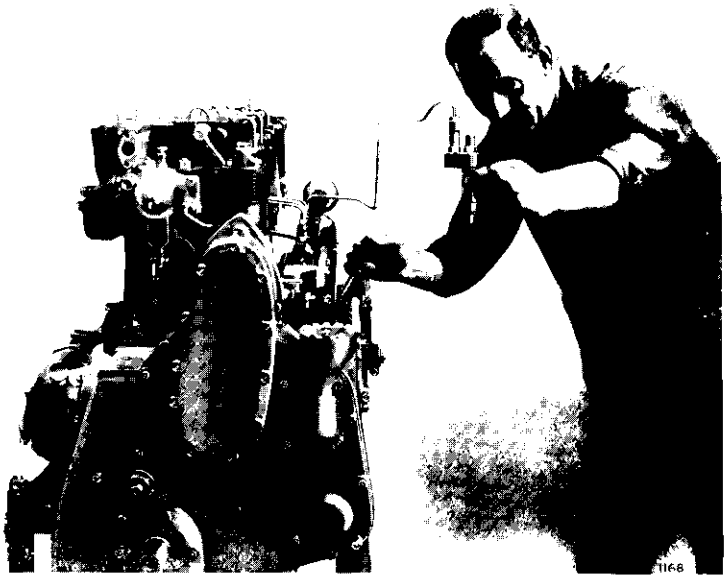


Fig. 10

65. **To Clean the Sprayer Nozzle.** After having pricked the jet-holes (from the outside, of course), it will be realised that any obstruction so removed will fall into the central bore. Obviously, the only effective way of cleaning the central bore is to force a liquid through the jet-holes **from the outside of the nozzle to the inside,** which is done in the following manner:— Take the utility syringe supplied with the engine and change the ordinary nozzle in favour of the special one made to fit the sprayer nozzle. (This special nozzle is also supplied with the engine). Draw into the syringe some clean paraffin and, in the special syringe nozzle, insert the sprayer nozzle, pressing it in place by the fingers. A pressure now applied to the plunger of the syringe will force a flush of paraffin through the jet-holes and the central bore in a sense opposite to that of the fuel when the sprayer is in work. See Fig. 12.



TESTING A SPRAYER

Fig. 11

To repeat, it is obviously futile to attempt to clear the central bore by blow through in the same direction as the fuel flows when the sprayer is in work.

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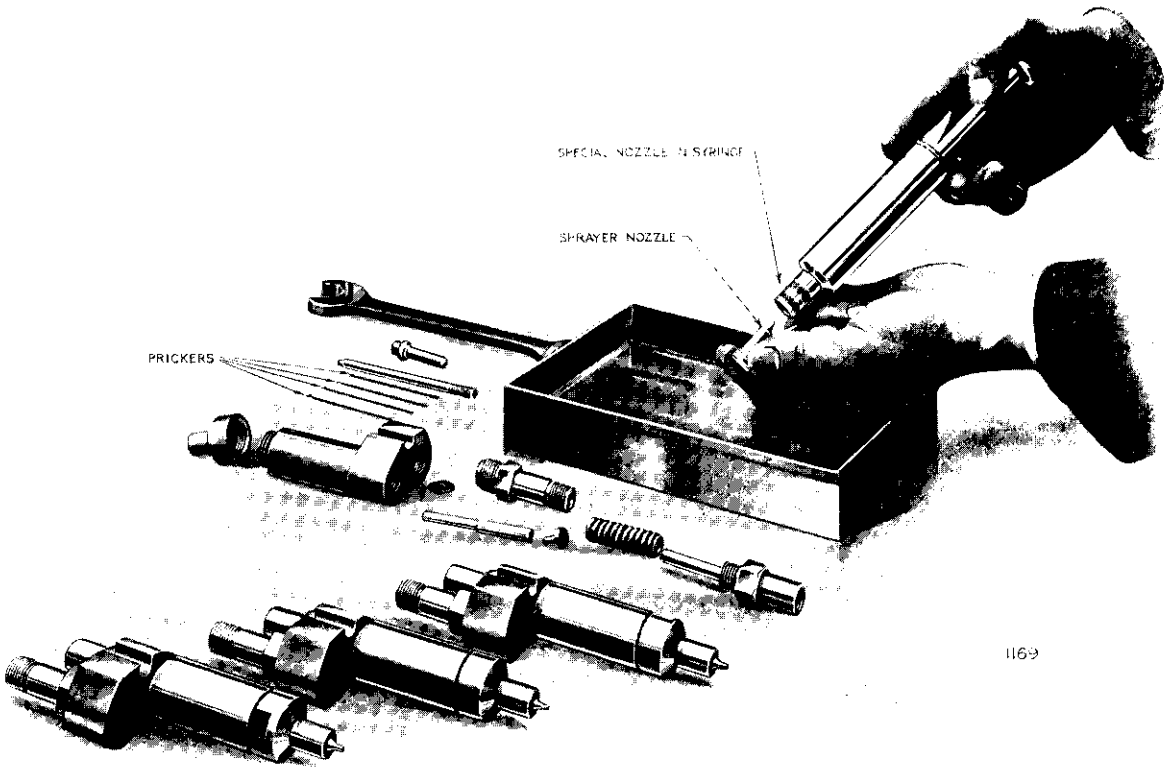

Fig. 12

66. **To Test for Leak of Sprayer Valve.** Remove the sprayer from the engine and recouple it to its sprayer pipe as directed in para. 64 with both unions tight. Give the fuel pump handle a few strokes in order to expel all air from the sprayer. Now press on the pump handle with a force just short of that required to lift the sprayer valve from its seat. If the valve be unsound, fuel will emerge from the jet holes and run down the nozzle. A certain amount of leak is inevitable in the best of valve seats. (See Fig. 11.)

The following will be a useful guide: if, when pressing on the pump handle with about one-half of the force necessary to lift the sprayer valve from its seat, no more than two drops per minute fall from the sprayer nozzle, the valve seats may be passed as being sound.

67. **To Correct a Leaking Valve.** Remove the sprayer from the engine and screw off the cap nut which retains the sprayer nozzle. Examine minutely the valve seat on both the nozzle and the piston for dirt or anything that may prevent the proper seating of the valve faces. Whether or not any obstruction has been found, wash the parts in paraffin and replace without wiping. If, on further trial, the valve be still defective, the seats may require grinding in, but grinding should be done only as a last resource, and as seldom as ever possible.

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68. **To Grind the Sprayer Valve Seats.**—Take the sprayer to pieces in the following order : -

(1) The screwed cap and the nozzle.
(2) The breech plug and spring.
(3) The hollow piston valve with the small spring seat.

Remove the spring seat from the hollow end of the piston valve and screw into the hollow the knurled grinding tool supplied with the engine and replace the piston valve in the sprayer. Then smear the valve seat **with the most minute possible dab of flour emery and oil, taking the utmost care that no emery gets anywhere but on the valve seat, as otherwise it might tend to destroy the close fit which is so essential for the piston.** Placing the sprayer nozzle in its screwed cap, screw the latter about two turns on the sprayer body, then, while pressing the piston valve hard down on to its seat in the nozzle, by the aid of the grinding tool, screw home the cap, first with the fingers and then tighten up lightly with a spanner. The object of this step is to ensure that the valve seat in the nozzle is in perfect alignment with that on the piston valve. During grinding apply only very **light hand pressure.**

69. **After Grinding.**—Take all to pieces and wash every part scrupulously clean with clean paraffin, and, **without wiping,** reassemble in the following order : -

(1) The piston valve with the small spring seat at the upper (hollow) end.
(2) The spring.
(3) The breech plug.
(4) The screwed cap with the nozzle in place.

70. **To Assemble the Sprayer.** - It is imperative that the parts be assembled in the above sequence in order that the spring pressure on the piston valve shall bear on the valve seat of the nozzle all the time during the screwing home of the cap : in this way only can the correct alignment of the valve seats be ensured. Before assembling the nozzle, blow it through with the syringe as directed in para. 65.

71. **Screwed Cap and Nozzle.** -Before assembling for grinding or after examination, see that the outside surface of the nozzle and the bore of the cap are perfectly clear of carbon or other matter which might interfere with the alignment mentioned in 68 and 70.

72. **Lift of Piston Valve.** This dimension is 0·010 in., and is very important, therefore, when dismantling sprayers, do them one at a time, so that the parts be kept to their own sprayer bodies and not be interchanged with those of another sprayer. This happens to be one of the few cases where interchangeability is not practicable.

73. **Sprayer Pipe Unions.** -It is imperative that these unions do not leak, especially those in the valve gear chambers on the cylinder heads. Please read paragraph 34.

74. **Defective Sprayers.** -If a sprayer is known to be defective, do not run the engine any longer than is absolutely necessary as this will cause undue wear accompanied by other evils.

GENERAL OPERATIONS AND MAINTENANCE *continued.*

75. **Replacing a Sprayer in the Cylinder Head.**—The nose of the sprayer body is slightly taper, whereas the hole in which it fits in the cylinder head is parallel, consequently, the space thus left becomes, in the course of time, filled with carbon, which of itself is quite negligible. When, however, the sprayer is withdrawn, it leaves a conical liner of carbon which must be removed before replacing the sprayer; otherwise the carbon liner is liable to become disturbed and so prevent the sprayer body making a true gas-tight joint on the conical seat. The carbon liner is easily removed by the aid of the fluted reamer now being supplied with all engines. On application, a reamer will be sent at a nominal charge.

76. **Replacing a Sprayer in the Cylinder Head.**—When clamping a sprayer in the cylinder head, do not tighten up the nuts more than is necessary. The feeling of tightening up against the spring of a clamp is very different from that of bolting two surfaces together, and so is liable to deceive the engineer into screwing harder down than is necessary. It requires but comparatively little screw pressure to make a tight joint on the conical seat.

77. **Routine Cleaning of Sprayers.**—It is an excellent practice to have a complete set of spare sprayers which may be changed every 300 hours. This permits of systematic, leisurely cleaning and examination without loss of running time. If they were returned to the makers they would be examined, cleaned and tested for a merely nominal charge.

78. **Withdrawal of Sprayer.**—If a sprayer has been in use some considerable time, it may require slightly more than hand pressure to withdraw it. In such case, use a spanner as a lever. Place one end under the union nut and allow the middle of the spanner to rest on the top of the cylinder head, then gently tap downwards the other end. This will free the sprayer so that it can be lifted out by the fingers.

79. **Water Circulation.** This is effected by a circulation pump, gear driven by the engine. It is recommended that the temperature of the circulation water be maintained at about 140°F. (60°C.)

79.1 **Water Temperature Control.** Marine engines and all engines which draw their cooling water from large or unlimited supplies of water at or about atmospheric temperature are fitted with a temperature control which "Shunts" or "bye-passes" warm water from the discharge pipe to the suction pipe of the circulation pump, thus raising the temperature of the water going into the cylinder jackets. It will be readily understood that the by-pass cock serves as a means of controlling, within limits, the temperature of the water in the cylinder jackets and at the point of discharge, which is of special utility when the engine is running at light loads during which the temperature of the discharged water should be maintained at about 130° or 140°F., that is, when it is just about as hot as the hand can momentarily bear.

Note.—When starting the engine, it is important that the control cock be closed, otherwise air may get into the circulation pump and interfere with its operation.

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80. **Centrifugal Water Pump. Gland and Greaser.**—Give one turn every day to the grease cup and keep it *filled with mineral grease. The gland is packed with special, cut cork washers.* When required, new ones can be quickly fitted and should be obtained from the engine makers. Do not use hemp packing as it is likely to score the impeller shaft.

81. **Water Pump. Drain. Frost.** As the pump is exposed and is not automatically drained *with the rest* of the system, it is necessary to drain it separately. The drain cock will be found at the lowest point on the pump case. If, by any chance, water became frozen in the pump, it is obvious that serious consequences might follow any attempt to start and run the engine. In order to guard against this contingency, so far as is possible, the diameter of the impeller spindle of centrifugal pumps is reduced for a short length near the driving square, so that any undue load will fracture the reduced spindle by twisting and thus prevent damage to the driving gears which cost ever so much more to replace than an impeller.

82. **To Fit a New Impeller.** *Make sure that the fit of the driving square allows a small amount of slack,* as only by this means can correct alignment with the spindle bush be ensured.

83. **Circulation, again.** Inspection should be made regularly in order to ascertain if circulation be taking place.

84. **Cylinder Heads, Water Joints.** *These are made by a series of small, inexpensive rubber rings. It is* good practice to renew them whenever the cylinder heads are removed.

85. **Cylinder Heads. Removal. Decarbonising.** In order to obtain the best results from the engine and to maintain it in an efficient and economical state, it is recommended that the heads be lifted off and the valves and other parts cleaned not less frequently than every 500 hours. These intervals have, to our knowledge, commonly been doubled and trebled, but we do not recommend such intervals, because, unless the engines be running under proper conditions, undue wear of parts takes place. Little need be said about the removal of carbon deposits which will be found chiefly in the valve ports; *the deposit on the piston and cylinder heads being of little consequence.* The operation of removing the heads is very simple and straightforward. The holding down nuts are accessible by means of the box spanner from the top of the head.

86. **To Avoid Damage to the Sprayer Nozzles,** which project from the flat surface of the cylinder head, it is strongly recommended that the sprayers be withdrawn before removing the heads. See para. 78.

87. **Replacing the Inlet Valves.** These valves are formed with patent deflectors and are prevented from turning round by the specially formed valve collars and split pins. It is **absolutely essential** that the valves be replaced in their correct position, that is, with the deflectors on the same side of the valve spindle as are the manifolds, and they must be definitely positioned by the split pin in the valve collar. To ensure this, the slot for the split pin in the collar as also the pin hole in the valve stem do not pass through the centre line of the valve stem. It will be realised that this device makes it practically impossible for one to screw the valve into the collar and to thread in the split pin with the valve half a turn wrong.

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88. **Re-fitting Inlet and Exhaust Valve Spring Collars.**—Particular care should be taken to make sure that the spring collars are not screwed further down the valve stems than is necessary to thread in the split pin, otherwise the valves would not have sufficient lift and the operating mechanism would suffer damage.

89. **Replacing a Cylinder Head.**—The gas joint of head to cylinder is made by a soft copper plate. When replacing a head, it is therefore only necessary to see that the faces are absolutely clean and to apply a smear of seccotine or other fluid joint compound. Care should be taken to avoid scraping any metal off the surfaces and not to allow jointing compound to become hard before assembling. Screw up all the nuts equally.

When replacing a cylinder head, it is recommended, as in para. 84, to renew the small water joint rings.

90. **Tappet Clearance.** After replacing a cylinder or after every 300 hours, adjust, if necessary, the clearance between the end of the tappet rod and the heel of the valve rocker. The correct clearance for both inlet and exhaust valves is 0·015 in. (fifteen thousandths of an inch). When tightening the lock nuts, it is quite unnecessary to use great pressure. The adjustment should always be made with the piston at the top of the compression stroke. To find this position, decompress all the cylinders and turn the flywheel until the inlet valve under consideration just closes, then turn the flywheel a further half turn ; the piston will now be at or near the end of the compression stroke. This position may also be verified by observing the injection pump belonging to the cylinder in question, the priming lever of this pump will show that the pump tappet is in the lifted position.

91. **Governor-Control Slider Bar.**—This slider bar is operated by the centrifugal governor, and its function is to vary the amount of fuel injected into the cylinders and thus vary the power of the engine. It is connected to the governor lever by the governor-bar connecting link. The effect of moving the slider bar towards the flywheel is to increase the amount of fuel injected into the engine and *vice versa*. If the bar is moved to the full extent towards the timing case, there is no injection. The correct setting of the slider bar with relation to the governor is such that when the governor weights are parted to their full extent by inserting the fingers through the inspection opening in the governor case, the length of the governor-bar connecting link is so adjusted as to give the slider bar a position approximately $\frac{1}{32}$ in. from its maximum stroke towards the timing case. If the link has thus to be adjusted at any time, care should be exercised in seeing that the holes of the joint pins are parallel and that the slider bar moves freely.

92. **Timing-Chain Drive. Adjustment for Slack.** It is not good to run the engine with the chain unduly slack : on the other hand, it is imperative that it runs with a certain amount of slack as defined as follows. The chain is correctly adjusted when it is possible to move the middle of the nearly vertical run through approximately a distance of $\frac{1}{4}$ in. on either side of its mean position. The adjustment is effected by an idler sprocket running on a stud eccentrically housed in the timing case. The method of adjustment is obvious.

The chain should be inspected for slack every 500 hours. To repeat, do not, on any account, run the chain with less slack than that indicated above.

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93. **Decompression. Adjustment of Valve Lift.**—The act of turning a starting lever into position No. 1 (decompression) causes a cam to bear upon an adjustable screw fixed in the heel of the inlet valve rocker lever which cam lifts the heel and consequently holds open the inlet valve, *i.e.*, it cannot now close. The amount of opening is determined by the adjustable screw. In case of derangement, adjust this screw so that it lifts the inlet valve 0·040 in. (forty thousandths of an inch) from its seat.

MISCELLANEOUS NOTES ON THE OVERHAUL OF THE ENGINE.

94. **Drawing the Pistons and Connecting Rods.**—These can be drawn in either of two ways: 1, through the bore of the cylinders, after removing the heads; or 2, by lifting the cylinders from the crankcase. A piston ring guide is sent with the engine in case method 1 is preferred. The gudgeon pin is free to turn in the piston and in the connecting rod; in other terms, it is fully floated. To remove the pin, it is sometimes necessary to use a wooden drift and so lightly drive it out.

95. **Piston Rings.**—When new rings are to be fitted, see that, when inserted at the mouth of the cylinder bore, they have a gap clearance of about 0·005 in. (five thousandths of an inch).

96. **Big-End Bearings. Main Bearings.**—Whenever new bearing shells have to be fitted to any of these bearings, the following things should be observed. The bearing shells must be a perfect fit in their housings. Both the big-end bearing and the main bearing are so designed that, when bolted up, the halves of the bearing shells butt against each other, metal to metal, as also do the cap of the bearing and its housing and the fitting is such that, when bolted up, the bearing is perfectly free on the crank pin or journal. In order to ensure that the bearing shells are tightly held in their housings, the whole is so fitted that, when the bolts are only slightly more than finger-tight (just before finally tightening), there remains a gap of 0·002 in. (two thousandths of an inch) between the cap and the housing.

Bearing shells should be carefully hand-scraped so that, when bolted up, they are perfectly free on the pin or journal but yet have no play or slack. Do not make any attempt to "burn in" a bearing by running the engine, as this will bring no end of trouble.

Observe that the oil grooves in the main bearings are in correct alignment with the feed holes in the crankshaft. There is a right and a wrong way round for these shells. All bearings are so fitted that the numbers lie on the governor side of the engine.

Pay particular attention to the joints of the feed pipe of the main bearings and use always new packings.

97. **Crankshaft.**—This is located endwise between the two main bearings nearest to the flywheel and should have an end-play of 0·010 in. (ten thousandths of an inch).

All the other bearings should have an end-play of 0·040 in. (forty thousandths of an inch) to allow of expansion. Before assembling the crankshaft, thoroughly clean and wash out all the feed passages and carefully examine all the bearing surfaces for any signs of abrasion: a scratch or a dinge can usually be detected by rotating the half of a bearing shell on the shaft.

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98. **Valves.**—Exhaust valve stems should have a clearance of 0·006 in. in their guides while 0·003 in. will suffice for the inlet valve stems. When assembling the spring collars, do not screw them further down the valve stems than is necessary in order to thread in the cotter pin.

Directions for assembling the inlet valves have been given in para. 87 (very important). See also para. 88.

99. **Valve Camshaft.**—Little need be said about this organ since an inspection will readily reveal the method of construction. When assembling, take care that the cams come under the correct tappet, *e.g.*, that the exhaust cam is under the exhaust tappet and not under the inlet tappet or *vice versa*. The exhaust cam, it will be noticed has a less rise than the inlet cam but is of longer period. Make sure that the binding screws are thoroughly tightened home. A special, square box key is supplied with the engine for this purpose.

100. **Clearance Between Valve Heads and Piston.** It will be seen that shallow recesses are formed on the top of the pistons to give clearance to the valve heads and to allow of an over-lap timing diagram. The diameters of the inlet valves and their recesses differ from those of the exhaust valves, therefore this must be taken into account when fitting the piston on the connecting rod so that the recesses shall fall underneath their corresponding valves. The correct way in for the piston is clearly indicated by the lettering, "TAPPET SIDE" on the top of the piston.

101. **Timing of Valves.** When reassembling an engine after an overhaul, it is of the utmost importance to pay special attention to the timing of the valves and other organs with relation to the crankshaft, for if the timing be not in accordance with the timing marks on the flywheel and the timing gears, the valves will foul the pistons and **serious consequences will result.** For this reason, it is desirable, during timing to place the lower end of the tappet rod in the cam-tappet socket and not to push the upper end under the valve rocker until all is verified. In this way, one can observe the vertical motion of the free end of the tappet as the flywheel is rotated to and fro. This motion should be such that when the piston is towards the top of the exhaust stroke, if all is correct, the inlet valve will be on the point of opening while the exhaust valve will be on the point of closing. In other words, the centre of the overlap between the inlet opening and the exhaust closing should occur when the piston is approximately on the top dead centre, after the exhaust stroke.

102. **Timing of Fuel Injection.** Drawn across the periphery of the flywheel will be found a number of pairs of lines, one pair for each cylinder or crank, and a short line called the zero line will be found on the upper crankcase, in the case of engines fitted with normal (22 in.) flywheels and on No. 1 cylinder, in the case of engines fitted with extra heavy (26 in.) flywheels. Taking, for example, the pair on the flywheel belonging to No. 1 cylinder, when the longer line marked "No. 1 T.D.C." is opposite to the zero line on the engine, No. 1 crank is exactly on the T.D.C. (top dead centre), and when the shorter line marked "No. 1 cylr. Injection" is opposite the mark on the engine, fuel injection of No. 1 cylinder begins. Similar remarks apply to the other cylinders.

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103. A finger lever and index will be noticed on the side of the gearcase: this is a timing device used only by the engineers when testing the engine: it has no interest or utility for the user, consequently the finger is permanently locked and marked in its correct position by the two binding set-screws, which should never be tampered with. (This para. applies only to L. 3 engines).

104. NOTE.—No. 1 cylinder is the one at the fuel-pump end of the engine.

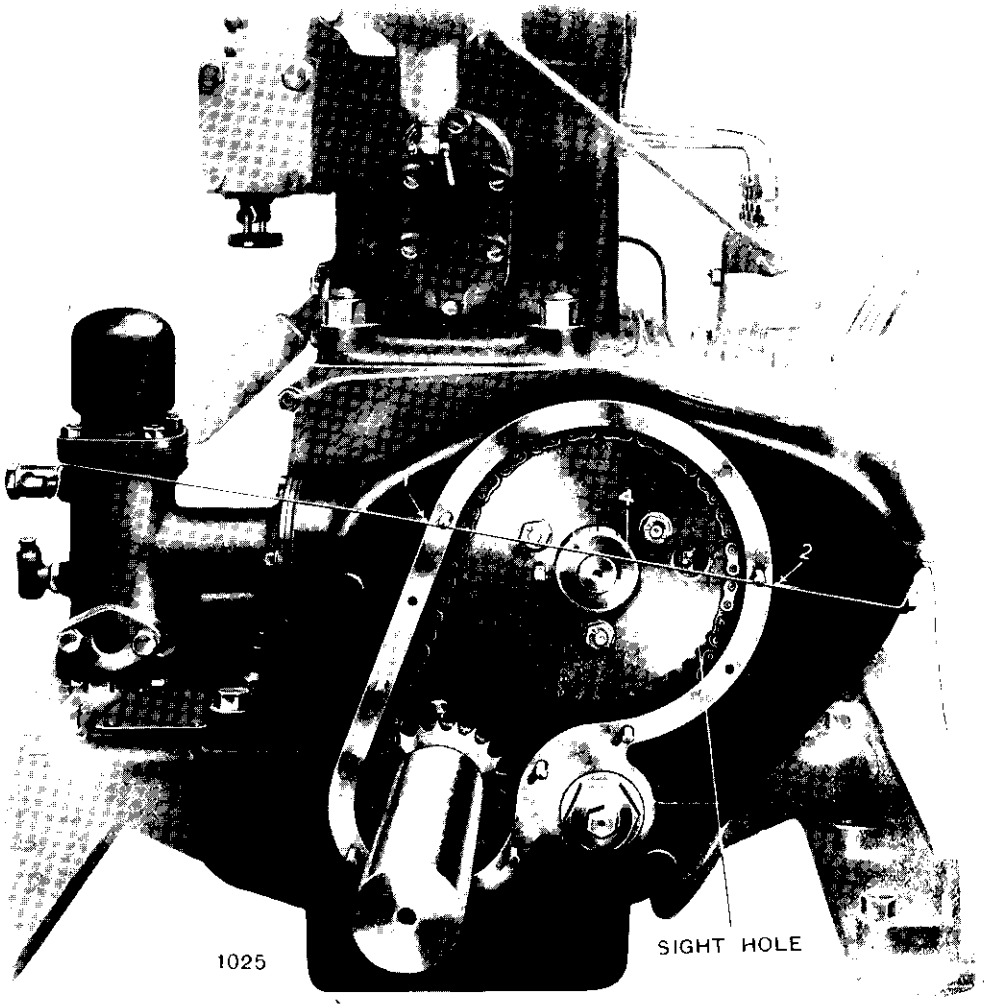

FIG. 13

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105. **Timing of Fuel Injection.**—Each fuel pump is provided with a sight hole or window through which can be seen the plunger moving up and down. On the sides of the window is a horizontal line and also one on the plunger. When these two lines coincide, the pump is at the beginning of the injection period and this event takes place, of course, at the same time that the corresponding injection lines on the flywheel register with the zero line as described in para. 102. When so checking the timing, be careful not to be misled by turning the flywheel in the wrong direction. On the fuel-pump tappet are locked screws which should never be disturbed. In case of derangement from some cause or other, the screw should be readjusted so that, during the complete stroke of the pump, the line on the plunger should travel equal distances above and below the line on the side of the windows. This is, of course, only an approximate setting, the final and accurate setting is achieved by obtaining simultaneous coincidence of the lines on the plunger of the fuel pump and on the sides of the window and coincidence of the fuel injection lines on the flywheel with the zero line as in para. 102.

106. **Timing of Camshaft Gears.** (See Fig. 13).—Remove the cover of the gear case and turn the flywheel until No. 1 crank comes on the top dead centre of the compression stroke. (See para. 102). When all is correctly timed the following events take place: -

(1) The dots 1 and 2 on the gear case and the dots 3 and 4 on the boss of the camshaft gear are all in one straight line as indicated by the white cord in the picture.

(2) The line on the disc of the large chain-gear registers with the line on the boss of the camshaft gear.

(3) Through the sight hole in the large chain-gear the teeth of the valve and pump camshaft gears are visible, and it will be found that the dotted tooth of the valve camshaft gear lies between the two dotted teeth of the pump camshaft gear.
In all cases the "dots" are countersinks made by the point of a drill.

107. **Timing of Inlet and Exhaust Valves.** The cams are so fixed on the camshaft that they cannot be displaced. The only way therefore of deranging the timing is by playing with the screws in the heel of the rocking levers. Should these be displaced they should be re-adjusted so as to give 0·015 in. clearance between the toes of the levers and the ends of the valves when the latter are closed.

108. **Correction for Stretch (Wear) of Timing Chain.** Owing to the fact that, in the course of time, the timing chain wears and consequently increases in length, the timing of the valves and the fuel injection becomes slightly retarded, therefore compensation should be made when required. To this end inspect the timing as indicated in para. 102, after, say, 700 hours working, and if it be found that the timing is retarded, proceed as follows: Turn the flywheel until the injection timing line is in line with the zero line on the crankcase, then slacken the three hexagon nuts on the main chainwheel shown in Fig. 13 and rotate the fuel pump camshaft or the valve camshaft until the lines on the windows of the fuel pump coincide as indicated in para. 105. Check the timing again after tightening the nuts. Injection should begin at approximately 7° before the T.D.C.

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109. **Timing of Decompression.**—Decompression is effected by turning the starting lever into the horizontal position which causes a cam to bear upon a screw tappet at the side of the inlet valve rocking lever, in such a way as to prevent the valve from closing entirely. In case of derangement of this screw tappet, it should be re-adjusted so as to lift the inlet valve 0·040 in. from its seat.

110. **Air Inlet Valve.** -It will be noticed that the spring collar of the valve has a flat side which is located by a flat bearing surface on the inside of the gear box on the cylinder head. The object of this device is to ensure that the valve head with its patent baffle shall not run out of its correct position. As a further precaution, the split-pin hole is drilled slightly away from the centre line of the valve so that, when replacing the valve after cleaning, should it be half a turn wrong, it will not be possible to thread the split-pin through the hole. This, of course, forms a clear indication whether or not the valve is in its correct position.

111. **Air Intake.** Immediately below the main air intake will be found a small lever handle which operates an internal flap valve. When the lever is in the position marked "HOT," the valve opens the air manifold to a jacket surrounding the exhaust manifold, at the same time, closing it to the cold air muffle. When in the position marked "COLD," the valve closes the air manifold to the hot air jacket and opens it to the cold air muffle.

112. Hot air is recommended when running light or below quarter-full load. Above quarter load, hot air is not necessary, and indeed is undesirable, as it entails a loss of power.

113. **Bilge Pump Friction Clutch.** Outside the gear case of the pump is a large hand-nut with a central locking screw. The hand-nut is attached to a sleeve which screws in and out of the gear case cover. To engage the clutch, screw in the sleeve as far as it will go. To disengage the clutch, unscrew out the screw as far as it will go.

For the purpose of adjusting the spring load on the clutch, the hand-nut is screwed on to the sleeve and locked by the central screw, so that when this screw is slackened, the hand-nut is free to turn upon the screwed sleeve. To increase the spring load on the clutch, first, disengage the clutch as above, then slacken the central screw and **unscrew,** by a fraction of a turn, the hand-nut on the sleeve and lock again. It will be evident that unscrewing the hand-nut relative to the sleeve increases the stroke of the sleeve and therefore the spring pressure.

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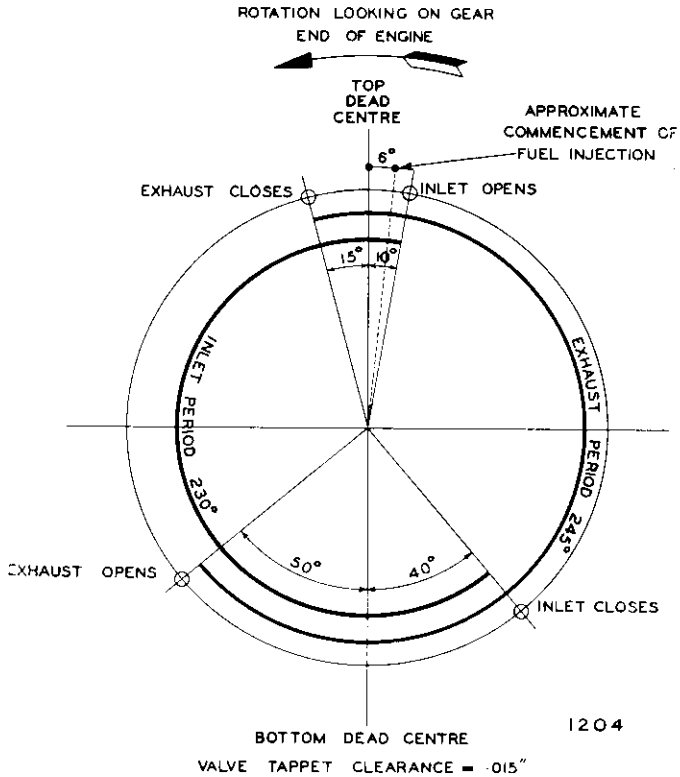
114. **Fuel Pumps. Cam Shaft Case.**—The parts enclosed in this case are continuously lubricated from the main pressure system. As, however, owing to convenience of construction, this oil does not pass through the delivery strainer, and as a precaution against the remote contingency of the nozzle of the feed pipes becoming choked, it is advisable to make sure that the parts are receiving an adequate supply of oil. This may be verified by looking down the vertical well on the side of the case, after opening the rotable inspection door. (There are two of these wells on engines with five and six cylinders). This inspection should be made while the engine is running in order to see the oil splashing from the moving parts.

115. **Governor Case.**—The preceding paragraph applies equally to the governor case, inspection being made through the opening which is closed by the large screwed plug, while the engine is running.



TIMING DIAGRAM

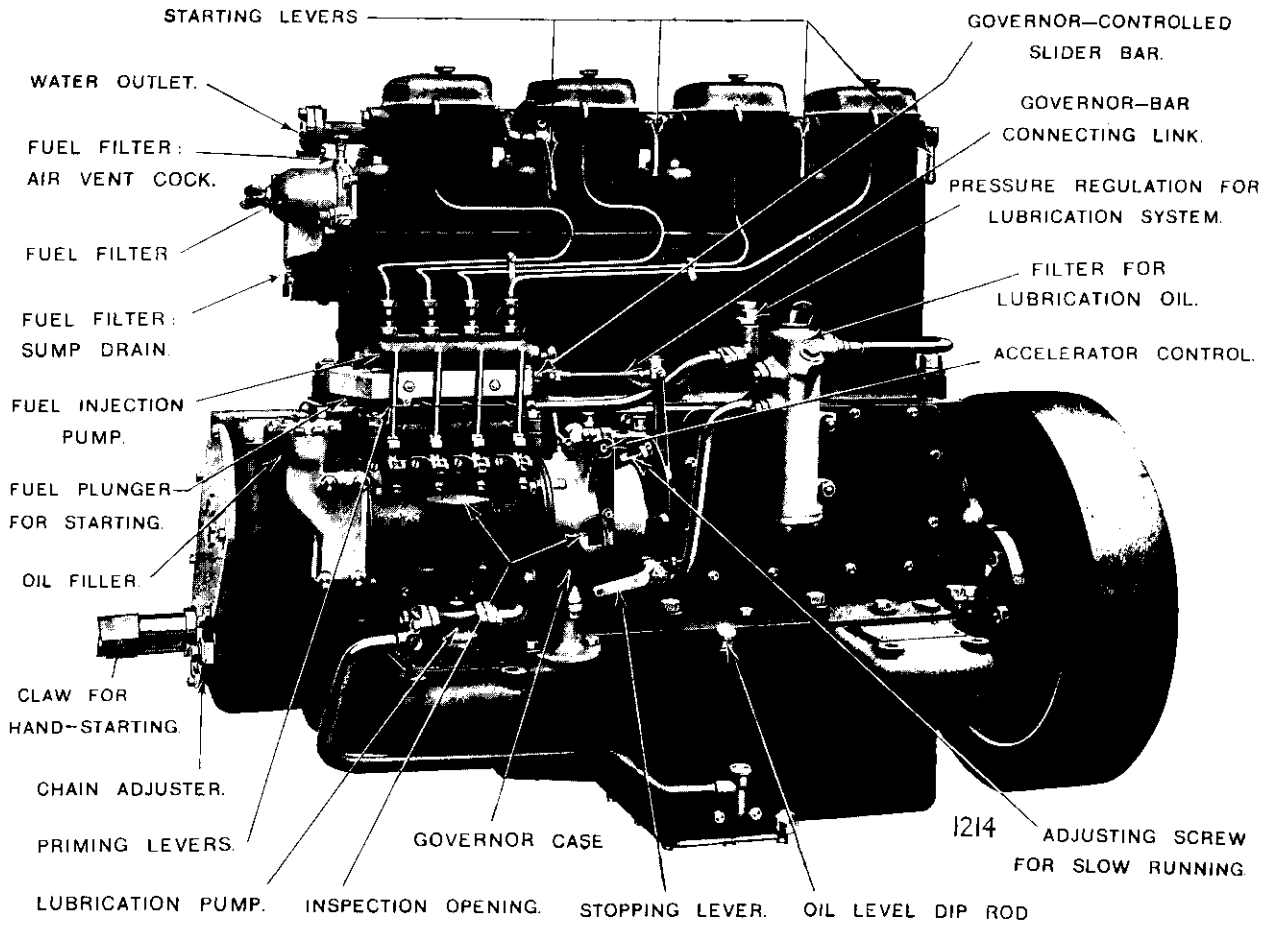

STARTING LEVERS
GOVERNOR—CONTROLLED SLIDER BAR.
WATER OUTLET.
GOVERNOR—BAR CONNECTING LINK.
FUEL FILTER: AIR VENT COCK.
PRESSURE REGULATION FOR LUBRICATION SYSTEM.
FUEL FILTER
FILTER FOR LUBRICATION OIL.
FUEL FILTER: SUMP DRAIN.
ACCELERATOR CONTROL.
FUEL INJECTION PUMP.
FUEL PLUNGER FOR STARTING.
OIL FILLER.
CLAW FOR HAND-STARTING.
CHAIN ADJUSTER.
PRIMING LEVERS.
GOVERNOR CASE
1214
ADJUSTING SCREW FOR SLOW RUNNING.
LUBRICATION PUMP.
INSPECTION OPENING.
STOPPING LEVER.
OIL LEVEL DIP ROD

Fig. 14

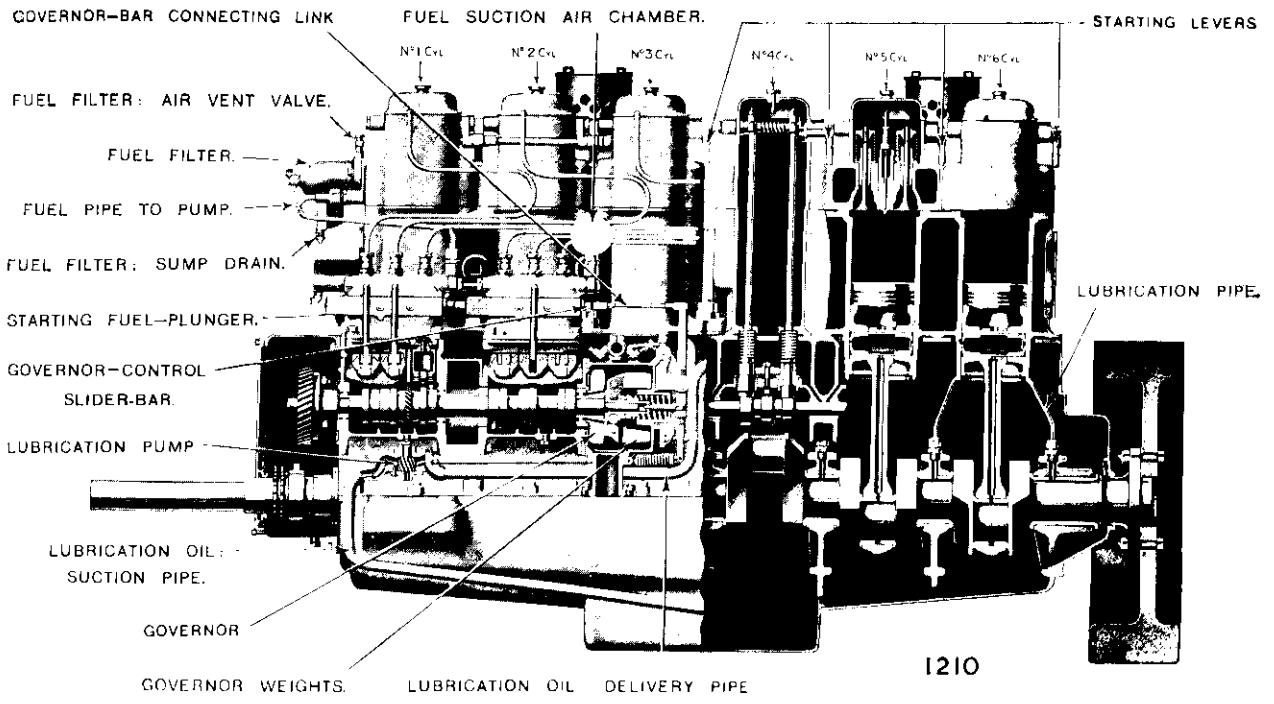

GOVERNOR—BAR CONNECTING LINK
FUEL SUCTION AIR CHAMBER.
STARTING LEVERS
N°1 Cyl
N°2 Cyl
N°3 Cyl
N°4 Cyl
N°5 Cyl
N°6 Cyl
FUEL FILTER: AIR VENT VALVE.
FUEL FILTER.
FUEL PIPE TO PUMP.
FUEL FILTER: SUMP DRAIN.
LUBRICATION PIPE.
STARTING FUEL—PLUNGER.
GOVERNOR—CONTROL SLIDER-BAR.
LUBRICATION PUMP
LUBRICATION OIL: SUCTION PIPE.
GOVERNOR
1210
GOVERNOR WEIGHTS.
LUBRICATION OIL DELIVERY PIPE

Fig. 15