Instruction Book No. 43.4

SUPPLEMENTARY INSTRUCTIONS

For the operation of

GARDNER
L3 TYPE

DIESEL ENGINES

To be used in conjunction with L3B Engine Instruction Book No. 62.3

L. GARDNER & SONS LTD

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INTRODUCTION

The care and maintenance of the L3 series engines closely follows that for the L3B type engines as detailed in Instruction Book No. 62.

Certain important differences, however, require special mention and these are set out in the following supplementary instructions with special reference to the appropriate page numbers and paragraph titles in Instruction Book No. 62.

Should further information be desired in respect of component and engine overhaul, reference should be made to the L3 Workshop Tools, Equipment and Instructional Drawings Book No. 57.

The L3 series engines are constructed with three, four, five, six, and eight cylinders having the same bore 5-½ in. (139.7 mm) and stroke 7-3/4 in. (196.8 mm) as the L3B type engine but at the same time it must be emphasised that many vital components such as crankshafts, piston assemblies, connecting rods, inlet and exhaust valves, sprayer, cylinder heads, cams, etc., **are not interchangeable** between L3 and L3B engines.

<u>Table 1: Engine Data</u>

Engine Type	Swept Volume		Marine propulsion engines, also engines for industrial duty, electric generator sets and marine auxiliary duties					Engines for automotive duties (railcars and light locomotives). (Variable speed – mechanical drive.)					Engines for intermittent duties, air compressors, excavators, saw mills, etc.			
	cu in	litres	BHP	RPM	Marine propulsion engines only: Approximate weights including electric starter and bilge pump			BHP	RPM (2)	Maximum torque		Approx weights (cwt)	BHP	RPM	Maximum torque	
					Direct Drive (1)	2-1 rev. gear (1)	3-1 rev. gear (1)			lb/ft	RPM				lb/ft	RPM
3L3	552	9	57	900	42	44 ½	45 ½	-	-	-	-	-	-	-	-	-
4L3	736	12	76	900	44	46 ½	47 ½	102	1200	488	700	28	85	1000	463	700
5L3	921	15	95	900	52 ½	55	56	128	1200	510	700	33	106	1000	579	700
6L3	1105	18	114	900	55	57 ½	58 ½	153	1200	733	700	38	127	1000	695	700
8L3	1473	24	152	900	65	67 ½	68 ½	204	1200	978	700	48	170	1000	927	700

Notes: (1) Weights in centiweight (cwt), example 42 = 4200 lbs.
(2) Where engine speed is fixed, as in Diesel-Electric drive, the maximum RPM is restricted to 900

NOTE. – Marine Propulsion Engines – Normal static inclination aft is 7°. For greater inclination please consult the Works.

The powers quoted above are those developed at normal atmospheric temperature and barometric pressure and for engines which have to operate at high altitudes, or under adverse climatic conditions, we observe the de-rating data detailed on page 14 and 15 in L3B Instruction Book No. 62.

Conditions of duty may also demand some amendment to the powers above quoted and, conversely, certain applications may permit of engines being set at the Works to somewhat higher speeds and powers. Full information in this respect is readily available from the Works upon receipt of the relevant details.

On pages 8 to 11 in this publication a number of engine performance curves are reproduced and from these it will be observed that fuel consumption and mean effective pressure remain sensibly constant irrespective of the number of cylinders.

The curves are prepared from figures regularly observed during normal production tests of the various engines and large scale prints of all performance curves are available upon application to the Works.

OPERATING AND MAINTENANCE INSTRUCTIONS

STARTING THE ENGINE (Pages 33 & 34) – In addition to the hand starting and electric starting methods given in Instruction Book No. 62, a number of L3 series engines were arranged for starting by compressed air. With this starting arrangement the minimum air pressure required to start from cold is approximately 220 lb./sq.in. and when hot this figure may be reduced to 160 lb./sq.in.

TO START BY COMPRESSED AIR –

Step No. 1 Decompress all cylinders.

Step No. 2 Bar the flywheel round until the air starting mark on the Fuel Injection Pump Driving Shaft Damper coincides with the metal pointer mounted on the adjacent crankcase door on all engines, with the exception of the 3L3. With 3L3 engines, the pointer is mounted on the forward end of the crankcase and the air starting mark is engraved on the pulley, the ratchet box, or the barring collar mounted on the forward end of the crankshaft. In a 3 or 5 cylinder engine the cylinder which corresponds to the air start mark must be on its firing stroke, this can be ascertained by feeling which fuel pump ram is lifted by means of the fuel pump priming lever, e.g., suppose in a 5 cylinder engine that air starting is set to operate No. 3 cylinder, then if this cylinder is on its firing (correct) stroke, No. 3 fuel pump priming lever should have a lot of free movement. If not, No. 3 cylinder is not on its correct stroke for starting. The flywheel must then be barred round one complete revolution until the air starting mark is again opposite the pointer.

Step No. 3 Put all decompression levers into the running position.

Step No. 4 Turn the stopping lever upwards as far as it will go.

Step No. 5 If the engine is cold lift the starting fuel plunger to allow the fuel pump control rod to move to its maximum towards the flywheel.

If the engine is warm it is unnecessary to lift the starting fuel plunger.

Step No. 6 Release the locking screw on the air control valve which is situated at the aft end of the crankcase. On some L3 engines the locking screw is stamped with - Open Three Turns.

Step No. 7 Lift the control valve by means of the air starting lever as far as it will go. The crankshaft will now revolve, and after about one revolution the engine will start. Immediately, release the starting lever.

Step No. 8 Screw down the control valve. On the air supply bus pipe is fitted a small vent cock. This cock should be left open when the engine is running to relieve the air pressure on the starting valve stems and so permit their lubrication.

<u>AIR STARTING VALVE TIMING AND TAPPET ADJUSTMENT</u> – These valves are set to open at 25° before TDC of the cylinder to which they are fitted. They close 90° after TDC. The correct clearance between the small bell crank lever and the end of the valve is .015 in. This must be checked or set when the line in question is on its exhaust stroke, i.e. the exhaust valve open and the starting hand lever in its starting or lifted position.

<u>AIR CHARGING</u> – On each engine which is equipped with air starting there is one cylinder to which is fitted a charging valve. The maximum pressure to which air can be charged satisfactorily by this method is 260 lb./sq.in. To charge the air receiver proceed as follows:

Step No. 1 — Set the engine running light (without any load) at a speed of about 600 or 700 RPM, or about twice the idling speed.

<u>Step No. 2</u> — Stop the fuel injection to whichever cylinder is fitted with the charging valve (this valve varies according to the number of cylinders the engine possesses) by pulling back the fuel pump priming lever and latching in this position. This in effect merely turns the cylinder in question into an air compressor.

<u>Step No. 3</u> — Release the screw-down valve on the pipe from the charging valve.

<u>Step No. 4</u> — Unscrew the charging valve about two turns. The air receiver is now being charged. It is not advisable to use the charging valve for periods longer than five to six minutes at a time, as over-heating will occur. After five or six minutes the charging valve should be tightened and the valve on the pipe closed until the pipe and valve have cooled, when charging may be continued. This procedure will only be found necessary when large quantities of air have to be stored, as in the case of the initial charging of the receiver, or, if all the stored air has been inadvertently lost. Under no circumstances must the air charging valve be operated without first cutting off the fuel injection to the cylinder which is fitted with the charging valve. If any attempt is made to charge the air receiver with fuel still being injected into the cylinder, serious damage will result, apart from the grave risk of an explosion.

<u>AIR CHARGING VALVE GLAND</u> – In this valve is incorporated a gland which will require adjustment from time to time. After long use the gland may require repacking, in which case a heat resisting asbestos and graphite type of packing should be used.

<u>LUBRICATING OIL PRESSURES</u> <u>(Page 32)</u> – When the engine is running and the oil temperature has been reached, about 135°F (57°C) the oil pressure gauge should read as follows:

Industrial and Marine Engines, 35 lb./sq.in. at 900 RPM

Other Variable Speed Engines, 35 lb./sq.in. at 1000 RPM

OIL PRESSURE REGULATION VALVE (Page 62) – The adjusting screw is set during test to the pressure indicated above with the lubricating oil at a temperature of almost 135°F, but in certain installations, or until the engine has attained maximum working temperature, the oil in the sump may not attain so high a temperature as 135°F, consequently the pressure recorded may be about 2 lb./sq.in. higher than that mentioned. In this event, if the regulation valve has been dismantled for any reason, it should be re-set to give 37 lb./sq.in at 900 RPM, or at 1000 RPM, as the case may be, when the engine is thoroughly warm.

The oil temperature should not be allowed to exceed 145°F and on no account must the engine be run if the oil pressure is less than 25 lb./sq.in.

LUBRICATING OIL SUCTION FILTER (Page 64) – This unit is similar in design to that of the L3B type engine except that when assembled in the lower half crankcase the gauze covering faces downwards on L3 series engines and not upwards as with the L3B type engines.

LUBRICATING OIL DELIVERY FILTER (Page 65) – On L3 series engines the lubricating oil delivery filter contains a special gauze element. This element must be removed and thoroughly washed in paraffin or fuel oil after every 400 hours running time.

ENGINE WATER CIRCULATING PUMP (Pages 44 & 72) – A number of L3 series engines are equipped with plunger type water circulating pumps, designed to draw cooling water from large or unlimited supplies.

The pump is mounted on the manifold side of the crankcase and is positively driven by an eccentric and clip from the valve camshaft. Construction of the pump is similar to that of the bilge pump for which servicing and maintenance instructions are given in Instruction Book No. 62, page 43.

WATER TEMPERATURE CONTROL (Page 73) – Engines fitted with plunger type pumps have a manually operated temperature control va lve and flow indicator. The temperature control valve, when opened, "shunts" or "by-passes" the warm water from the discharge pipe on the engine to the suction pipe on the inlet side of the pump, thus raising the temperature of the water flowing into the cylinder jackets. It will be readily understood that the manually operated by-pass valve serves as a means of controlling, within limits, the temperature of the water in the cylinder jackets and at the point of discharge.

This 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°F or 140°F i.e. when it is just about as hot as the hand can momentarily bear.

NOTE: - When starting the engine or when idling, it is important that the temperature control valve be closed, otherwise air may get into the circulation pump and interfere with its operation.

CYLINDER WATER JACKETS (Page 48) – In marine engines which are sea water cooled there is always a likelihood of sand or sediment accumulating in the water jacket. Special precautions must be taken and observations made from time to time that this accumulation does not impede the flow of cooling water through the inlet holes in the base of the cylinder blocks.

EXHAUST MANIFOLD: WATER JACKETED TYPE – A number of L3 series engines are equipped with water jacketed exhaust manifolds. With this type of manifold, cleaning holes are provided in the lower side of the jackets for removal of silt and scale. Provision is also made for the manifold sections to be readily dismantled when desired.

For cleaning purposes, a piece of 3/16 in. or ¼ in. diameter steel rod suitably bent and worked through the cleaning holes will enable the silt and scale to be loosened sufficiently for flushing away with water.

For dismantling of the sections, it will be found (after removal of the bolts) that the bolt holes in the flanges are tapped 7/16 in. (Whitworth thread) to receive jacking screws. These will be found in the standard tool box supplied with each engine.

When dismantling is desired, remove the manifold from the engine and lay it on a flat surface. The bolts and nuts should be removed from each pair of flanges in rotation and replaced by the short setscrews in one of the flanges. The jacking screws should then be screwed into the other flange and gradually tightened in diametrically opposed pairs, until the flanges are thus jacked apart.

Transfer of the setscrews and jacking screws will enable all the sections to be dismantled in a similar manner.

FUEL PUMP CALIBRATION (Page 53) – The calibrating details for all L3 series engines are as follows:

Table 2 – Fuel Pump Calibration

Fuel Pump Camshaft	Engine Governed Max. RPM	B.M.E.P. lb./sq. in.	Camshaft RPM During Calibration	Time in Seconds	Average delivery from each Plunger in Cubic Centimetres
4	1200	91.5	600	60	89.4
4	900	90.9	450	75	79.7
4	800	91.5	400	75	70.0

FUEL SPRAYER TESTING (Page 55) – While the testing of L3 fuel sprayers is the same as for L3B sprayers, it must be stressed that L3 sprayers are not interchangeable with L3B type sprayers.

SPRING LOAD ON SPRAYER VALVE (Page 58) – The correct spring load for the L3 sprayer valve is 59 to 61 lb. when compressed to its working length of 1.320 in.

HYDRAULIC OPENING PRESSURE OF SPRAYERS (Page 58) – Where it is desired to determine the opening pressure of the sprayer valve by the hydraulic method, the hand operating pump must have a plunger diameter of approximately 10 mm (equal to that of the engine pump) and must be operated slowly. Under these conditions the following readings should obtain:

(a) With the sprayer valve seat and nozzle seat in new condition a spring load of 60 lb. corresponds to a hydraulic opening pressure of 178 Kg per square centimetre or 172 Atm. A tolerance of plus or minus 1 ½ % is permissible.

As the valve and nozzle seat become worn after long use (say 8,000 hours) the seat width is increased and the effective seat diameter becomes smaller. A 60 lb. spring load will then give a somewhat lower hydraulic opening pressure.

Provided that the needle valve vibrates satisfactorily and does not leak when tested by hand on the engine pump or test pump, proceed as follows:

(b) If the operating pressure has fallen to not less than 163 Kg. per square centimetre or 157 Atm. Increase the spring load by the addition of shim washers at the upper end of the spring, between the spring and the screwed stop, to raise the opening pressure to 169 Kg. per square centimetre or 163 Atm.

(c) If a sprayer, due to long use and consequently greatly increased valve seat width, has an opening pressure below 163 Kg. per square centimetre or 157 Atm., it should be replaced by a service unit and returned to the Works for complete overhaul.

LIFT OF SPRAYER VALVE (Page58) – The correct lift of the L3 sprayer valve is .012 in.

SPRAYER PIPE UNIONS (Page 58) – The minimum permissible bore size at the pipe union is .078 in. (5/64 in.). If the bore size is less than this, incorrect output readings will be recorded.

SLOW RUNNING ADJUSTMENT (Page 59) – For railc ar locomotive duty the engines are set to idle at 350 RPM during tests at the Works. On marine propulsion engines the idling speed is adjusted to 250 RPM at no load, and no attempt should be made to reduce idling below this speed.

MAIN BEARINGS (Page 45) – L3 series engines are fitted with white metal lined steel shell main bearings. These bearings are flanged and can be supplied to standard size or undersize as follows:

H1 for journals of standard size

H2 for journals from .005 in. to .030 in. undersize

H3 for journals from .035 in. to .060 in. undersize.

When fitting new bearings, they may require judicious use of the hand scraper to remove "high spots" ensuring that the crankshaft is perfectly free to turn. The bearings should have a running clearance of 0.003 in. on the crankshaft journals. A bearing which has insufficient clearance will rapidly attain destructive temperatures.

It will be observed that each main bearing is stamped with a number to correspond to the number on the bearing cap and must be assembled number to number.

The tightening torque for L3 main bearing cap nuts is the same as that for L3B main bearings, namely 2100 lb.in.

CRANKSHAFT ENDWISE LOCATION (Page 47 Sub. Para. (b)) – The L3 crankshaft is located endwise between the two main bearings nearest to the flywheel and should have and end clearance of 0.004 in. All other bearings should have an end clearance of 0.040 in. Full details concerning crankshaft end float and bearing clearances are contained in L3 Workshop Tools Book No. 57.

BIG END BEARINGS (Page 67) – Early L3 type engines up to No. 124241 were fitted with white metal lined steel shell bearings. These bearings can also be supplied to standard size or undersize as follows:

F.1 for crankpins standard to .005 in. undersize

F.2 for crankpins .010 in. to .050 in. undersize

F.3 for crankpins .055 to .095 in. undersize.

When fitted to the crankpin there must be a running clearance of 0.0025 in. and an endwise clearance between the crank webs of 0.003 in. minimum to 0.010 in. maximum. Whenever the bearings are dismantled for any reason it is of great importance that they are refitted in their original position. As with the main bearings, the big end bearing shells are also stamped with a number to accord with the number of the connecting rod in which they are fitted and must be assembled number to number.

Engines after No. 124241 were fitted with pre-finished, copper-lead-lined bearing shells and are therefore not to be bored when fitted to the rods. Full instructions for the fitting of pre-finished big end bearings are contained in Instruction Book No. 62, page 67.

The tightening torque for L3 connecting rod big end nuts is the same as for the L3B type, namely 980 lb.in.

CYLINDER BLOCK TIGHTENING TORQUE (Page 49) – The correct tightening torque for L3 cylinder block foot nuts is 1900 lb.in.

CYLINDER HEAD TIGHTENING TORQUE (Page 50) – The tightening torque for L3 cylinder head nuts is the same as for L3B cylinder heads, namely 1800 lb.in.

TIMING CHAIN RENEWAL AND REFITTING (Page 68) – L3 engines up to serial No. 112100 were equipped with timing chains having a detachable link. The useful life of these chains is about 20,000 hours but the detachable link should be renewed once during this time. When fitting the detachable link, great care must be taken to see that the spring clip is not over-stressed and retains its grip in the grooves on the pins when fitted. The clip must be fitted so that the closed or rounded end is leading in the direction of rotation and the pointed or open end is trailing. In this connection, the clockwise or anti-clockwise rotation of the engine must be borne in mind.

After long use, wear of the timing chain should be carefully checked. The following method is a useful guide in determining the extent of wear in the chain.

Thoroughly wash the chain in paraffin and stretch it out on a flat surface. Through the last pin hole in each end of the chain insert fitting pins about 2 in. long (after first removing the detachable link). Stretch the chain to its full extent and measure the distance between the inner sides of the fitting pins. If the length is greater than 47-9/16 in. the chain is worn beyond permissible limits and must be renewed.

INLET AND EXHAUST VALVES (Page 61) – When replacing inlet and exhaust valves in L3 cylinder heads, the correct clearances between valve stems and guides must be as follows:

Inlet valve 0.003 in. Exhaust valve 0.004 in.

VALVE TAPPET CLEARANCES (Page 72) – These are adjusted when the engine is cold. The correct clearances for inlet and exhaust valves are as follows:

Table 3 – Valve Tappet Clearances

Duty	Engines running up to 900 RPM	Engines running over 900 RPM
Inlet	.005 “	.005 “
Exhaust	.012”	.015”

NOTE: - Decompression Valve lift is the same as for L3B type engines, namely 0.040 in.

TIMING OF INLET AND EXHAUST VALVES (Page 71) – With the tappet clearances set at .010 in. the correct valve opening and closing periods are as follows:

Inlet Valve opens 12° 40’ before TDC and closes 42° 40’ after BDC

Exhaust Valve opens 54° 10’ before BDC and closes 19° 10’ after TDC

FUEL INJECTION TIMING (Page 71) – For L3 engines set to a maximum speed of:

Table 4 – Fuel Injection Timing

Engine Type	R.P.M.			
	800	900	1000	1200
3 & 4L3	18 before TDC	19 max. before TDC		
5 & 6L3	19 before TDC	20 max. before TDC		
8L3	20 before TDC	21 before TDC		
4, 5, 6 & 8L3			21 30’ before TDC	24 max. before TDC

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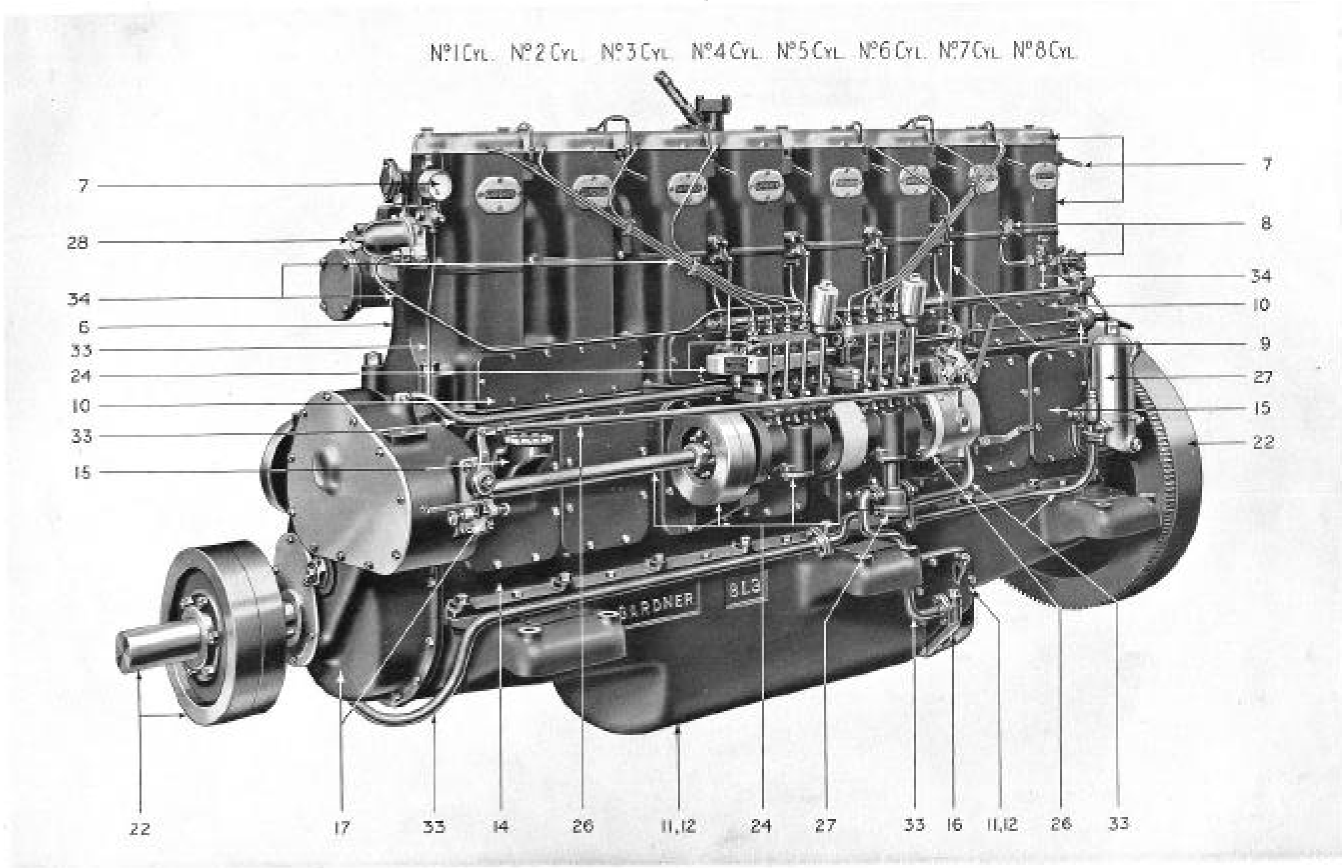
NEAR OR PORT SIDE VIEW OF L3 ENGINE—Plate 1



NOTE:—The numbers refer to Plates and not to Sections.

IMPORTANT:—This is a composite illustration embracing all states of design of the L3 engine, and in no sense must it be regarded as a standard.

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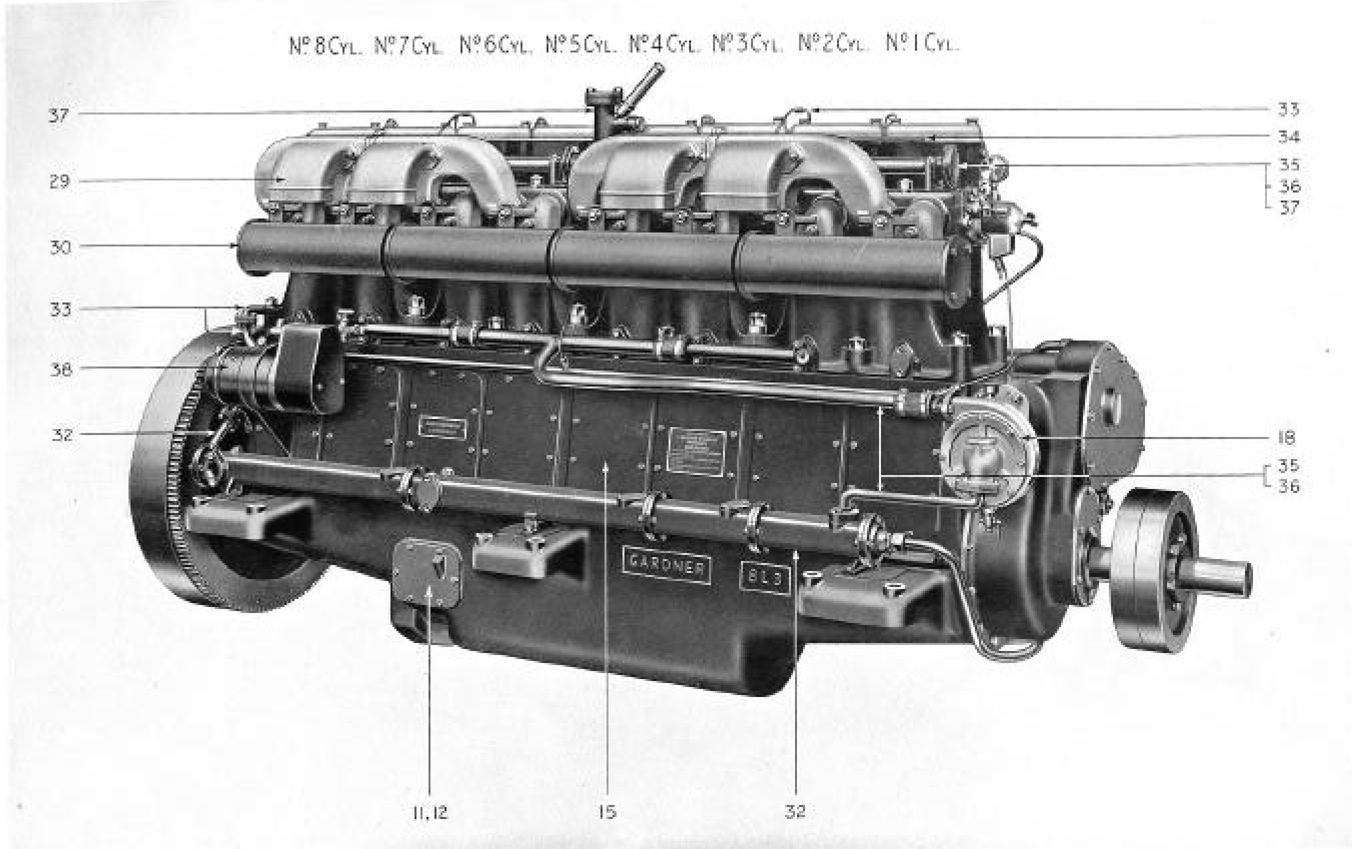
OFF OR STARBOARD VIEW OF L3 ENGINE—Plate 2



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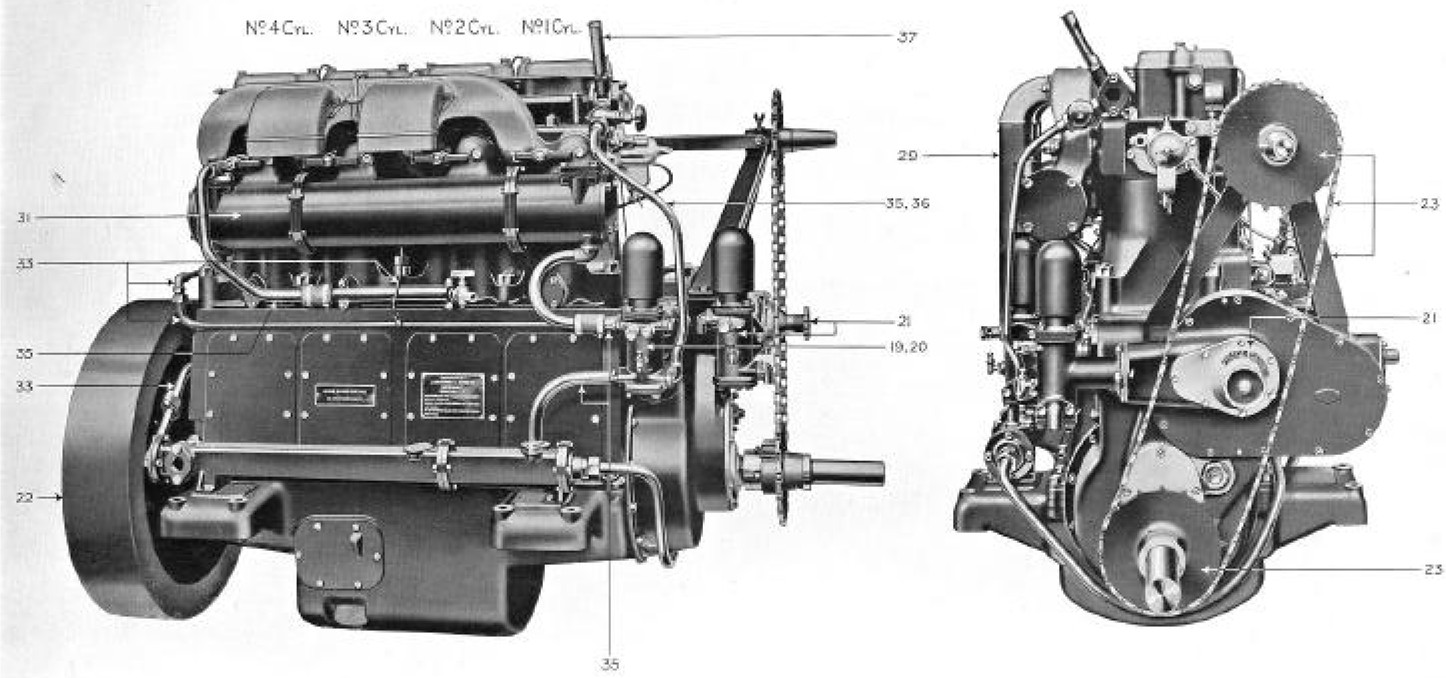
STARBOARD AND FORWARD VIEWS OF L3 ENGINE—Plate 3



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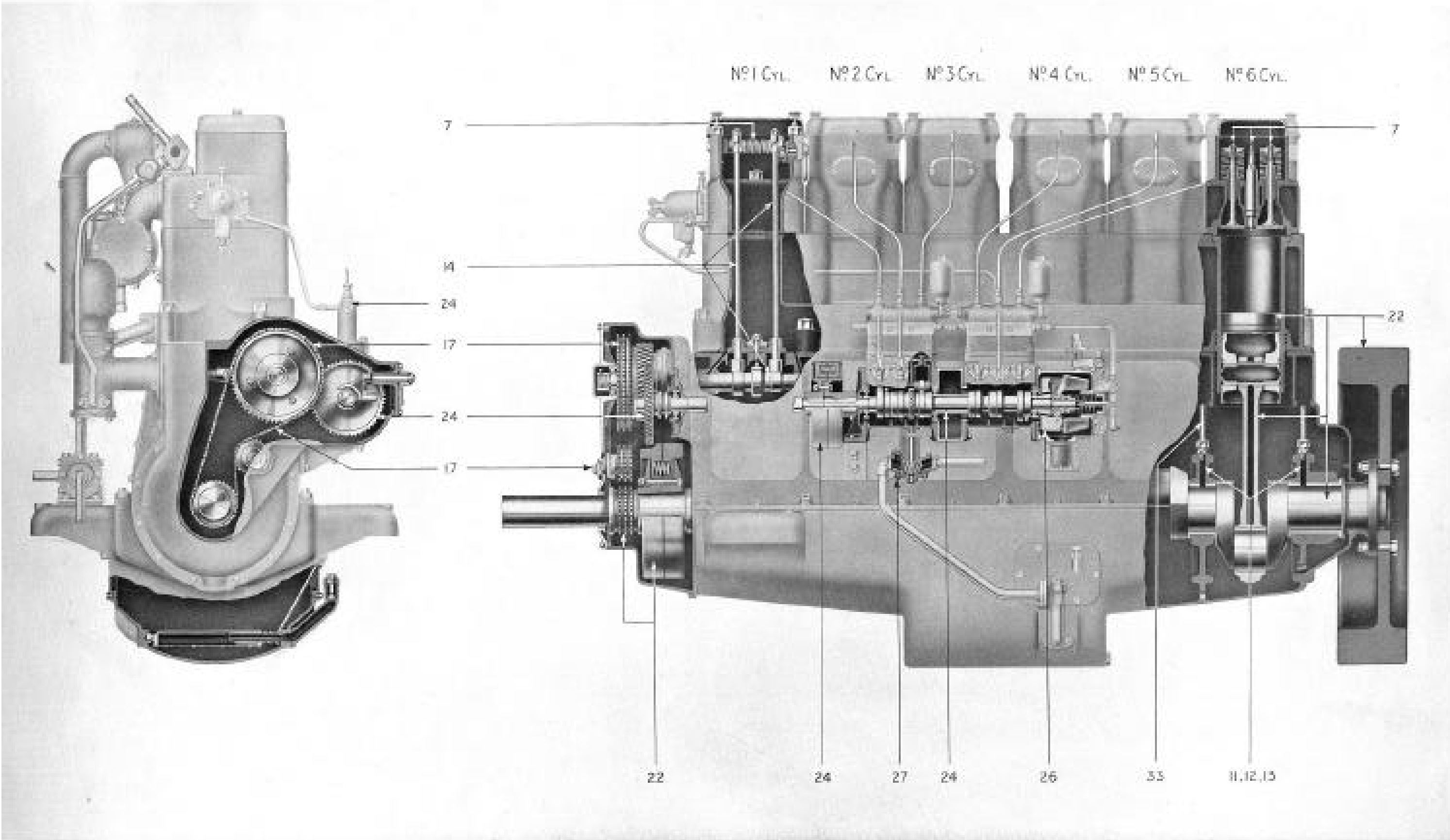
SECTIONAL VIEW OF L3 ENGINE—Plate 4



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