

Engine No. 22439

Publication No. 651 B.

**ERECTION INSTRUCTIONS
WORKING INSTRUCTIONS
AND
SPARE PART LIST
FOR THE
CAMPBELL HORIZONTAL
COLD STARTING
HEAVY OIL ENGINES**



THE CAMPBELL OIL ENGINE CO. LTD., TYNDALL ST., CARDIFF, S. WALES

TELEGRAMS : CAMPBELL CARDIFF

TELEPHONE : CARDIFF 31307

The Campbell Horizontal Cold Starting Heavy Oil Engine

ERECTION.

(1) **WORKING PRINCIPLE.** During the first or "Suction" stroke, air is drawn into the cylinder through the inlet valve by the suction of the piston. On the second or "Compression" stroke, this air is compressed by the piston returning. At the end of this stroke, the pump injects the fuel. The mixture is then fired by the heat of the compression and the explosion drives the piston forward on its third or "power" stroke. Returning on its fourth or "exhaust" stroke, the piston expels the burnt gases through the exhaust valve. This "cycle" is repeated continuously.

The camshaft runs at half the speed of the crankshaft so that the valves open only once in two revolutions of the crank.

The speed is regulated by the Governor which controls the quantity of fuel injected. If the speed rises the effective stroke of the Fuel Pump is slightly diminished. If it falls the effective stroke is slightly increased. The speed is thus maintained practically constant.

The Engines are arranged to start from cold. They require no lamp under any conditions and should be started on Diesel oil or Gas oil. On those Engines equipped for running on Crude residuals, or Vegetable oils, the changeover can be made a minute or two after starting. They should also be changed back to the refined fuel oil a few minutes before stopping.

(2) **FOUNDATIONS.** The foundations must be generally in accordance with the plan supplied. **N.B. THE CONCRETE BLOCK SHOULD HAVE PROVISIONS FOR MOUNTING THE FUEL FILTER, BY INSERTING THE RAG BOLTS IN THE CONCRETE WHEN MAKING UP THE BLOCK.** Place the engine on the block with the foundation bolts in position. Line up the engine to the shaft to be driven packing it evenly and level with wedges under the engine bed, then grout in cement around the bolts and up to the bed. When the cement is set, tighten the foundation bolt evenly. **Care must be taken in the grouting-in of the concrete and in the final tightening down of the Foundation Bolts to see that they are tightened down evenly.** If this is not done the Base plate casting is likely to be distorted and lead to overheating of the Main Bearings. Place the water tanks in position and couple up the piping after making sure that all pipes are clean and free from scale. Note that the top pipe must rise from the engine to the tank to avoid an air lock. It should enter the tank at least 6" below the rim. See that the cock at the bottom of tank allows water to flow to the engine.

Place the fuel tank(s) in position and connect the fuel pipes. Make sure that these pipes are free from grit and dirt. In the case of engines using heavy fuel where an exhaust heater is supplied, the pipe from the larger tank (the heavy oil tank) is connected to the top of the heater, and the pipe from the smaller (light oil tank) to the three-way cock on the side of the heater. Thus the heavy oil is passed through the heater and the light oil is by-passed direct to the Fuel Pump.

When it is intended to run the engine on light and medium oils that do not require heating the fuel tank is connected directly to the filter which is mounted on the foundation block under the Fuel Pump.

(3) **ASSEMBLING.** All parts must be thoroughly cleaned, and moving parts well oiled. The fly-wheel(s) and pulley must be securely keyed in place and all keys, screws, bolts and nuts must be thoroughly tightened. **TO PREVENT DISTORTION OF THE SHAFT WHILE DRIVING UP THE FLY-WHEEL AND PULLEY KEYS, FIT A BLOCK OF HARD WOOD BETWEEN THE CRANKWEBS, OR WEDGE A BOLT AND NUT BETWEEN THEM.** Adjust the bearings carefully, so that the shafts move freely without being slack.

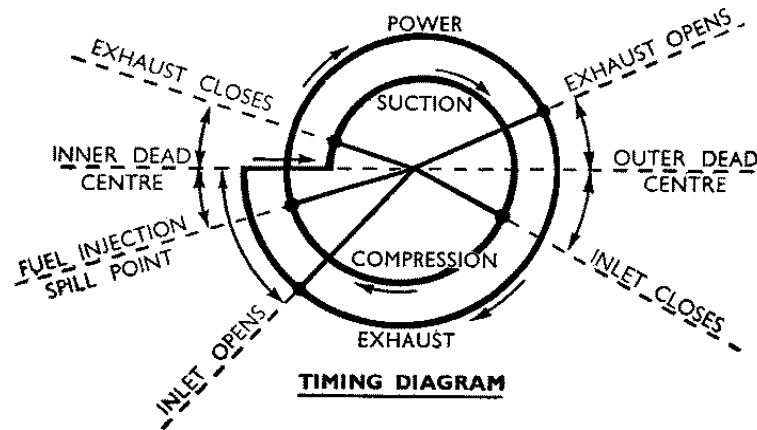
Before setting to work, the piston and connecting rod must be dismantled and all rust preventing composition removed with the aid of petrol. The bearings, gudgeon pin, and all oil ways must be thoroughly cleaned, and if necessary the rings taken out and the grooves cleaned. On re-assembling, carefully adjust the bearings at each end of the connecting rod and well oil before putting in place. Thoroughly clean out the cylinder with petrol or paraffin and oil liberally before inserting the piston. See that the openings in the piston in the rings are NOT all in line and none are at the bottom, and **make sure that the piston and rod are put right way up in the cylinder**, that is the small hole in the skirt of the piston and the hole in the connecting rod are on the top.

Special care must be taken to ensure absolutely correct alignment of the bearings; this should be tested as follows:—after the shaft is in place and the bearings adjusted, turn the crankpin on to the top Centre and measure accurately with calipers or micrometer the distance between the crank webs at the extreme end furthest from the crankpin. Then turn the crank to the bottom Centre and measure again in the same place. **IF THE DIFFERENCE EXCEEDS 2/1000 OF AN INCH, THE BEARINGS MUST BE FURTHER ADJUSTED UNTIL THE DIFFERENCE IS REDUCED TO 2/1000 OF AN INCH OR LESS.** The same test should be made on the inner and outer horizontal Centres.

NOTE. THIS TEST FOR ALIGNMENT SHOULD BE MADE ABOUT EVERY SIX MONTHS, and the bearings adjusted when necessary. Unless due attention is given to this, a serious breakdown may eventually occur.

When fitting or replacing the Mechanical Lubricator, special care should be taken to ensure that the two stud nuts holding the tank in position are tightened evenly. If this is not done, the tank is liable to become distorted, and in this case the pumps will not function.

The gear wheels which drive the camshaft must be correctly set or valves will not open and close at the proper times (see valve diagram). The marked tooth on one wheel is to go between two marked teeth on the other. The mark is generally an "O" stamped on the end or top of the teeth (see paragraphs 27 and 28).



If a line be marked on the side of the crank slab passing from a point in the centre of the crankpin to the centre of the shaft, then the angles shewn on the timing diagram above represent the angles that this line makes with the horizontal centre line of the engine cylinder. At such angles of the crankshaft the valves must be just opening or closing as the case may be. These angles are obtainable with Inlet Tappet clearance and Exhaust Tappet clearance.

(4) **THE EXHAUST PIPE** should be laid in a trench AND MUST BE FREE TO EXPAND LENGTHWAYS. Bends should be avoided, but if indispensable, must be easy; the pipe must be clear of wood or other inflammable materials, and if very long should be larger than the standard size. The exhaust box must not be fixed, but must be free to slide as the pipe gets hot and expands.

(5) **FUEL HEATER.** If fitted this is attached to the exhaust branch under the cylinder head, and by warming the oil, renders it fluid enough to flow freely to the pump. If the engine is run on heavy oils that are not refined, a small tank is necessary to contain refined oil for starting and stopping purposes. If the engine is allowed to stand for a time with un-refined fuel oil in the fuel pump and atomiser, the corrosive contents of these oils may cause serious trouble.

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(6) **THE WATER TANK(S)** must be placed with the bottom at least as high as the bottom of the engine cylinder. The pipes should be short and direct with as few bends as possible. The pipe to the engine should be connected with a stop cock, close to the bottom of the tank. It must enter the cylinder at the under side, AND HAVE A DRAIN COCK AT THE LOWEST POINT. The return pipe must slope upwards and enter the tank at least 6" below the surface of the water.

If there are two or more tanks, all but one must have a gully inside, reaching from the top to about 3 inches (75 m/m.) from the bottom. The tanks must be connected by pipes near the top, one end of each pipe entering a gully. The bottom water pipe (and the supply from the main, if any), must connect to the tank without a gully, the return pipe being coupled to the tank at the other end of the series. The overflow pipe (if any) should be fitted to the same tank as the return pipe, and above it, so the latter is always under water.

(7) **THE FUEL TANK** should be placed near the engine, the bottom being about 5 feet (1.5 metres) above the top of the engine foundation, or higher if the oil is thick. The fuel pipe should be short and direct with as few bends as possible and must be connected to the Fuel Filter or the Fuel Heater if fitted.

When heavy residual oils are used, the fuel pipe between the tank and engine should be larger than the normal size.

(8) **AIR FILTER.** This should be dipped in thin lubricating oil and allowed to drain before assembly on the engine.

RUNNING THE ENGINE.

(9) PREPARATIONS FOR STARTING.

(a) See that there is plenty of oil in the fuel tank(s) and turn on the fuel cock.

(b) Prime the fuel pipes (see paragraph 23).

(c) Fill all the lubricators and oil reservoirs. In the ring lubricated bearings the oil must cover the bottom of the rings, but should not touch the bearings, or issue from the overflow.

Where an inspection hole and cover are provided on ring oil bearings, the oil should be filled to within $\frac{1}{4}$ inch of the lower edge of the hole in the front of the Bearings.

(d) Fill the Exhaust valve cap with lubricating oil and screw in.

(e) Start the sight feed lubricator and put a few drops of oil on the valves and governor and in the oil holes on all the moving parts. Give a few strokes on the rear plungers of the mechanical lubricator, then prime the lubricating pipes with a few strokes on the front plungers. Repeat this until oil is seen to be issuing from piston lubricator check

valve when the piston is at inner dead centre and from the pipe into the distributing ring (attached to the crank web). Pour a little oil into this ring. Fill the wick feed lubricator with oil. Avoid pouring excessive quantities of oil on the piston as this may work into the combustion chamber and cause excessive engine speed.

(f) See that the water in the tanks covers the return pipe, that the cock on the water pipe to the engine is open and the drain cock shut.

(g) If it is an "open" or "through" circulation turn on the water, see that it issues at the outlet, and leave it on. Try the inlet and exhaust valves by hand to make sure they are not stuck by deposit from the fuel oil. See that the driving belt is on the loose pulley. Work the fuel pump priming handle until the resistance of a SOLID column of oil is felt. (See paragraph 23).

CAUTION. DO NOT INJECT ANY FUEL BY HAND BY WORKING THE PRIMING HANDLE AFTER THIS RESISTANCE IS FELT.

(10) TO START THE ENGINE.

(a) Raise Exhaust lifter handle which is attached to the shaft below the camshaft.

(b) By means of the starting handle turn engine until a fair speed is obtained.

(c) Whilst still turning, knock down the Exhaust lifter Handle when engine will fire.

(d) Remove starting Handle from Crankshaft.

N.B. It is advisable to oil crankshaft before fitting starting Handle as this will allow easy withdrawal of handle after engine has fired.

NOTE.—When starting the first time, unscrew the speed adjusting nut and locknut in the governor head until the spring exerts very little pressure, run for a few minutes, then stop and feel the crankshaft, connecting rod, and camshaft bearings. If they are quite cool, start up again and run for 10 to 20 minutes, then stop, and if the bearings are still cool, screw up the speed adjustment in the governor head, restart and put on some load. Make one or two short runs with gradually increasing load until satisfied all is in good order. The bearings and piston when new, should be lubricated plentifully at first. Never run at more than the rated speed without consulting the makers, or an accident may result.

(11) **AFTER STARTING.** Make sure all lubricators are working. Feel the bearings occasionally to ascertain if they are cool. At any sign of over-heating examine the lubricators immediately, and give a flush of oil by hand. Fill the small oil holes occasionally. Due attention to lubrication is essential.

If a refined oil tank is fitted and used for starting, after running for a few minutes turn over to the Heavy oil by means of the 3-way cock.

(12) **BEFORE STOPPING.** (a) If refined as well as heavy oil is used, turn over to refined oil two or three minutes before stopping, to clear the Heavy oil out of the pipes and fuel pump. If this is not done difficulty may be experienced in starting from cold. The Fuel pump and atomiser may also become corroded if it remains long in stationary contact with some Heavy oils.

(b) Throw off load.

(13) TO STOP THE ENGINE.

(a) Having thrown off Load, hold forward the fuel pump priming handle thus preventing fuel being injected.

(b) When engine has almost stopped, still holding fuel pump priming handle forward, raise exhaust lifter handle.

(14) **AFTER THE ENGINE HAS STOPPED,** stop the sight feed lubricator above the governor. Turn the flywheel round until the piston is inside the cylinder, in starting position.

WHENEVER FROST IS LIKELY TO OCCUR while the engine is not running, the water must be run off from the cylinder jacket to avoid bursting by the formation of ice. Any pipes which do not get emptied with the jackets can be emptied by loosening a union or flange.

(15) **CLEANING.** Draw the piston occasionally. Scrape it and thoroughly clean the rings and grooves before replacing. If the rings are stuck, they can be freed with paraffin. When drawing the piston, take care not to damage the crankpin, or to let the connecting rod fall on front end of piston or liner; any bruise made on the crankpin must be carefully filed down, smoothed with emery cloth, and cleaned of all dust before re-assembling the bearing.

To drive out the gudgeon pin, use a hard wood or brass punch, first removing the circlips. Take care to replace the piston on the connecting rod with Small End lubricating hole on top.

Lubricate well when replacing all moving parts. See that all nuts, especially lock nuts, are replaced and properly tightened. When replacing nuts on any part, do not pull each hard down as it is put on, but put all on finger tight, then tighten gradually, giving each nut, say, half a turn at a time.

Where the fuel is a Heavy or residual oil, sludge may accumulate. The tank should be examined weekly and any sludge or water drawn off. If this is not done, there may be difficulty in getting the engine to work.

The water jacket should be cleaned out yearly or more often, if the cooling water is hard or dirty.

THE AIR FILTER should be removed occasionally, cleaned in paraffin and re-coated with thin lubricating oil. The period between cleaning will depend upon the conditions under which the engine is working.

THE FUEL FILTER pack should be removed at intervals, depending upon the cleanliness of the fuel, and washed out in paraffin. If compressed air is available the pack should be placed in the paraffin and an air hose inserted inside the pack and blow paraffin through the felt ; this is a quick and efficient method of cleaning. Care must be taken when cleaning the filter pack that no grit or dirt is transferred to the inside, since there would then be nothing to prevent this grit from damaging the Pump or Atomiser.

The pack should be renewed when washing fails to remove the accumulated dirt or when the felt becomes worn.

TROUBLES AND THEIR REMEDIES.

(16) ENGINE NOT STARTING EASILY.

Causes	Remedy
(a) Air in the fuel pipes.	See paragraph 23.
(b) Atomiser spindle sticking or not seating properly.	See Maker's Booklet
(c) Fuel pump plunger sticking or valves leaking.	See Maker's Booklet
(d) Inlet or exhaust valves stuck or leaking.	Wash with paraffin and grind in if necessary.
(e) Piston rings or piston and liner worn.	If necessary re-bore liner and fit new piston and rings.
(f) Incorrect assembly of gear wheels.	Re-assemble correctly.
(g) Fuel filter dirty or clogged.	See paragraph 15.
(h) Incorrect valve adjustment.	Adjust (See paragraph 29).

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(17) ENGINE LOSING POWER OR STOPPING.

(a) Insufficient fuel supply.	Examine fuel tanks, fuel pipes, fuel filter, fuel pump valves, atomiser, etc.
(b) Air in fuel pipes.	See paragraph 23.
(c) Atomiser out of adjustment or spring broken.	See Maker's Booklet

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| (d) Air filter choked with dust. | Wash in petrol or paraffin and dip in lubricating oil. Allow excess oil to drain off before fitting again. |
| (e) Fuel tank empty, or an accumulation of sludge or water in it. | See paragraph 15. |
| (f) Fuel filter pack dirty or clogged. | See paragraph 15. |
| (g) Excessive leakage passed piston rings or valves. | See paragraphs 16d and 16e. |
| (h) Small end, Big end, main or outer bearings too tight, or seized through lack of lubrication. | Make sure of lubrication. Slacken if necessary. |

(18) **CONTINUED FIRING AND EXCESSIVE SPEED.** Due to too much fuel injected, either by hand accidentally or through failure of the governor. To avoid a dangerous increase of speed immediately throw in the exhaust valve lifter. This prevents compression and thus stops ignition.

As soon as the speed drops to normal, throw out the exhaust valve lifter, thus resuming ignition, otherwise the pump may again flood the combustion chamber. Stand by until assured all is in order. If the governor is suspected, it is advisable to stop and correct the defect.

Take care not to pump fuel into the combustion chamber by hand when priming.

(19) IRREGULAR FIRING.

- (a) Atomiser spring may be too slack.
- (b) Atomiser spindle may be stuck, or nozzle choked. (In each case see Maker's Booklet).

(20) SMOKY EXHAUST.

- (a) Atomiser spring too slack, see Maker's Booklet.
- (b) Soot or lamp black liberated from fuel oil containing asphalt. This cannot be avoided, but if atomiser is properly adjusted, there will be very little deposit in the engine.

(21) KNOCKING. Cause	Remedy
(a) Piston sticking, through insufficient lubrication.	Always attend first to lubrication.
(b) Slack Bearings.	See paragraph 31.
(c) Loose Keys.	See paragraph 33.
(d) Ignition too early.	See Maker's Booklet.
(e) Atomiser Spindle stuck.	See Maker's Booklet.

(22) **OVERHEATING OF THE CYLINDER.** The cylinder jacket, when the engine is on load, should never get so hot that one's hand cannot be comfortably held against it. Overheating may be due to stoppages of the water circulation or inadequate lubrication of Piston. See there is sufficient water in the tanks, and if necessary clean out the cylinder head water jacket and the pipe lines.

If new piston rings have been fitted, overheating may be caused by too small a gap in the piston ring slots. The gap should be a minimum of 0.020" and should not exceed .025".

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ADJUSTMENT AND CARE OF ENGINE.

(23) **PRIMING THE FUEL PIPE.** Before the first start, after cleaning the Fuel Filter, or after overhauling, the pipe lines between the Fuel Tank and the atomiser must be filled with fuel oil with no air. To do this, having filled the tank :—

- (a) Slacken back the Fuel Pump to Atomiser pipe Joint at atomiser.
- (b) Slacken back the thin drain-off line between the atomiser and the Fuel Filter at atomiser.
- (c) Slacken back the vent plug on the Fuel Pump.
- (d) Slacken back the screw on top of the Fuel Filter.
- (e) Ensure that the fuel cam is not pressing up the fuel pump.
- (f) Turn on the Fuel cock on the tank and allow the fuel to flow until it issues from the Filter, the Fuel Pump vent, and the atomiser return pipe.
- (g) Tighten the joints when no air is seen in the fuel coming from them, tightening Pump Vent Screw last, leaving the main Fuel pipe between the pump and the atomiser still loose at atomiser joint.
- (h) The Priming Handle on the Fuel Pump should NOW be operated until fuel flows from this latter joint with no air bubbles.
- (i) Tighten up the joint.
- (j) Operate the Priming Handle again gently until a solid resistance is felt, but be careful not to inject fuel into the Cylinder by continuing to operate the handle against this resistance.

- (k) If refined oil is used for starting only, then the pipes and heater for the heavy oil must also be full. To ensure this, slacken back the union on top of the oil heater. Tighten up this union again only when sure that the fuel issuing from it is free from air bubbles.

Never let the fuel fall below the outlet in the tank or it will be necessary to prime the fuel system again. When filling the tank always pass the fuel through the oil strainer and never leave the lid open.

(24) **ATOMISER.** For all maintenance and working instructions see Maker's Booklet.

(25) **FUEL PUMP.** For all maintenance and working instructions see Maker's Booklet.

(26) **GOVERNOR.** Keep all parts clean and free, and lubricated regularly. Small changes in speed can be made while the engine is running by slackening the knurled locking nut and adjusting the other knurled nut. The lock nut should be tightened down when the desired speed is obtained.

(27) **INLET VALVE.** If the valve leaks, grind it by partly rotating the valve on its seat, using very fine emery powder and oil evenly distributed on the valve face. Turn the valve to a fresh position occasionally while grinding. The inlet valve plug sometimes requires grinding on to its seat in the cylinder head. The studs must be removed to rotate the plug. When ground, both faces should present a grey appearance all over. Wipe the joint surface thoroughly before replacing ; no jointing material is required.

The valve spring should be adjusted until it is just tight enough to prevent "chattering" of the valves and to close it smartly.

(28) **EXHAUST VALVE.** The Spring should only be tight enough to prevent the valve opening on the charging stroke. Examine the valve occasionally, and if leaking grind it (See paragraph 27). Set and tighten the removable guide in place carefully, so as not to throw the valve off its seat, and grind the valve with the guide in place. Do not grind oftener than is really necessary. If the Spindle gets stuck, paraffin will free it.

(29) **TO TIME THE INLET VALVE AND EXHAUST VALVE.**

(a) Remove the Indicator Plug at the Flywheel side of the Cylinder Head, to prevent compression.

(b) Set the Inlet Valve tappet clearance at..... by adjusting the length of the operating rod, and the Exhaust Valve tappet clearance at..... by adjusting the length of the tappet screw. These adjustments must of course be made when the lobe of the cam is away from the rollers in each case.

(c) Make sure that the mark on the Exhaust and Inlet Valve Cam Backing Plate coincides with the mark on the cam.

(d) Make sure that the marked tooth on the Camshaft Gear engages between the two marked teeth on the crankshaft Gear.

(e) Turn the engine until the piston is just starting on the Exhaust stroke, that is when the lobe of the cam is depressing the exhaust rocker arm.

(f) Lay a straight-edge across the side members of the Base Plate allowing it to protrude sufficiently just to touch the side of the Flywheel.

(g) Turn the engine until it is just possible to turn the Inlet Valve roller with the fingers, that is until a very minimum of clearance is apparent on the Inlet Valve Tappet. At this point the lower edge of the straight edge should coincide with the line marked "I.O." (Inlet open) on the side of the Flywheel.

(h) If the timing is not correct it may be adjusted by slackening the three nuts retaining the Cam at the end of the camshaft and rotating the cam on the camshaft until the correct position is reached. Tighten the three screws.

(j) Replace and tighten up the Indicator Hole Plug.

The timing of the Inlet Valve automatically ensures the correct timing of the Exhaust Valve.

(30) TO TIME THE FUEL PUMP.

(a) Make sure the fuel lines and the tank are filled with a thin fuel oil.

(b) Make sure that the marked tooth on the camshaft gear engages between the two marked teeth on the crankshaft gear.

(c) Unscrew the pipe joint and the Delivery Valve Holder at the top of the Fuel Pump. Remove the spring and the non-return valve. Screw back the Delivery Valve Holder and the pipe line.

(d) Unscrew the fuel supply pipe at the atomiser.

(e) Turn on the fuel supply and place a receptacle under the end of the atomiser supply line.

(f) Lay on straight edge across the side members of the Base Plate, allowing it to protrude sufficiently just to touch the side of the Flywheel.

(g) Turn the engine until the piston is on the compression stroke and continue turning until the fuel oil just stops issuing from the pipe line. At this point the lower edge of the straight edge should coincide with the line marked "F" on the side of the Flywheel.

(h) If the timing is not correct, remove the side cover of the Fuel Pump drive casing and slacken the three nuts locating the fuel cam. Turn the cam until the fuel just stops issuing from the fuel pipe line when the lower edge of straight edge coincides with the mark of the Flywheel.

(j) Tighten up the cam nuts and replace the side cover.

(k) Replace the non-return valve and spring in the Fuel Pump.

(l) Connect up the atomiser joint.

(m) Prime the fuel line (See paragraph 23).

(31) **BEARINGS.** Give particular attention to lubrication. Never run with slack bearings, which result in excessive wear and ultimate breakdown. Keep the connecting rod bearings especially in good order.

(32) **CONNECTING ROD BOLTS.** The large end Bolts are made of nickel steel and do not require to be annealed. They should be examined yearly however, and renewed if they show signs of strain. Always replace the bolts in accordance with the corresponding marks on the bearing shells and nuts and compression plate.

(33) **LOOSE KEYS.** If a knock is heard which cannot be traced to loose bearings, make sure the keys are tight in the flywheel, pulley and gearwheels (See paragraph 3). Never continue running with a loose key, as a serious accident may result. Loose or ill-fitting keys should be corrected at once.

(34) **PISTON AND RINGS.** Put on new rings one at a time, replacing those most badly worn, and allow each some days to wear to a good fit before putting on another. Before fitting each ring in the liner ensure that the ring gap is correct. To do this put the piston ring in the liner and ensure that it is parallel with the end of the liner. This can best be done by using the outer end of the piston as a guide. The gap in the piston ring should be a minimum of .020" and should not exceed .025".

To get the rings on, slide them over strips of very thin metal laid across the grooves. Before taking out or replacing the piston, remove the inlet valve plug (to prevent compression), and hold off the fuel pump handle so that a charge of fuel cannot be sent into the cylinder. Never put a light into the cylinder until it is cold, and the inlet valve plug has been removed. Make sure no fuel is left in the cylinder, and keep your face away from openings when first introducing a light. **DO NOT** remove carbon from land above top ring to the start of the conical head, other parts should be cleaned of carbon.

(35a) CYLINDER HEAD AND LINER. (One Casting)

One $\frac{1}{8}$ " thick rubber gasket is fitted between the cylinder head and the water jacket and one similar gasket between the cylinder head and the cylinder head water jacket cover. One rubber ring is fitted round the end of the liner to seal it against the cylinder jacket and a smaller one is fitted round the cylinder head water jacket cover and the atomiser boss. These rings should be thick enough to stand about $\frac{3}{32}$ " (2mm.) above the groove before being pushed into place. Soft soap smeared on the rubber rings makes their assembly easy. **DO NOT** stretch rings when fitting them in position.

(35b) CYLINDER HEAD AND LINER (Two Castings). If copper ring joints are fitted between the head and liner and the liner and base-plate, always replace with new ones on re-assembly.

If joints are not fitted, the flat joint surfaces should be ground on each other, as with valves (See 27) when they become pitted or show leak marks.

Always clean these surfaces thoroughly before re-assembling.

(36) SIGHT FEED MECHANICAL LUBRICATOR. To adjust the delivery of lubricating oil it is only necessary to screw the rear plungers in or out, thus lengthening or shortening the effective stroke of the plunger. The number of drops per minute is not rigidly fixed but should be between 30 and 40 for the cylinder and between 20 and 25 for the large end of the connecting rod. Considerably larger quantities should be used when the engine is new.

A flush of oil can be given by pressing the rear plunger a few times until the cup in the sight glass is filled. If the engine is stationary it will also be necessary to press the front plunger a few times, after filling cup with the rear plunger.

NOTE. At the first start or when the engine has not run for some time, it will be necessary to work these plungers until the lubricating oil lines are full. If this is not done no oil will get to the piston, or the small and big end bearings of the connecting rod, until the engine has been running long enough to fill the pipes, and trouble will result. Some oil should also be poured into the Crankpin Oiling Ring, under these circumstances.

(37) FUEL OIL. If the engine is fitted with an oil heater and refined oil tank, it will run well with practically any kind of Heavy or Residual Oil, such as Gas Oil, Scotch Shale Oil, Russian or Roumanian Naptha, Ostatki, Italian Mazout, Borneo or Tarakan Liquid Fuel, Mexican and Comodoro Rivadavia Fuel Oils, the Fuel Oils of Persia, India, Burma, the East Indies, Texas, Peru, Bolivia and Chile, etc. It will also work with most of the vegetable oils such as Cotton Seed oils. Some of the very thick oils may require special heating arrangements.

NOTE. Owing to improvements which are made from time to time, the design of any Engine may not agree in all details with the foregoing description.

INSTRUCTIONS FOR ORDERING

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WHEN ordering Spare Parts from the illustrations and description given in the following pages, the number of the part or parts should be stated, and also the Code Word as a check, or if telegraphing, the Code Word only need be used. **In addition, the number of the Engine—which will be found stamped ON THE MAKERS NAME PLATE EACH SIDE—should always be quoted.** Thus “KAHAK TWENTY THOUSAND” would be translated as meaning “Send one Governor Spindle, part 97 for Engine No. 20,000.”

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As figures are very liable to be altered during transmission, it is better, when telegraphing, to use the Code Word for the part, and write the Engine Number in words. To avoid mistakes in transmission, it is advisable to write all Code words in Roman (“printed”) Capitals.

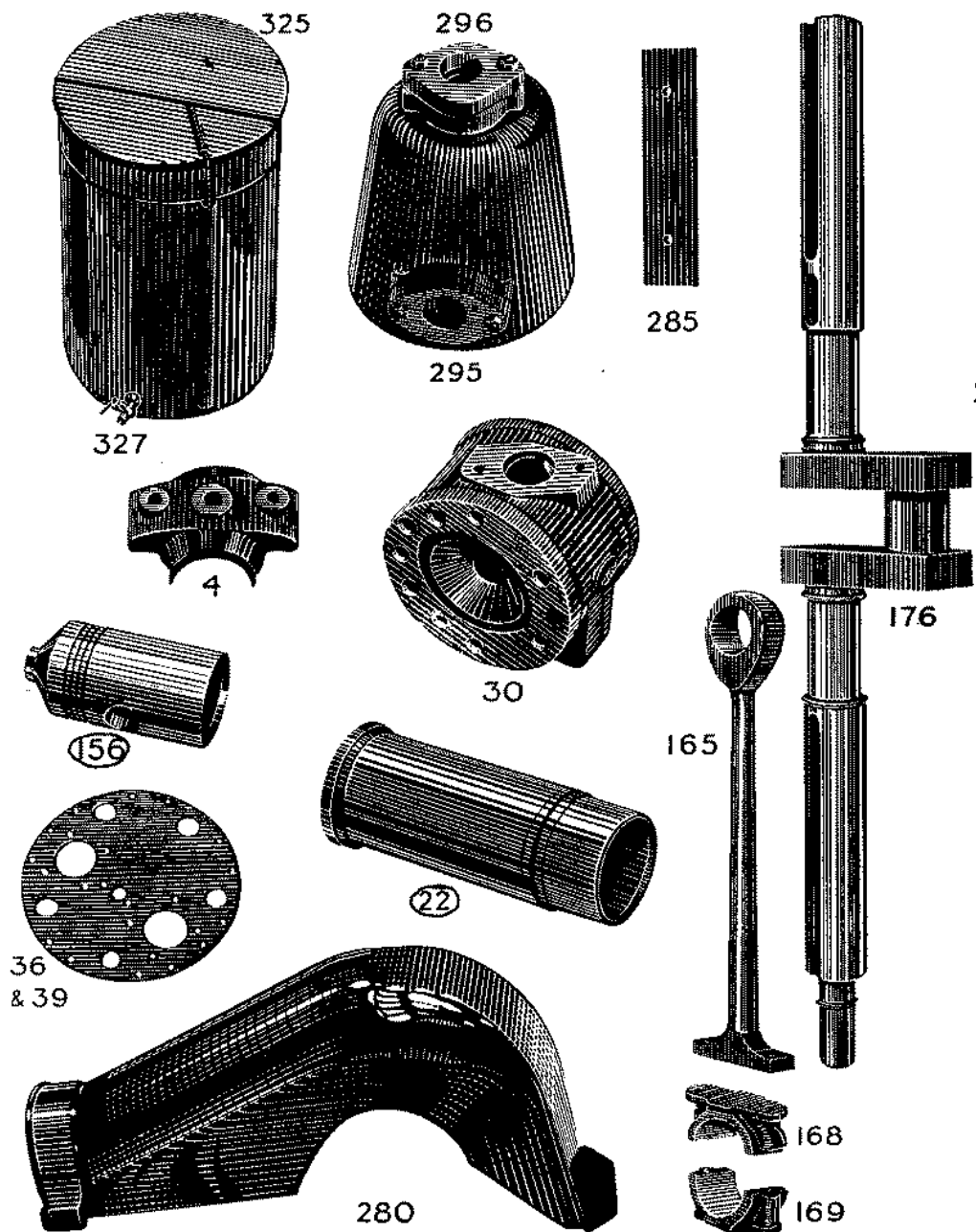
SPECIAL NOTE :— When ordering parts to replace those subject to wear, or which require to be refitted from time to time, such as Cylinder Liners, Pistons, Piston Rings, Bearings, Valve Plugs, etc., it is advisable to send a gauge for those dimensions which are subject to alteration, such as the diameter (and sometimes the width) of Piston Rings and the Taper Hole in which a Valve Plug fits. This latter

and all gauges made of sheet-metal should be clearly marked to show which portion represents the space in which the gauge has been fitted. If this is not done the gauge is often useless.

Gauges for the diameter of Piston Rings may be made of a piece of iron-wire (about $\frac{1}{4}$ in. diameter) filed to a rounded point at each end and made exactly to fit the smallest diameter of the cylinder through which the rings have to pass, usually at the outer end of the cylinder. An old ring is of no value as a gauge or sample to work to.

If a part which does not appear in this list is required and there is any possibility of the written description not being understood, it is advisable to send also a simple sketch to enable the part to be identified.

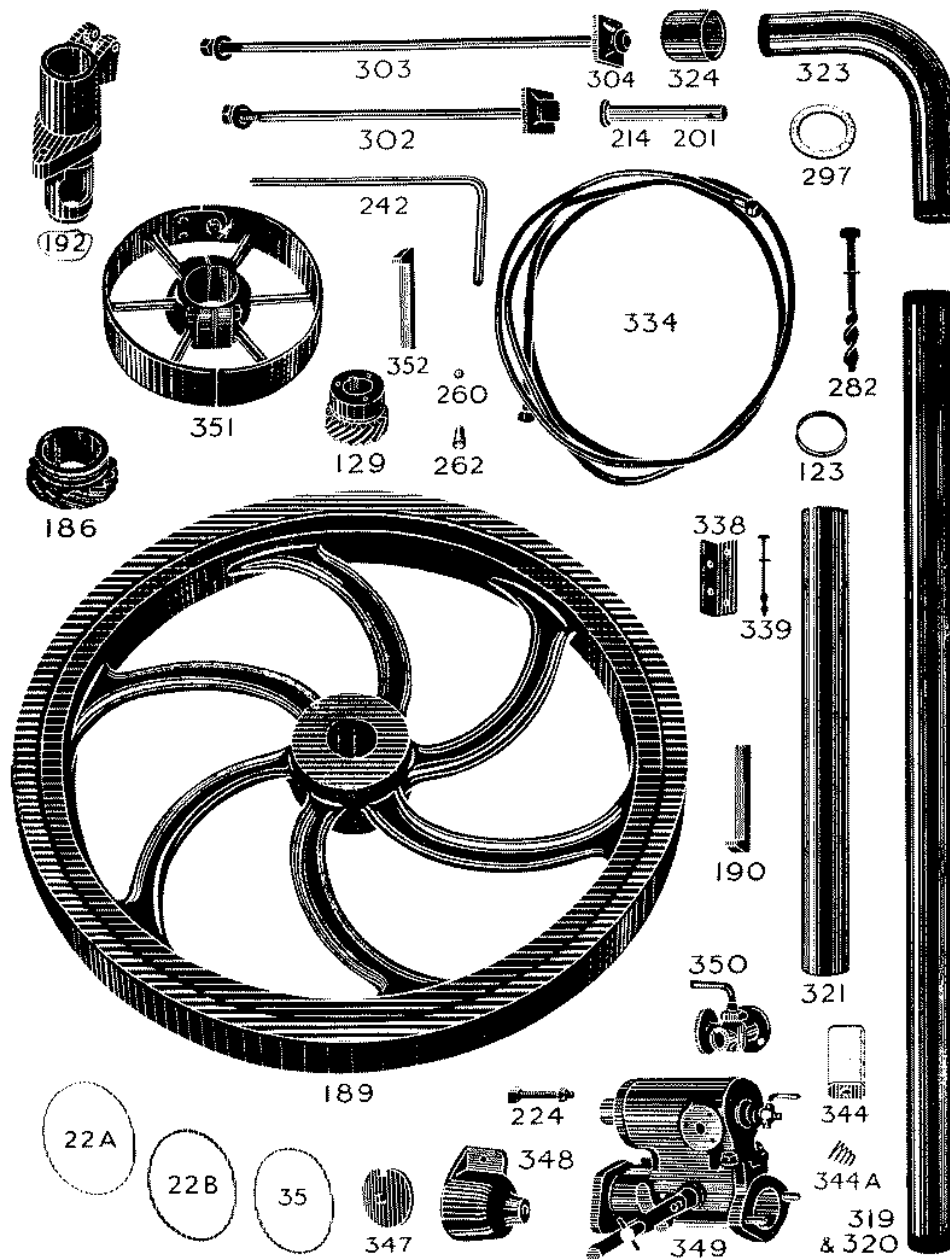
As there are various types and sizes of these engines, parts fulfilling the same function are not all alike in design, but although the part required may differ in appearance from the illustration, so long as it corresponds in its use to the one illustrated the correct design will be supplied, **providing the Engine Number is stated.** This is most important. **It is not sufficient to give merely the power of the engine or its cylinder dimensions. The number should always be stated.**



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CODE WORD	No.	NAME OF PART
KA EAD	4	MAIN BEARING CAP
KAABA	22	CYLINDER LINER
KAABS	30	CYLINDER HEAD
KAABK	36	COVER PLATE GASKET
KAABH	39	COVER PLATE
KAABL	156	PISTON WITH SET OF RINGS AND PISTON PIN
KACAA	165	CONNECTING ROD (ROD ONLY)
	168	LARGE END BEARING, ROD HALF
KACAC	169	" " " CAP HALF
KADAA	176	CRANKSHAFT (SHAFT ONLY)
KASAA	280	SPLASH GUARD
KAPAF	285	SOLE PLATE FOR OUTRIGGER BEARING
KATAA	295	EXHAUST BOX
KATAB	296	EXHAUST BOX FLANGE (2)
KAIBM	325	FUEL TANK
KAIBN	327	FUEL TANK TAP

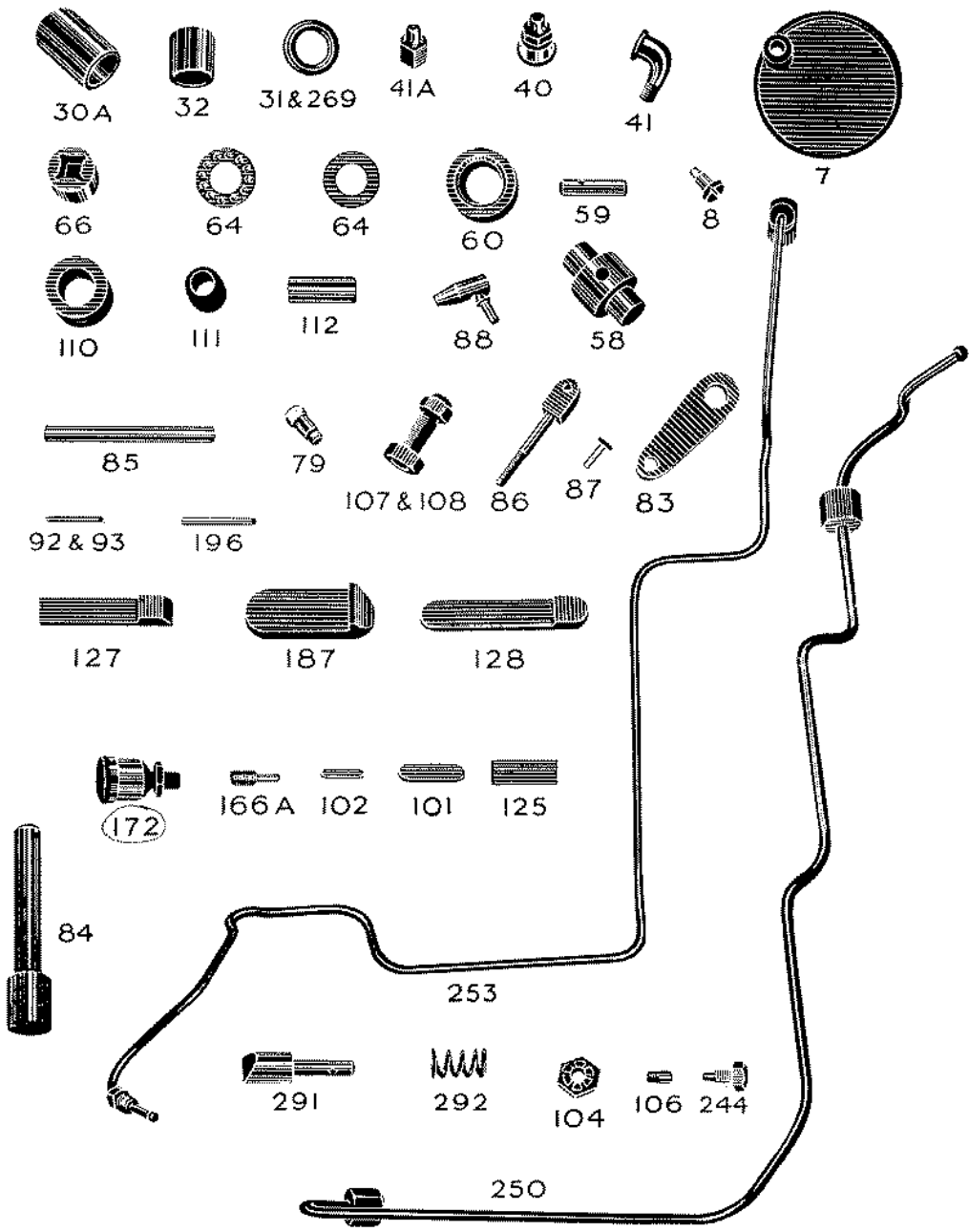
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CODE WORD	No.	NAME OF PART
KAABT	22A	COPPER LINER JOINT PLAIN (IF FITTED)
KAABU	22B	CORRUGATED LINER JOINT (IF FITTED)
KAABV	35	RUBBER JOINT RING FOR LINER
KAHAG	123	CAMSHAFT OILING RING
KAGAE	129	GOVERNOR DRIVING WHEEL
KAFAA	186	CRANKSHAFT SKEW GEAR
KARAA	189	FLYWHEEL
KATAC	190	FLYWHEEL KEY
KALAA	192	INLET VALVE PLUG
KALAN	201	PINS FOR INLET VALVE PUSH ROD ENDS (2)
KALBD	224	EXHAUST VALVE TAPPET SCREW AND NUT
KAMAA	242	EXHAUST VALVE LIFTER SHAFT
KABAD	260	BALL VALVE FOR CYLINDER LUBRICATION BUSH
KABAG	262	CHECK VALVE SPRING
KAPAG	282	RAG BOLTS FOR OUTRIGGER BEARING
KAABW	297	EXHAUST PIPE JOINT RING
KAQAV	302	SHORT ENGINE FOUNDATION BOLTS (2)
KAQAW	303	LONG " " " (2)
KAQAX	304	FOUNDATION PLATES (4)
KATAD	319	LONG EXHAUST PIPING (SCREWED EACH END)
KATAE	320	" " " (SCREWED ONE END)
KATAF	321	SHORT EXHAUST PIPING
KATAG	323	EXHAUST BEND (2)
KATAH	324	PIPE CONNECTING PIECE
KAUBB	334	FUEL SUPPLY PIPE AND UNIONS
KAUBE	338	FUEL FILTER SUPPORT BRACKET
KAUBF	339	RAG BOLTS FOR No. 338
KAUBA	344	FILTER ELEMENT
KAUAF	344A	SEATING SPRING FOR 344
KAQAN	347	REFINED OIL TANK COVER
KAQAM	348	REFINED OIL TANK
KAQAT	349	OIL HEATER
KARAC	350	3 WAY COCK
KATAJ	351	STANDARD PULLEY
	352	PULLEY KEY

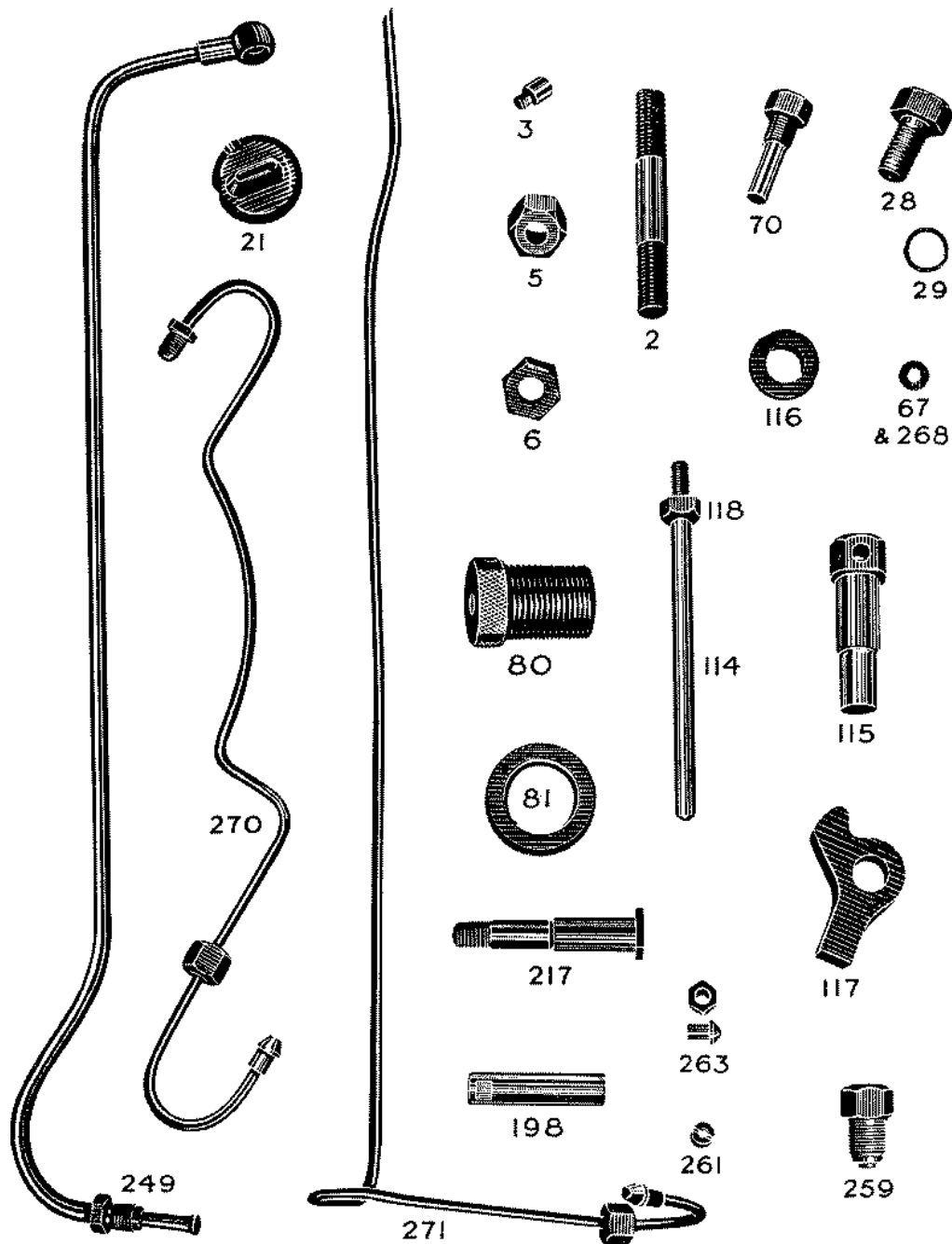
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Code Word	No.	NAME OF PART
KAABF	7	OILWELL COVER
KAABX	8	HINGE PIN FOR No. 7
KAABY	30A	ATOMISER COOLING TUBE
KAABZ	31	WATER SEALING CYLINDER HEAD RINGS (5)
KAXAN	32	CYLINDER HEAD WATER CIRCULATING TUBES (5)
KALAZ	40	EXHAUST VALVE SPINDLE LUBRICATOR
KAXAP	41	ELBOW FOR No. 40
KAXAQ	41A	STUD FOR No. 41
KAHAP	58	GOVERNOR LIFTER
KAHAR	59	GOVERNOR LIFTER PIN
KAHAL	60	GOVERNOR SPINDLE THRUST WASHER
KAHAS	64	THRUST BEARING
KAMBJ	66	DRAIN PLUG FOR GOVERNOR & FUEL PUMP BRACKET
KAXAR	79	OIL CUP FOR FUEL PUMP PLUNGER GUIDE
KAHBA	83	GOVERNOR LIFTER LEVER
KAHAZ	84	GOVERNOR FULCRUM SHAFT
KAHBB	85	GOVERNOR LEVER
KAHBE	86	GOVERNOR COUPLING ROD
KAHBF	87	COUPLING ROD PIN
KAHBC	88	BALL JOINT COMPLETE
KAHAQ	101	GOVERNOR SLEEVE KEY
KAHAX	102	GOVERNOR PINION KEY
KAXAS	104	GOVERNOR SPINDLE NUT
KAXAT	106	SPINDLE STOP PEG
KAJAF	107	FUEL PUMP PLUNGER GUIDE ADJUSTING SCREW
KAJAG	108	LOCK NUT FOR No. 107
KAJAA	110	FUEL CAM ROLLER
KAJAB	111	ROLLER BUSH
KAJAC	112	FUEL CAM ROLLER PIN
KAGAK	125	LUBRICATOR ECCENTRIC KEY
KAGAJ	127	CAMSHAFT SKEW GEAR KEY
KAGAH	128	GOVERNOR DRIVING WHEEL KEY
KACAF	166A	SMALL END BUSH RETAINING SCREW
KACAH	172	LUBRICATOR FOR LARGE END BEARING
KAFAB	187	CRANKSHAFT SKEW GEAR KEY
KAMAF	244	EXHAUST LIFTER LOCATING SCREW
KAVAL	250	FUEL PIPE & UNIONS. PUMP TO ATOMISER
KAUBC	253	LEAK OFF PIPE & UNIONS ATOMISER TO FILTER
KABAC	269	JOINT RING FOR CYLINDER LUBRICATION BUSH
KANAB	291	STARTING HANDLE DRIVING PIN
KANAC	292	DRIVING PIN SPRING
	92	MILLS PIN 1" x 1 1/8" g. (GOVERNOR ASSEMBLY)
	93	MILLS PIN 1 1/8" x 1 1/4" g. (GOVERNOR ASSEMBLY)
	196	TAPER PIN OR MILLS PIN 3/8" D.a. (INLET VALVE)

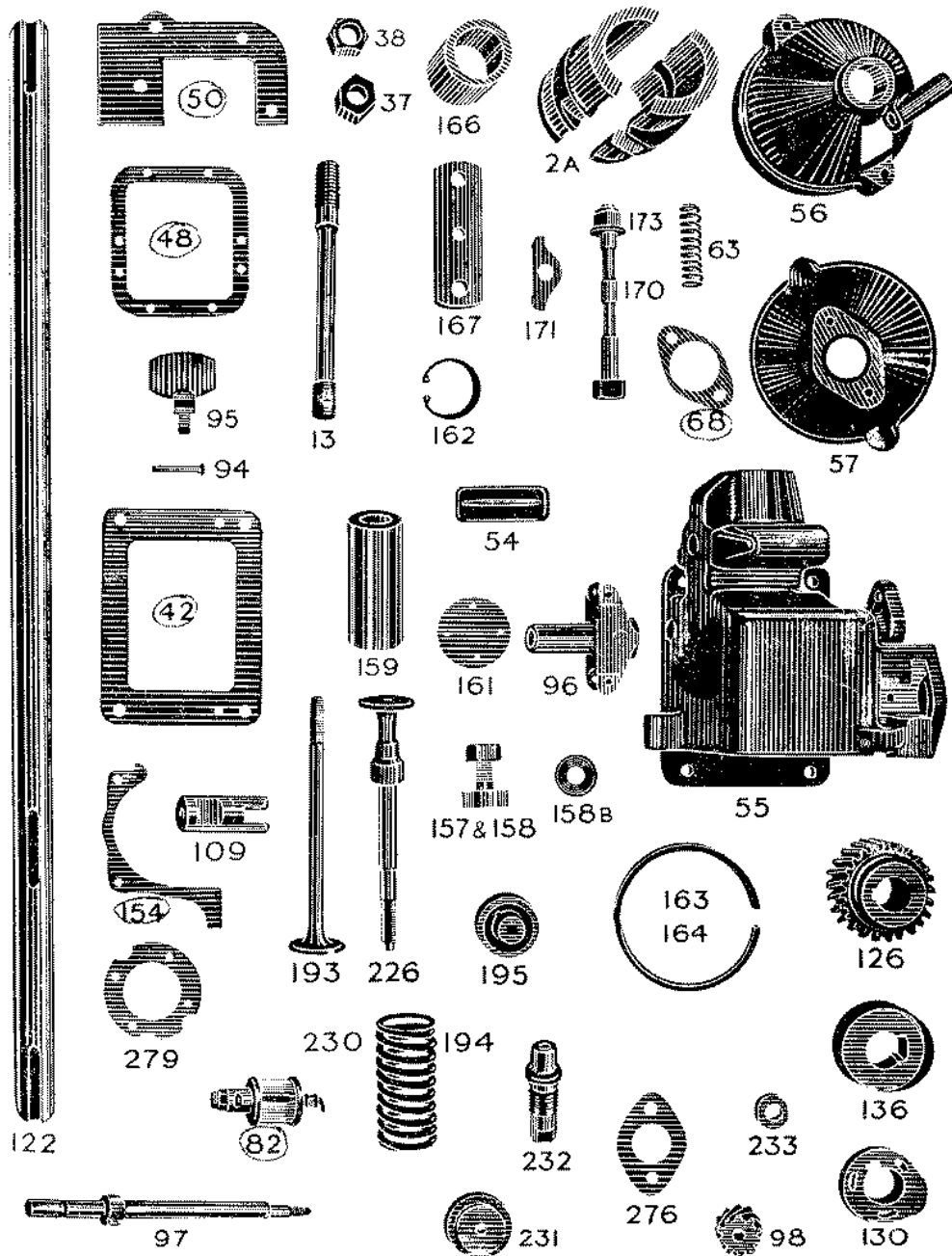
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Code Word	No.	NAME OF PART
KAEAE	2	MAIN BEARING CAP STUD
KAFAC	3	MAIN BEARING LOCATING PEG
KAXAU	5	NUT FOR No. 2
KAXAV	6	LOCKNUT FOR No. 2
KAEAA	21	MAIN BEARING CAP CLOSING PLUG
KAABE	28	CYLINDER HEAD INDICATOR HOLE PLUG
KAXAW	29	WASHER FOR No. 28
KAXAX	67	WASHER FOR CAMSHAFT OILWELL DRAW PLUG
KAJAH	70	FUEL PUMP PLUNGER GUIDE POSITIONING PIN
KAHAU	80	GOVERNOR ADJUSTING SCREW
KAHAV	81	LOCKNUT FOR No. 80
KAJAK	114	FUEL PUMP PRIMING HANDLE
KAJAM	115	PRIMING CAM SHAFT
KAJAL	116	SPACER FOR No. 115
KAJAJ	117	PRIMING CAM
KAXAY	118	LOCKNUT FOR No. 114
KALAF	198	INLET VALVE LEVER FULCRUM PIN
KALAQ	217	INLET VALVE RADIUS LINK FULCRUM PIN
KAVAX	249	FUEL PIPE & UNIONS, FILTER TO PUMP
KABAE	259	CYLINDER LUBRICATION CHECK VALVE BODY
KABAF	261	CHECK VALVE SPRING STOP
KAXAZ	263	NIPPLE & NUT FOR No. 259
KABAA	268	FIBRE JOINT FOR CYLINDER LUBRICATION BUSH
KAKAY	270	PIPE & UNIONS, CYLINDER LUBRICATION
KAKAZ	271	PIPE & UNION, CRANKPIN LUBRICATION

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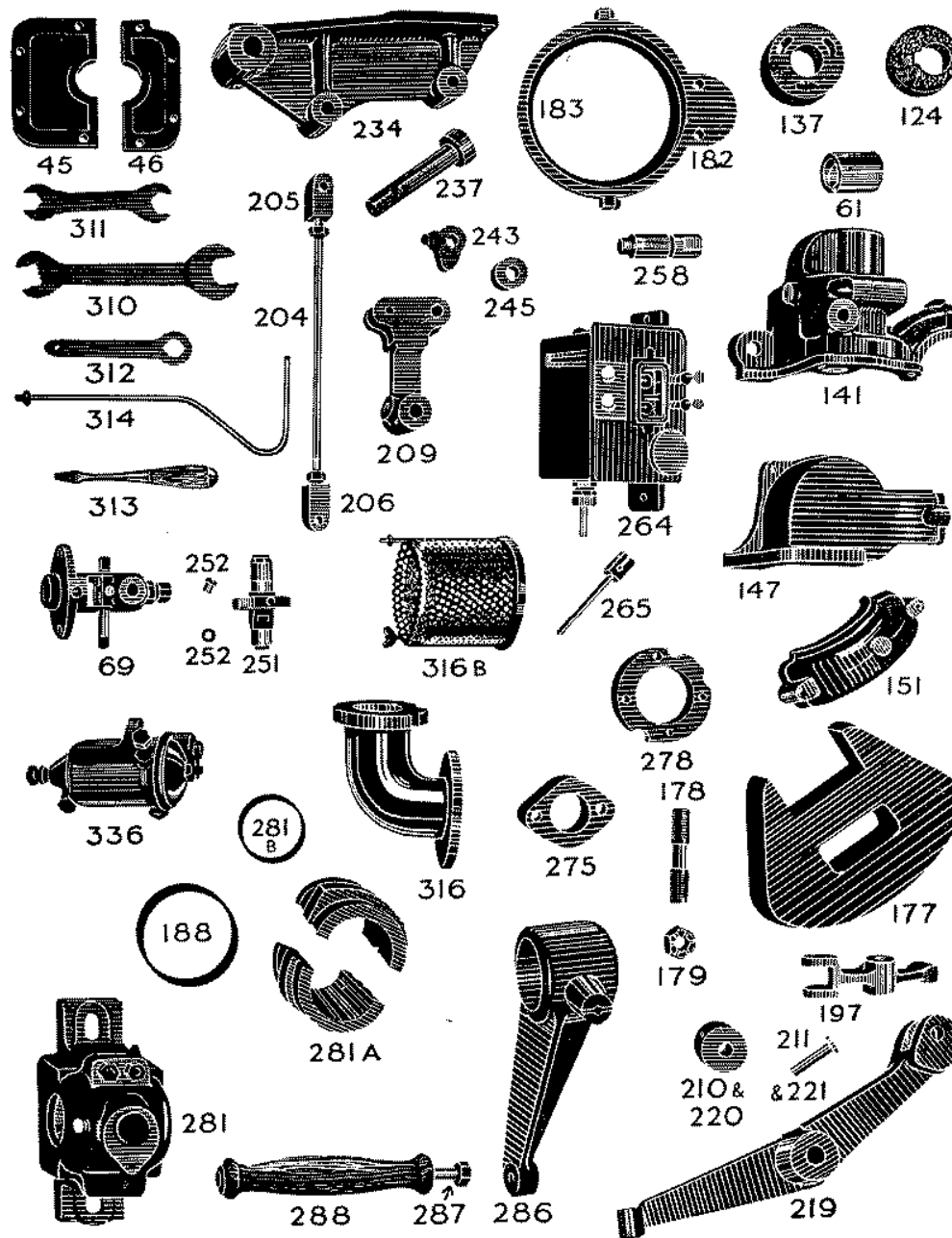


CODE WORD	No.	NAME OF PART
KAFAB	2A	MAIN BEARING (2 HALVES)
KAABB	13	CYLINDER HEAD STUDS
KAXBA	37	NUT FOR No. 13
KAXBB	38	LOCKNUT FOR No. 13
KAXBC	42	GOVERNOR & FUEL PUMP BRACKET GASKET
KAXBD	48	END COVER GASKET
KAXBE	50	SKIEW GEAR BRACKET GASKET
KAFAG	54	CAMSHAFT BEARING OIL WELL COVER
KAHAA	55	GOVERNOR & FUEL PUMP BRACKET
KAHAB	56	GOVERNOR COVER
KAHAC	57	GOVERNOR CASING
KAHAW	63	GOVERNOR SPRING (2)
KAXBE	68	FUEL PUMP FLANGE GASKET
KAHAY	82	GOVERNOR LUBRICATOR
KAHAT	94	GOVERNOR BALL FULCRUM PIN
KAHAN	95	GOVERNOR BALL
KAHAM	96	GOVERNOR SLEEVE
KAHAK	97	GOVERNOR SPINDLE
KAHAI	98	GOVERNOR PINION
KAJAD	109	FUEL PUMP PLUNGER GUIDE
KAGAC	122	CAMSHAFT
KAGAB	126	CAMSHAFT SKIEW GEAR
KAGAF	130	FUEL PUMP CAM
KAGAD	136	INLET & EXHAUST CAM
KAXBH	154	SKIEW GEAR OIL SEAL GASKET
KAABO	157	PISTON END BLOCK
KAXBG	158	NUT FOR No. 157
KANBJ	158B	JOINT RING FOR No. 158 (IF FITTED)
KAABP	159	PISTON PIN
KAXBK	161	PISTON BLANKING OFF PLATE & SCREWS
KAABR	162	CIRCLIPS (2)
KAABM	163	PISTON RING (RIGHT HAND SLOT)
KAXBL	164	PISTON RING (LEFT HAND SLOT)
KACAF	166	SMALL END BUSH
KACAB	167	COMPRESSION PLATE
KACAG	170	LARGE END BOLT (2)
KACAD	171	SHIMS (2)
KAXBM	173	NUTS FOR No. 170 (2)
KALAB	193	INLET VALVE
KALAG	194	INLET VALVE SPRING
KALAC	195	BOBBIN
KALAT	226	EXHAUST VALVE SPINDLE & DEFLECTOR
KALAX	230	EXHAUST VALVE SPRING
KALAW	231	EXHAUST SPRING COLLAR
KALAY	232	EXHAUST VALVE SPINDLE GUIDE
KALBC	233	NUT FOR No. 232
KAXBP	276	WATER FLANGE GASKET (2)
KAXBN	279	AIR INLET GASKET

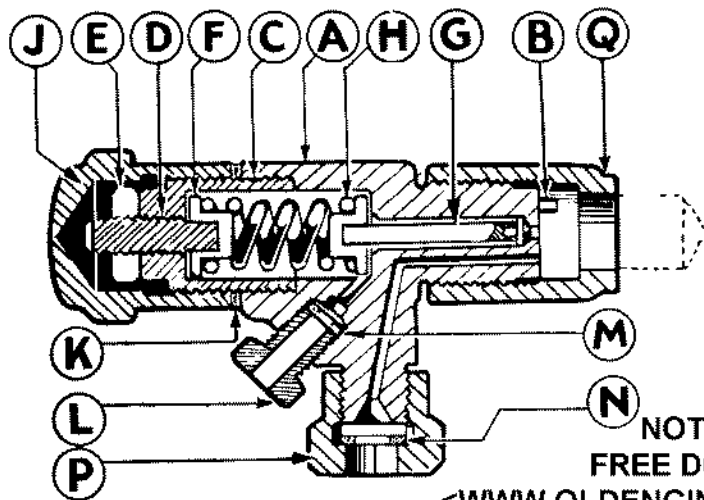
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CODE WORD	No.	NAME OF PART
KAHAD	45	END COVER FOR GOVERNOR & FUEL PUMP BRACKET TOP
KAHAE	46	" " " " " " " " " " BOTTOM
KAHAF	61	CAMSHAFT BEARING BUSH
KAXBX	69A	RETAINING PIN FOR No. 69B (Not Illustrated)
KAXBY	69B	FUEL PUMP RETURN SPRING
KAGAG	124	LUBRICATOR ECCENTRIC
KAGAA	137	INLET & EXHAUST CAM DRIVING COLLAR
KAFAD	141	SKREW GEAR BRACKET
KAFAE	147	SIDE COVER FOR No. 141
KAFAF	151	TOP COVER FOR Nos. 141 & 147
KADAB	177	BALANCE WEIGHT
KADAD	178	BALANCE WEIGHT STUD
KAXBO	179	NUT FOR No. 178
KADAG	182	CRANKPIN OILING RING WITH BRANCH
KAXBR	183	" " " " WITHOUT BRANCH
KAEAC	188	MAIN BEARING OILING RING
KALAE	197	INLET LEVER
KALAJ	204	INLET VALVE ROD & NUTS
KALAL	205	BOTTOM END LINK BLOCK
KALAK	206	TOP END LINK BLOCK
KALAP	209	INLET VALVE RADIUS LINK
KALAR	210	ROLLER FOR No. 209
KALAS	211	ROLLER PIN
KALBB	219	EXHAUST LEVER
KALBE	220	EXHAUST VALVE ROLLER
KALBF	221	ROLLER PIN FOR No. 220
KALBK	234	VALVE GEAR BRACKET
KALBJ	237	FULCRUM PIN FOR No. 219
KAMAB	243	EXHAUST LIFTER
KAXBS	245	COLLAR FOR No. 243
KAWAN	251	NOZZLE HOLDER COMPLETE
KAWAA	252	NOZZLE BODY & WASHER
KABAB	258	CYLINDER LUBRICATION BUSH
KAKAA	264	MECHANICAL LUBRICATOR COMPLETE
KAKBA	265	OPERATING ARM FOR No. 264
KAABC	275	WATER PIPE FLANGE
KAXBT	278	CYLINDER HEAD EXHAUST PIPE FLANGE
KAPAJ	281	OUTRIGGER BEARING COMPLETE
KAPAC	281A	BEARING BRASS
KAPAE	281B	OILING RING FOR No. 281A
KANAD	286	STARTING HANDLE LEVER
KANAA	287	SPINDLE & NUT FOR No. 286
KAXBU	288	WOODEN HANDLE
KAXAC	310	SPANNER $\frac{1}{2}$ " x $\frac{1}{2}$ "
KAXAJ	311	THIN SPANNER $\frac{1}{4}$ " x $\frac{1}{4}$ "
KAXAH	312	RING SPANNER $\frac{1}{2}$ " ACROSS FLATS
KAXBV	313	SCREW DRIVER
KAXAJ	314	VALVE GRINDING HANDLE
KAXBW	316	AIR INTAKE ELBOW
KALBL	316B	AIR FILTER
KAUBD	336	FUEL FILTER COMPLETE
KAWAW	69	FUEL INJECTOR PUMP (COMPLETE)



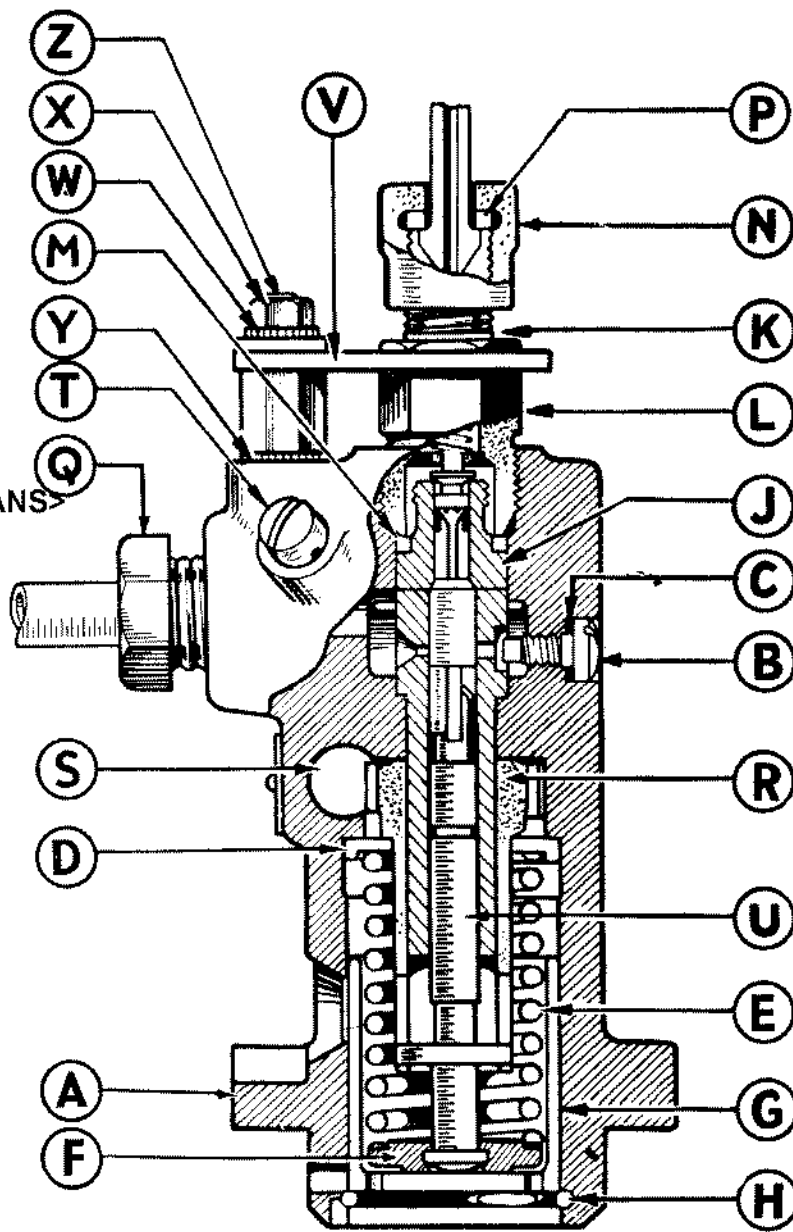
NOZZLE HOLDER

NOZZLE HOLDER

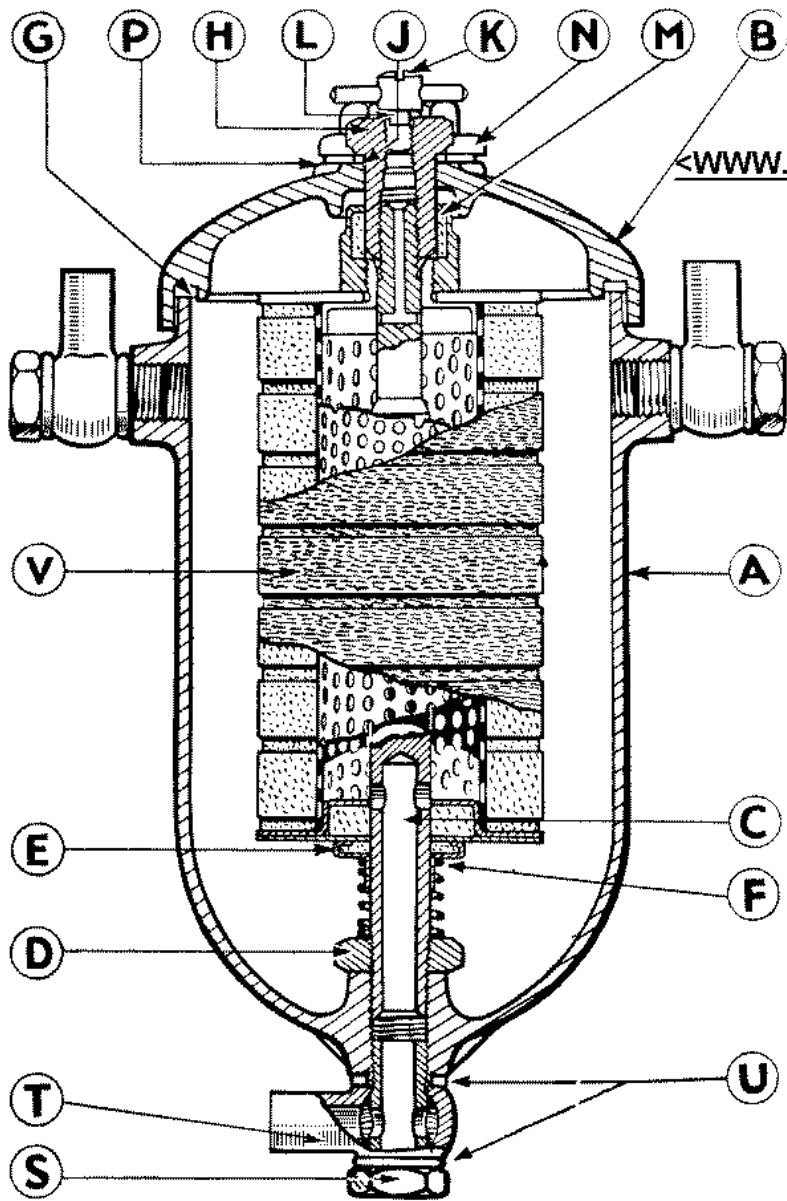
- 251 Nozzle Holder, complete.
- 251A Body.
- 251B Pin, Dowel.
- 251C Nut, Spring Cap.
- 251D Screw, Compression.
- 251E Nut, Locking Compression Screw.
- 251F Cap, Spring Upper.
- 251G Spindle Assy. with Lower Spring Plate.
- 251H Spring, Nozzle Valve.
- 251J Nut, Cap Nozzle Holder.
- 251K Washer, Protecting Cap.
- 251L Nut, Leak Off Connection.
- 251M Joint Washer for Leak off Connection.
- 251N Washer, Dely. Union.
- 251P Nut, Dely. Union.
- 251Q Nut, Cap, Nozzle.

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 FUEL PUMP

- 69 Fuel Pump, complete.
- 69A Fuel Pump Housing.
- 69B Pin, Locking.
- 69C Washer, Joint, for Locking Pin and Vent Screw.
- 69D Plate, Spring (Upper).
- 69E Spring Plunger.
- 69F Plate, Spring (Lower).
- 69G Guide, Plunger.
- 69H Ring, Spring, Plunger Guide.
- 69J Valve, Dely. Assy.
- 69K Spring, Dely. Valve.
- 69L Holder, Dely. Valve.
- 69M Washer, Joint for Dely. Valve.
- 69N Nut, Dely. Valve.
- 69P Washer, Dely. Valve.
- 69Q Nut, Inlet Union.
- 69R Sleeve, Regulating.
- 69S Rod, Control.
- 69T Screw, Air Vent.
- 69U Element complete.
- 69V Plate, Locking, Dely. Valve Nut.
- 69W Washer, Plain.
- 69X Nut for Stud.
- 69Y Washer, Locking.
- 69Z Stud Locking, for Dely. Valve.



FUEL PUMP



FUEL FILTER

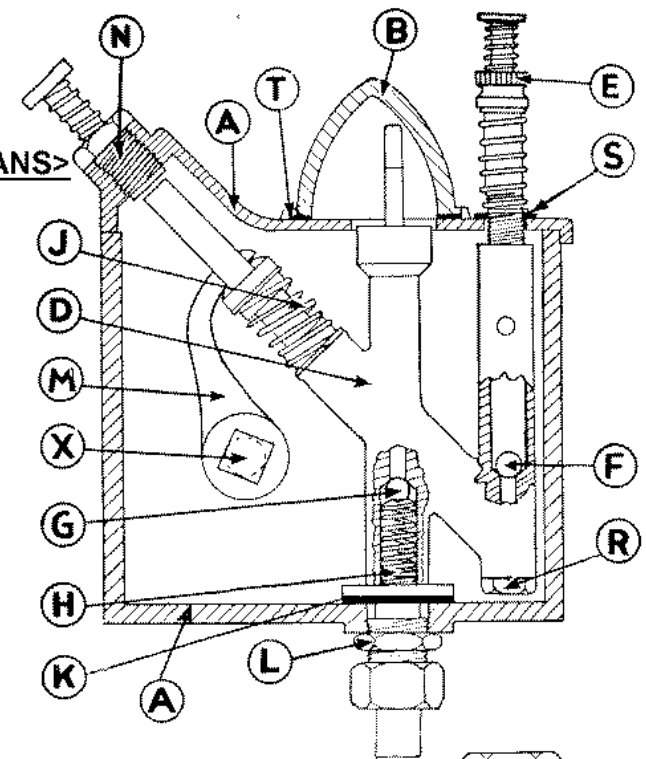
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FUEL FILTER

- 336 Fuel Filter, complete.
- 336A Fuel Filter Housing.
- 336B Cover Housing.
- 336C Bolt and Nut Centre Assy.
- 336D Nut Centre Bolt.
- 336E Washer, Seating Assy.
- 336F Spring, Seat Washer
- 336G Washer, Sealing, for Cover
- 336H Nut for Cover.
- 336J Washer Joint for above Nut.
- 336K Screw, Air Vent Assy.
- 336L Washer, Joint Air Vent Screw.
- 336M Spring Ring Cover Nut.
- 336N Plug, Filler.
- 336P Plug, Washer.
- 336Q Plug, Sludge.
- 336R Washer, Joint Sludge Plug.
- 336S Stud, Banjo Connection.
- 336T Connection, Banjo.
- 336U Washer, Joint Banjo.
- 336V Filter Insert, complete.

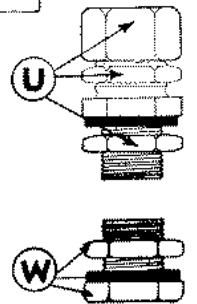
LUBRICATOR

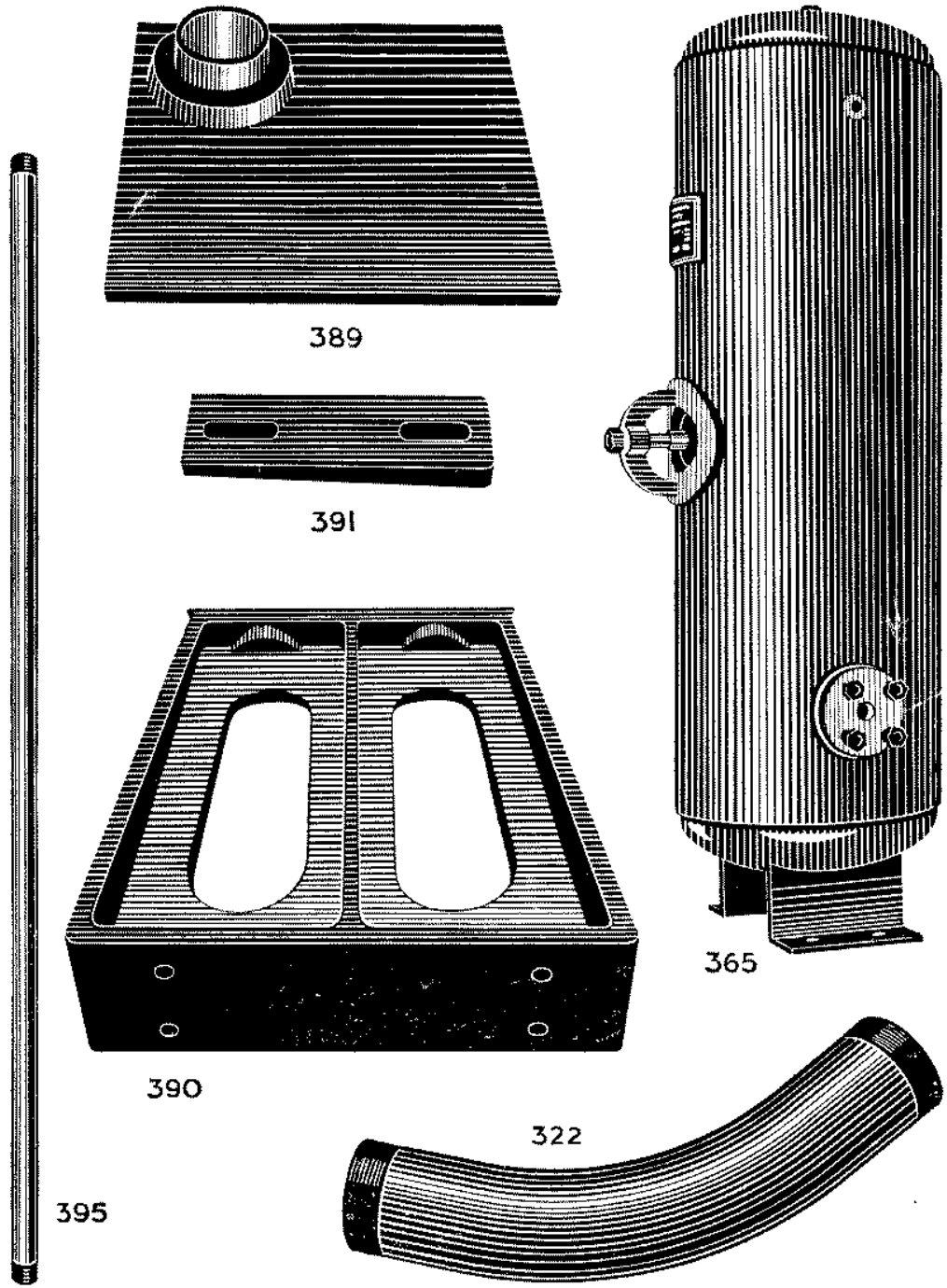
- 264 Lubricator, complete
- 264A Tank and Cover only.
- 264B Sight Glass.
- 264C Oil Level Gauge Glass.
- 264D Pump Unit, complete.
- 264E Quick Flush and Regulator with Springs.
- 264F Suction Check Valve Ball.
- 264G Dely., Check Valve Ball.
- 264H Dely., Check Valve Spring and Thimble.
- 264J Plunger Return Spring.



LUBRICATOR

- 264K Pump Unit Joint Washer.
- 264L Pump Fixing Locknut.
- 264M Plunger Finger.
- 264N Flush Button, complete.
- 264P Oil Strainer.
- 264Q Filler Cap.
- 264R Suction Valve and Ball.
- 264S Regulator Washer.
- 264T Sight Glass Joint.
- 264U Drive Shaft Bearing and Stuffing Box.
- 264W Drive Shaft Bearing and Joint.
- 264X Drive Shaft.





Code Word	No.	NAME OF PART
KAYBA	322	120° EXHAUST BEND
KAYBF	365	AIR RECEIVER
KAYBC	389	EXHAUST PIT COVER PLATE
KAYBK	390	OUTER BEARING PEDESTAL
KAYBL	391	ADJUSTABLE WEDGE
KAYBO	395	A.S. PIPE (LONG)

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MAKING THE ENGINE FOUNDATION FOR 15 H.P. RANGE

(See Figs. 1 to 8)

FIGURE 1

Dig a pit to the sizes shown where the engine is to be installed. In addition to this pit, a trench should be dug to accommodate the fuel, water and exhaust piping.

FIGURE 2

Make two boxes for the outer bearing foundation bolts. Use only eight very small nails to hold each box together.

FIGURE 3

Make four boxes for the engine foundation bolts. Use only eight very small nails to hold each box together.

FIGURES 4 and 5

Make foundation shuttering to the sizes shown. (The wood from the engine packing case will be found useful for this). The cross-pieces are for locating the foundation bolt boxes in position.

FIGURE 6

Set up the shuttering in position after wetting the sides and edges of the pit. The pieces of shuttering should be nailed together where possible, and struts pushed against the sides to prevent the shuttering collapsing outwards. Weights placed against the sides may be useful for this purpose. Care should be taken to position the four engine foundation bolt boxes and the two outer bearing foundation bolt boxes accurately. The rag bolts for the fuel filter can be placed in position by making two holes in the long side of the shuttering farthest from the outer bearing pedestal. These holes should be positioned as shown on the installation drawing, and should be of such diameter that the threaded ends of the bolts make a tight fit. The bolts should then be driven into the holes from the inside. One or two threads on the bolts should be visible on the inside of the shuttering. Now pour in the concrete, which should consist of approximately :—

5 cwt. (255 kg.) Portland Cement
10½ cwt. (535 kg.) Sand
21 cwt. (1070 kg.) 1½" (38 mm.) Clean Broken Stone
10 gals. (45.4 litres) Water.

This should be completed as quickly as possible, the concrete being pushed into the corners as the pouring proceeds. When the concrete reaches the level of the flat boards at the base of the outer bearing pedestal, weights

should be placed on the boards to prevent them from rising when the concrete is run into the main block.

As the outer bearing pedestal is slightly higher than the bed, concrete must be poured in here as well as in the main block.

Care must be taken not to disturb the position of the foundation bolt boxes when pouring in the concrete. Leave the top surface of the bed rough and about 11¼" (286 mm.) above the floor level. As soon as possible after casting the bed (about one day) remove the foundation bolt boxes. These may require to be broken up for removal, but all the pieces of wood should be removed. The bed should now be covered with wet sacks to prevent cracking and left for about two weeks to harden. If quick-drying cement is used instead of Portland cement, this time can be cut to six or seven days, but there is more risk of the concrete cracking. When the concrete is hard, the shuttering may be removed.

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FIGURE 7 WWW.OLDENGINE.ORG/MEMBERS/EVANS

Now place the engine foundation bolts in their holes, with the big cast-iron foundation plates on the bottom of the hole. Lower the engine baseplate over the bolts to within about 6" (152 mm.) of the top of the bed. Enter the foundation bolts through the holes in the engine baseplate and thread on the nuts and washers. Screw the nuts down until the bolts are level with the top of the nuts. The engine baseplate may now be lowered to within about ¾" (19 mm.) of the top of the block, and wedged in position with steel wedges or blocks.

Place the outer bearing foundation bolts in their holes, and lower the sole plate and bottom half of the outer bearing in position over them. Place the nuts and washers on the bolts and screw down until the bolts are level with the top of the nuts. The bottom half of the bearing brass should now be placed in position, taking care that the radius on the edge is nearest the engine.

The engine crankshaft should now be cleaned with petrol or light fuel oil to remove all rust preventative, and placed temporarily in position on the engine, and the wedges adjusted in height under the baseplate until a spirit level placed across and along the engine frame member shows that the bed is level. Pieces of metal packing strip should now be placed underneath the outer bearing sole plate until the bottom half of the bearing brass is just touching the underneath of the crankshaft outer bearing

journal. A spirit level should now be tried on the crankshaft to check that it also is level. If it is not, then all the wedges and packing must be adjusted until it is. A thin strip of wood should now be fixed round the top edge of the concrete bed and outer bearing pedestal. This is to form light shuttering for the grouting. It can be held in position by wire or string running right round. The top edge of the wood should be raised up above the top of the rough concrete block to a level half-way up the engine baseplate oil tray, and on the pedestal to a level half-way up the bearing sole plate.

The grouting may now be poured in (a fluid mixture of approximately 1½ cwt. (90 kg.) Portland cement, 2 cwt. (100 kg.) clean sand, 5 gals. (23 litres) water), care being taken to ensure that it runs down into the foundation bolt-holes in the engine bed and also in the pedestal. If possible, the grouting should be poured directly into the foundation bolt-holes through the holes provided in the sides of the engine baseplate. Continue to add the grouting until it reaches the top of the light shuttering, that is, half-way up the engine baseplate oil tray. Leave about seven days to harden.

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FIGURE 8 <WWW.OLDENGINE.ORG/MEMBERS/EVANS>

When the grouting is thoroughly set, the foundation bolts and outer bearing bolts should be tightened down evenly, and the light shuttering removed.

The crankshaft should be replaced in its bearings and the alignment checked again.

When the alignment is correct the crankshaft may be removed, and the engine assembled in the usual way.

(1) Suspend the crankshaft high enough from the ground so that the flywheel, in an upright position, may be guided on to it.

The engine number will be found on the flywheel boss, and this side should face the outer bearing. Slide the flywheel on, and tap the key in lightly.

(2) The crankshaft, complete with flywheel, should now be lowered into the bearings, care being taken that the marked tooth on the crankshaft screw gear comes between the two marked teeth on the camshaft skew gear.

(3) Now place the crankshaft oiling rings in position on the three crankshaft journals.

(4) The top halves of the main and outer bearings may now be placed in position, the caps fitted and tightened down, and the flywheel keyed in position.

(5) The crankpin should now be turned to the top centre position, and the distance between the crank webs at the extreme end farthest from the crankpin measured accurately with calipers or micrometer. Then turn the crank to the bottom centre and measure again in the same place. If the difference in these measurements exceeds 2/1000", the bearings must be adjusted by tightening the foundation bolts and outer bearing bolts, and/or by placing packing under the outer bearing until the difference is reduced to 2/1000" or less. The same test should be made at inner and outer centres.

(6) The large external oil ring should now be fitted to the crank web and the oil pipe adjusted so that it enters the ring exactly in the middle of the trough.

(7) Fit skew gear covers.

(8) The piston and connecting-rod should now be dismantled and all rust-preventing composition removed with the aid of petrol or light fuel oil. The bearings, gudgeon-pin and all oilways must be thoroughly cleaned and, if necessary, the piston rings removed and cleaned. Thoroughly clean out the cylinder liner with petrol or paraffin, and oil liberally before inserting piston. See that the piston ring gaps are *not* all in line and that none is at the bottom. Make sure on re-assembling that the piston and connecting-rod are the right way up in the cylinder. The small oil holes in the piston skirt and in the gudgeon-pin boss of the connecting-rod should be on the top.

The connecting-rod large-end bearing and the crankpin may now be fitted together, and the split-pins inserted in the large-end bolts.

(9) Connect up water piping to tank or tanks.

(10) Connect up exhaust piping.

(11) Connect up fuel line.

(12) Fill mechanical lubricator with the recommended grade of oil.

(13) Fill the main bearing and camshaft bearing oil-wells with the recommended grade of oil.

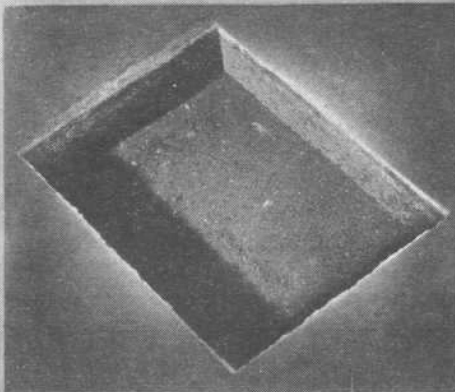
(14) Fit sight feed lubricator on governor.

(15) Apply oil to all pins and rollers and all moving parts.

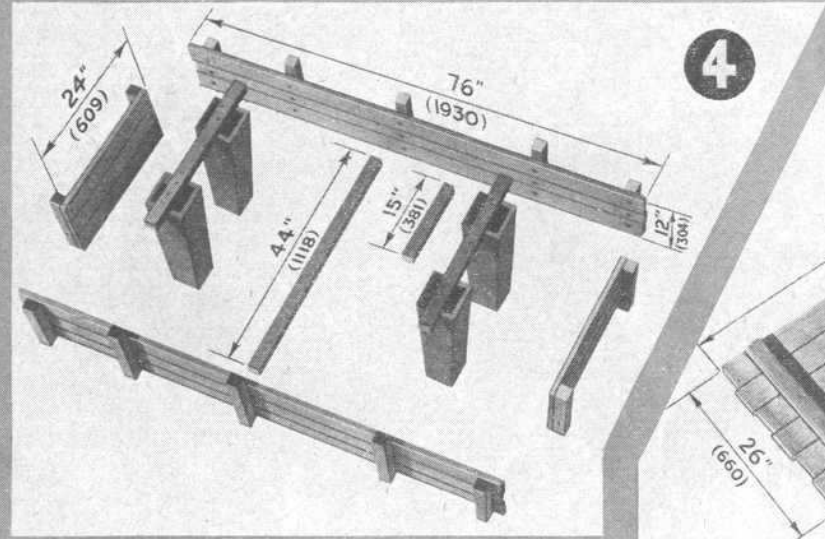
(16) The splash guard may now be fitted.

(17) Oil the starting-handle before placing on crankshaft.

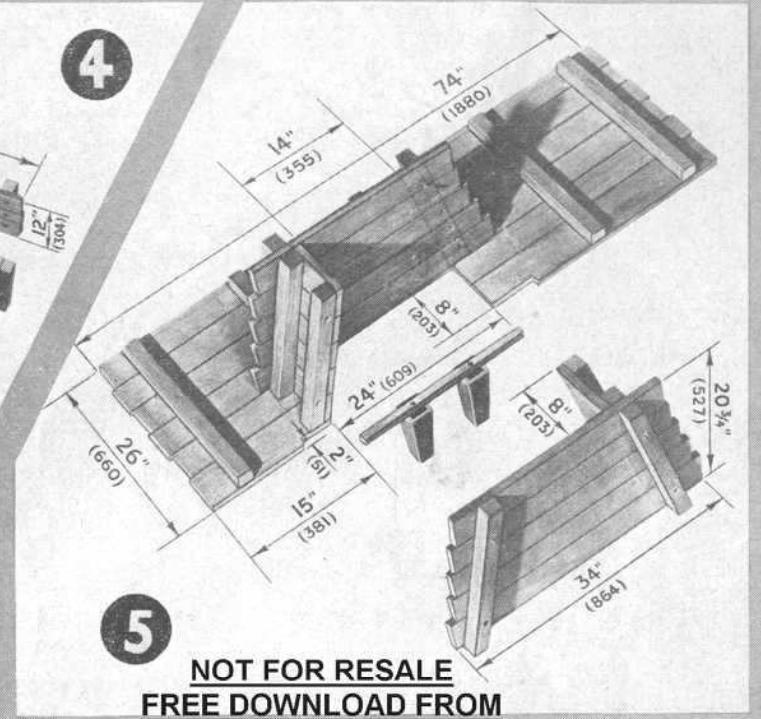
(18) The engine should now be turned over a few times with the exhaust lifter handle raised, to see that all parts are moving freely. Instructions for starting are given in Paragraph 9 at the front of this book.



1 66" x 48" x 16" DEEP
1676 x 1219 x 406 mm.

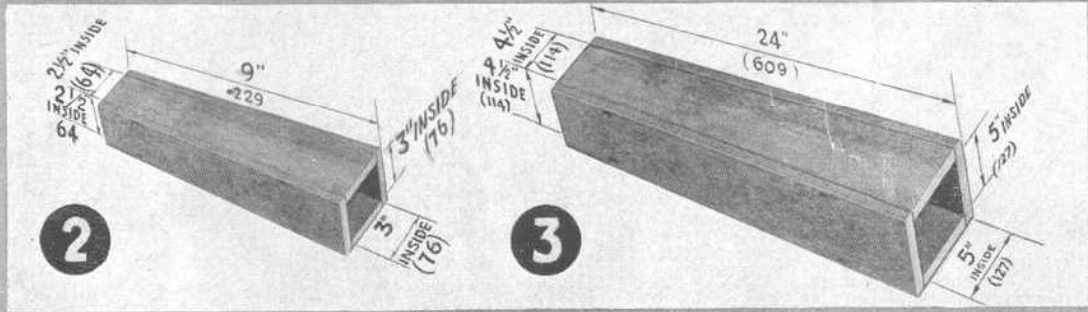


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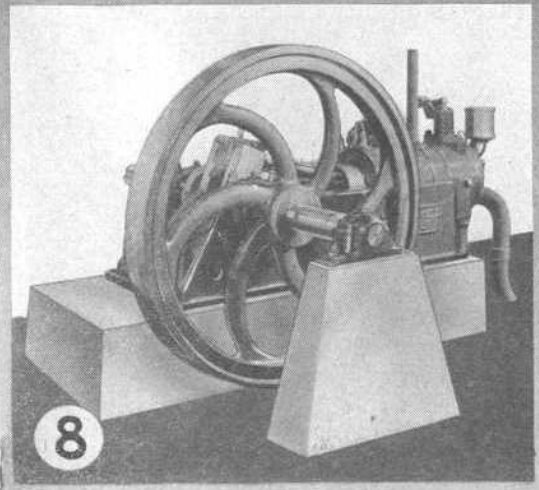
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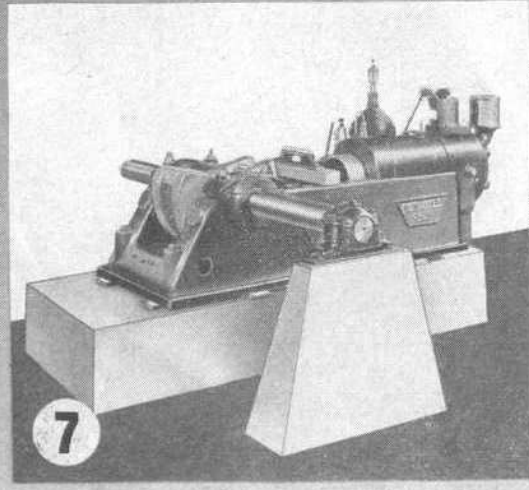


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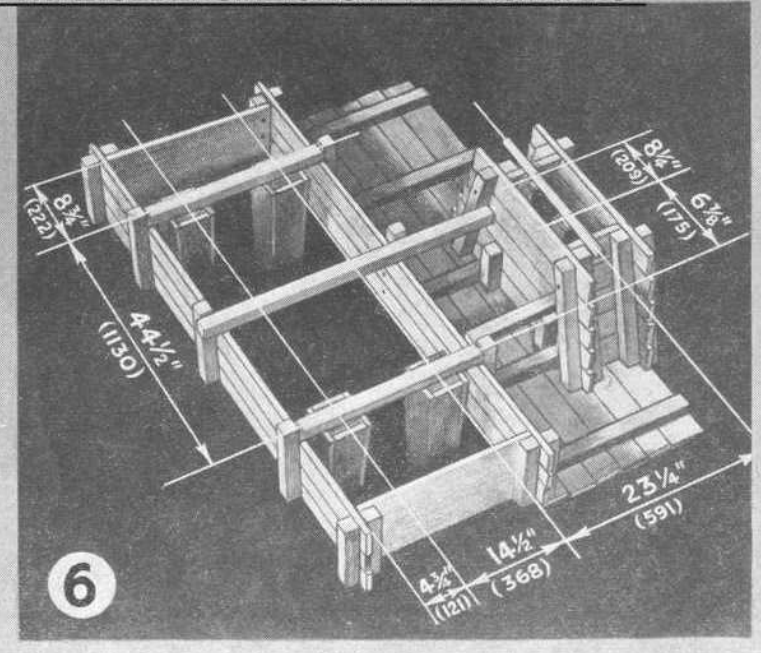
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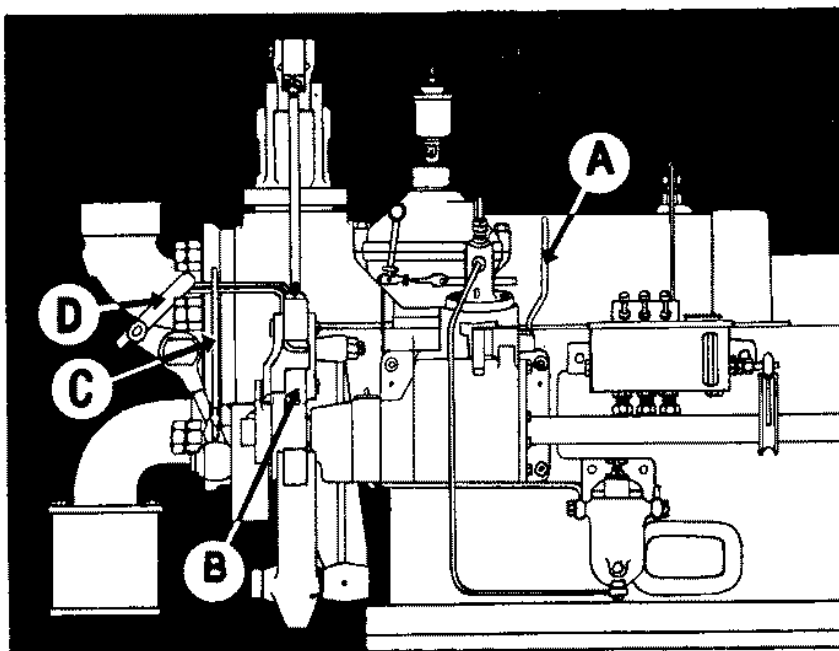


6

AIR STARTING DRILL—25-40 H.P. RANGE

DETAILS OF OPERATING BY STAGES

1. Open valve on air line between compressed air cylinder and engine.
2. Turn flywheel until piston is positioned slightly over top dead centre with exhaust and inlet valve both closed; *i.e.* engine is now in power stroke position.
3. Remove pin from cam-roller spindle " B." Move roller left to half compression position ; *i.e.* to engage narrow cam.
4. Open fuel supply cock on main fuel line. Check that fuel supply is reaching filter.
5. Pull fuel priming lever " A " toward you with right hand.



6. With left hand lift air starting lever " C " full distance of travel. The engine should now gather speed and compressed air supply should be left on until engine attains 50 r.p.m.
7. To start engine firing release fuel lever, continue with air supply. With right hand slide roller to the right on to the main cam and simultaneously release air lever. Insert pin in roller spindle.

RECHARGING COMPRESSED AIR CYLINDER

After the engine has gained maximum revs. continue running for several minutes. The following movements have to be made so as to recharge the cylinder to provide pressure for restarting engine.

1. Pull fuel priming lever towards you as in starting drill.
2. Open air supply valve to air cylinder by pulling down lever " D."
3. Observe pressure gauge, and when this indicates 150 lbs. release both levers. Engine should immediately continue firing and regain maximum r.p.m.

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Recharging cylinder will have to be performed in several stages, because engine speed reduces rapidly as air pressure increases. This can be continued in stages as required by reversing positions of fuel priming lever and air supply valve.

If it is intended to stop engine see that sufficient air pressure is available to restart.

BL/JS



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MALCOMMESS LTD FARM MACHINERY

Monteer Road, P.O. Box 80, Isando, Transvaal

Telephone: 975-5952. Telegrams: Malcommess. Telex: J7832

23rd September, 1970

Mr. J.J. Visagie,
P.O. Box 10,
ROTHDENE,
via Vereeniging

Dear Sir,

re: CAMBELL OIL ENGINE INSTRUCTION
SPARE PARTS LIST.

We have pleasure in advising you that we have now received the abovementioned book from the factory and we are now attaching this item to this letter for you.

We furthermore trust that the information you require will be found in this book.

Always with pleasure at your service.

Yours faithfully,
MALCOMMESS LIMITED

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B. H. P. Max 16.5

B. H. P. Max, 45.0.

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				(Black letters added by J.Evans Sept 2010 for clarity)					
				C.O.D.					