

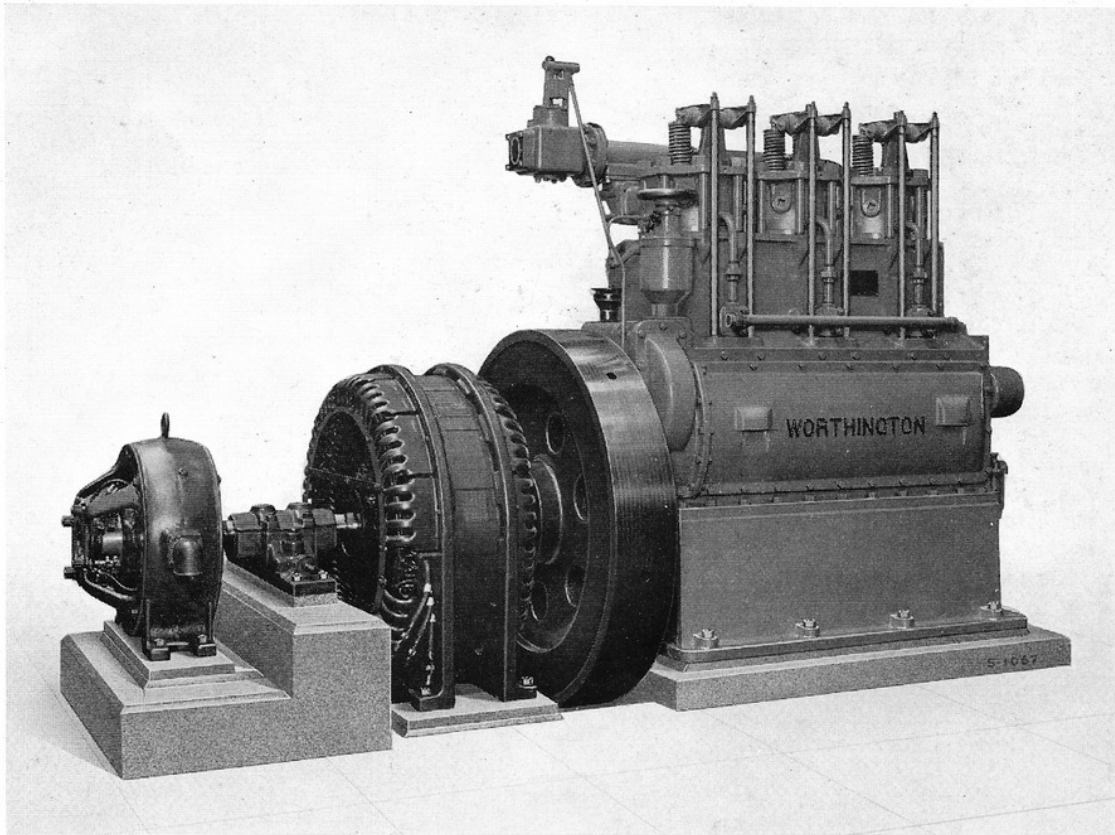
WORTHINGTON



GAS ENGINES

VERTICAL FOUR CYCLE

TYPES BG, CG, DG, EG



Type BG-3, Gas engine with generator and exciter

WORTHINGTON PUMP AND MACHINERY CORPORATION

Works—Buffalo, N. Y., Cincinnati, Ohio, Harrison, N. J., Holyoke, Mass.

Executive Offices: 2 Park Avenue, New York, N. Y.

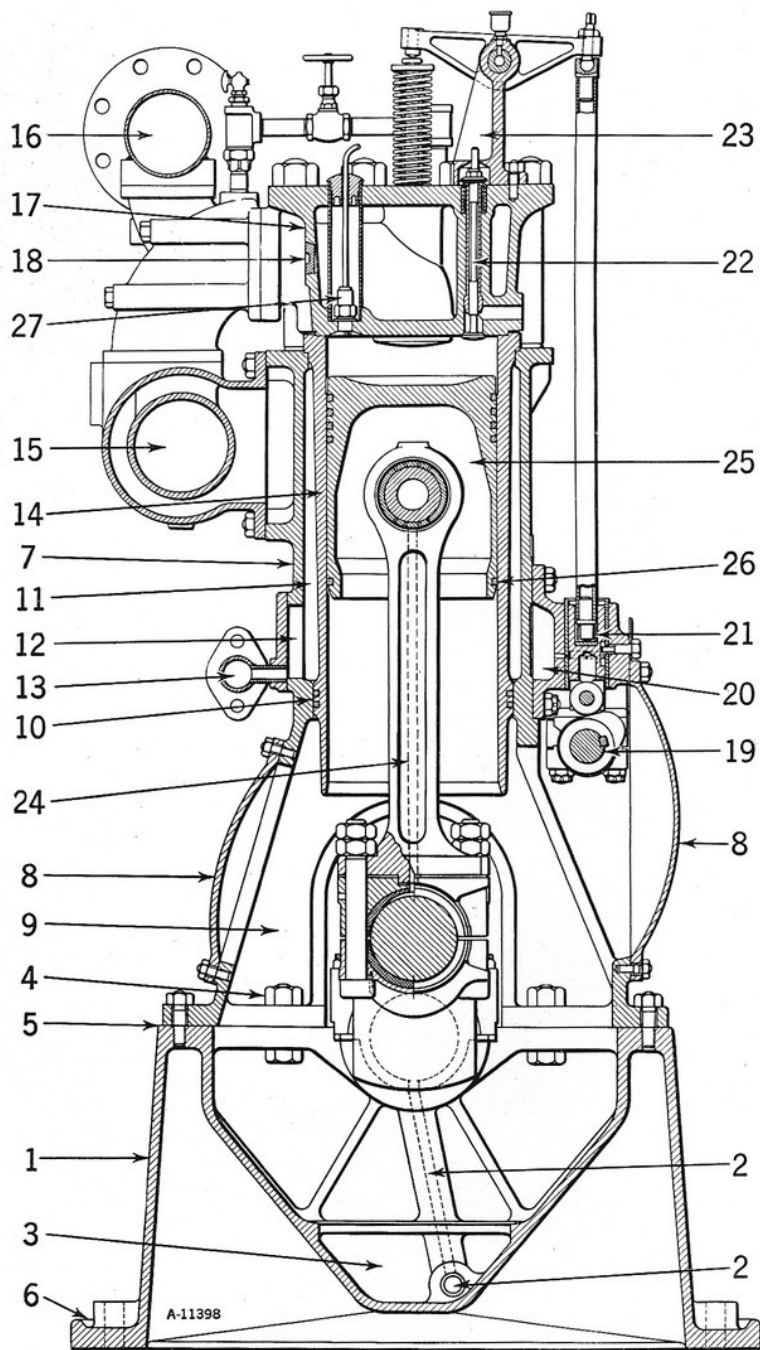
GENERAL OFFICES: HARRISON, NEW JERSEY

Branch Offices or Representatives in the Principal Cities of the United States and of all Foreign Countries



27 Salient Features

1. In the smaller sizes, base stands flat on top of foundation as shown. In larger sizes it is let into foundation to reduce height of engine above floor line.
2. Cast-in lubricating oil ducts—no joint to leak—oil supply goes to bottom of main bearings, *not* to caps—no pipes to be disconnected.
3. Lubricating oil sump, separated from crankcase by screens. No outside oil storage tank required.
4. Straight transmission of forces from frame to base.
5. Joint between base and frame, made oil tight by closely spaced bolts.
6. Continuous oil gutter to protect concrete from spilled oil.
7. Frame in one block, reaching from base to cylinder heads, assuring lasting alignment.
8. Large doors in front and rear, giving unobstructed access to main and crank bearings.
9. Strong ribbed webs for straight transmission of forces to base.
10. Water tight sliding joint, allowing expansion and contraction of liner. In the larger sizes a stuffing box is provided.
11. Individual symmetrical water jackets around each liner, providing definite water circulation.
12. Two large cleaning holes for each cylinder jacket, allowing access around entire liner.
13. Cooling water distributing manifold, supplying each cylinder jacket.
14. Removable cylinder liners secured on top of frame and guided at bottom in water tight sliding joint. See paragraph 10.
15. Water cooled exhaust manifold, secured to frame and *not* supported by cylinder heads. Water cooling protects plant and operator from heat. All cylinder heads can be removed at one time without disturbing manifold.
16. Intake manifold for gas and air mixture.
17. Cylinder head transmits forces from holding down studs thru conical walls in straight line and without bending stresses. No gasket at joint; therefore, no gasket trouble.
18. Large cleaning holes, permitting convenient access to all points of cylinder head jackets.
19. Camshaft unobstructed and conveniently removable at right angle to engine. Camshaft bearings adjustable. All cams hardened.



20. Continuously replenished oil reservoir from which all push rod and fuel pump tappets are lubricated.
21. Spring cushion supporting push rod and assuring constant contact of rollers on cams and rockers on valve stems. Silent operation.
22. Air starting check valve in cylinder head, operated automatically when air starting pilot valve opens.
23. Valve lever and pedestal assembly, easily accessible and removable.
24. Connecting rod with crank bearings, compression adjustable by shims.
25. Long cast-iron piston, designed for ample heat transfer to liner by correct distribution of material.
26. Wiper rings preventing loss of oil from crankcase.
27. Spark plug, easily removable with special wrench.



FOREWORD

Gas, beyond question, is a very reliable and convenient source of power. Natural gas is now available in many parts of the country at rates which make power production by gas engines economically competitive. This has increased the interest in gas engines—a field in which Worthington has always been a leader. Worthington has built gas engines since 1900 (altogether over 400,000 horsepower) and has accumulated such an amount of good judgment and knowledge in this field that any development coming from its shops deserves attention and confidence.

This present bulletin describes a new line of vertical four-cycle gas engines, built for the purchaser whose chief aim is lowest ultimate power cost over an extended period.

In arriving at a design best answering this purpose,

many factors have to be considered, namely: first cost, depreciation, renewals and repairs, fuel consumption and supplies, attendance and outages—in short, all factors affecting the balance sheet. These factors were considered, not by guess, but on the basis of Worthington's records of engine performance, comparative designs, life of parts and ultimate power costs, accumulated during the construction of approximately 900,000 horsepower of Diesel and gas engines.

The construction of the engine is neither light nor too heavy, and the speed and the torque ratings are moderate so that the engines may run at full load continuously without adverse effect upon the power cost. Continuous operation at full load is not only permitted but recommended.

POWER RANGE

The full line covers power requirements from 60 to 1000 horsepower in 2 to 8 cylinder units. This bul-

letin deals with engines from 60 to 660 horsepower. For larger engines see special bulletin.

FIELD

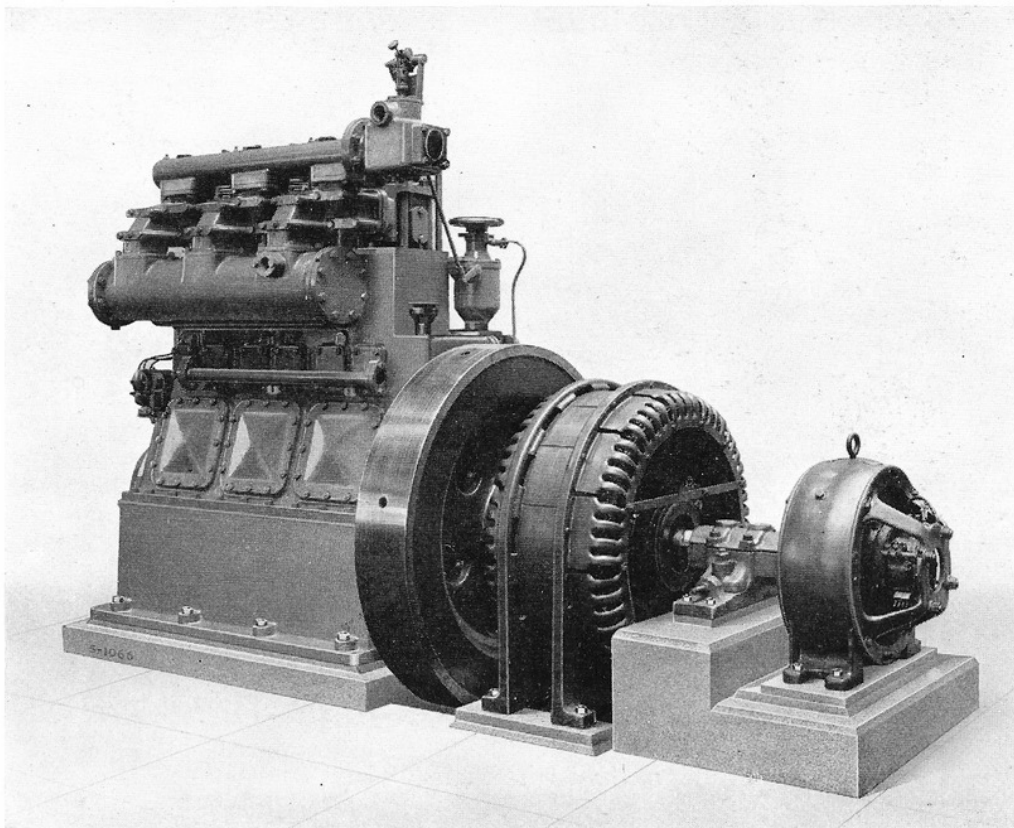
The engines are intended for applications meeting the following conditions:

1. Gas is available at an economical cost.

2. Lasting and reliable power production is intended.
3. Size and weight are not restricted to a degree excluding a reliable long life engine.

The engines can be adapted to the requirements of different applications by corresponding modifications.

The engines are convertible to Diesel engines by minor alterations.



Rear view of Type BG-3, engine showing mixing valve



FEATURES OF CONSTRUCTION

General. All pressure lubricated parts are sealed so that the engine may be operated indefinitely in heavily dust laden air. The cylinder heads, valve rockers and push rods are exposed to allow accessibility and observation of vital parts. The water connections between the cylinder and cylinder heads are external and in case of leakage water cannot enter the cylinder.

Lubrication. The lower part of the engine base forms the lubricating oil sump, holding the required storage. The level in the sump is indicated by a gauge and no outside lubricating oil tank is required.

From the sump, the oil is picked up by an attached circulating pump and returned to the engine through a self-cleaning strainer.

The engine is supplied with a steady stream of oil under pressure. This oil enters a main oil duct which is cast in the base and extends through its full length. Cast-in branches lead to the bottom of each main bearing. This construction avoids loose oil pipes in the crankcase, the possibility of leaks or breakages, and the necessity of disconnecting leads to main bearing caps. From the main bearings, the oil reaches

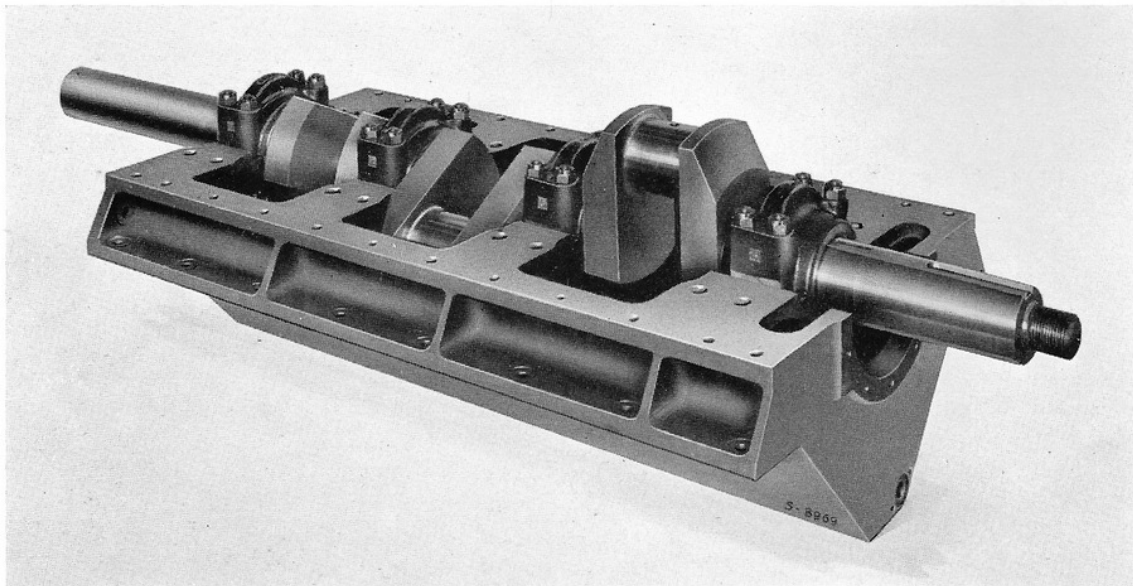
the crank bearings and wrist pin bearings under pressure in the normal manner through drilled passages in the crank shaft and connecting rod.

Other points requiring lubrication, camshaft gear, governor, etc., are supplied with oil under pressure from the main lubricating oil system.

In the larger sizes, the cylinders are lubricated by forced feed lubricators.

Base. The base is of cast iron, arranged for concrete, steel or timber foundation, as required. The base for mounting on concrete has an oil gutter protecting the concrete from spilled oil. The bottom of the base is machined to help in aligning the engine. In the smaller sizes, the base usually stands flat on the foundation.

Main Bearings. The bottom halves of the main bearings are babbitted shells which can be rolled out for inspection without removing the crankshaft. The top halves are formed by the babbitted main bearing caps. Both end main bearings are longer than the intermediate main bearings to allow for the weight of the flywheel and the over-hang of the shaft in case of front-end power take off. Each main bearing cap is



Engine base with shaft in place



held down by four studs, two on each side, to prevent a rocking motion of the caps which causes bending and fatigue failures of the studs.

Crankshaft. The crankshaft is made of carbon steel suitably heat treated and is forged in one piece. It is of ample proportions and rigidly supported by large main bearings.

Each individual application is checked to be sure no dangerous torsional vibrations come within the operating range. Critical torsional vibrations occur at some speed in any engine driven unit and such a check is necessary to avoid trouble from this source. They are not dependent on crankshaft dimensions alone but the entire system of rotating masses must be taken into consideration, including driven unit.

Connecting Rod. The connecting rods are forged of carbon steel and drilled in the center for oil passage. The crank boxes are separate babitted steel castings. The connecting rod bolts are of alloy steel. Their dimensions insure against failure. The wrist pin bearings are solid bronze bushings pressed into the eye-end of the connecting rod. This construction produces a more satisfactory bearing than a split design with its uncertainty and complication. It has been found that modern materials and lubrication make the wear of a solid bushing negligible.

Pistons. The pistons are of cast iron, the wrist pins hardened and fixed in the pistons. Wiper rings are provided to prevent oil waste.

Frame. The frame is of cast iron. It reaches from the base to the cylinder heads in one block. Into this block the replaceable liners are inserted from above, resting in a recess at the top of the frame and guided longitudinally at the bottom in a manner which permits free expansion and contraction of the liner without water leaks. In the larger sizes, this lower joint is formed by an adjustable stuffing box. Large doors in front and rear give unobstructed access to main and crank bearings.

Cylinder Liners. The cylinder liners are made of special wear resisting cast iron developed in the Worthington foundry. Performance shows that their wear resistance is uniform and excellent.

Cylinder Head. The cylinder head is so designed that dangerous stresses are avoided. Stresses may come from tightening of the holding down studs or from heat expansion and contraction. In the Worthington cylinder heads the force of the holding down studs is transmitted in a straight line through the strong conical walls to the seat, leaving the rest of the head unaffected. Heat expansion and contraction on the other hand has free play. The result is the excellent record of Worthington cylinder heads.

Exhaust and Intake Valves. Exhaust and intake valves are made of heat resisting material. In the smaller engines they seat directly in the cylinder head. In the larger engines they operate in removable cages. Exhaust and intake valves are interchangeable. Exhaust valve cages are water cooled.

Camshaft. The camshaft is removed at right angles to the engine after taking off the front gear case door. This is in contrast to the less expensive automotive construction of placing the camshaft bearings in the frame and removing the shaft lengthwise from the engine. All cam shaft bearings are split and adjustable. The camshaft is driven by spur gears with silent helical teeth, at the flywheel end, because at that end the crankshaft is steadied by the flywheel and the gears run smoothly and silently. Cams, rollers and push rod guides are lubricated from a cast-in oil chamber extending over the full length of the engine and supplied by the main oil system.

The entire camshaft assembly, including its lubrication, is enclosed with a tight cover.

Mixing Valves. The mixing valves provide the correct mixture of gas and air. Balanced air valves are used to relieve the governor. Adjustment for the quantity of gas is made by rotating a single knurled adjusting screw. This arrangement allows excellent control and best fuel economy.

Ignition. Spark plugs are provided in correct location in the cylinder heads. Current is furnished by magneto (battery ignition can be provided upon request).

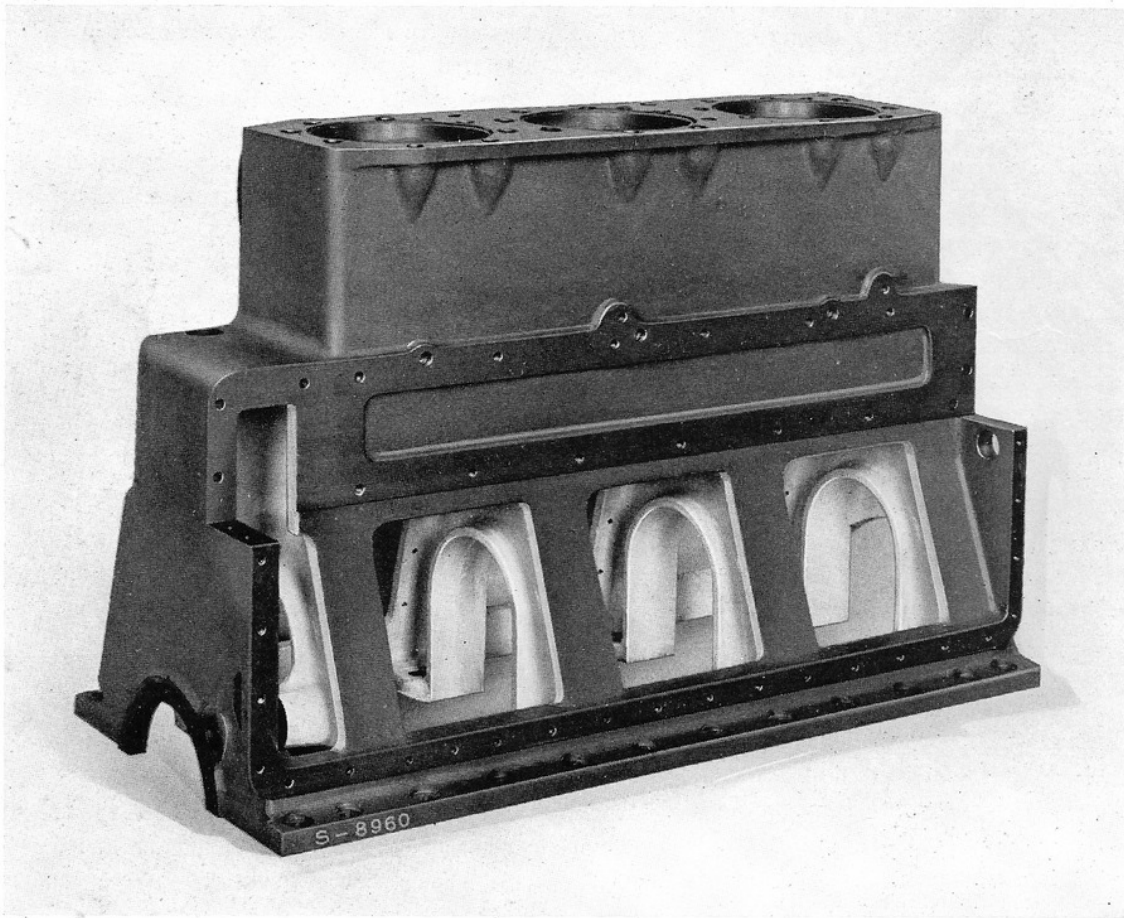
Water Cooling. The outstanding point is that the water flow in all jackets is directed so that high water



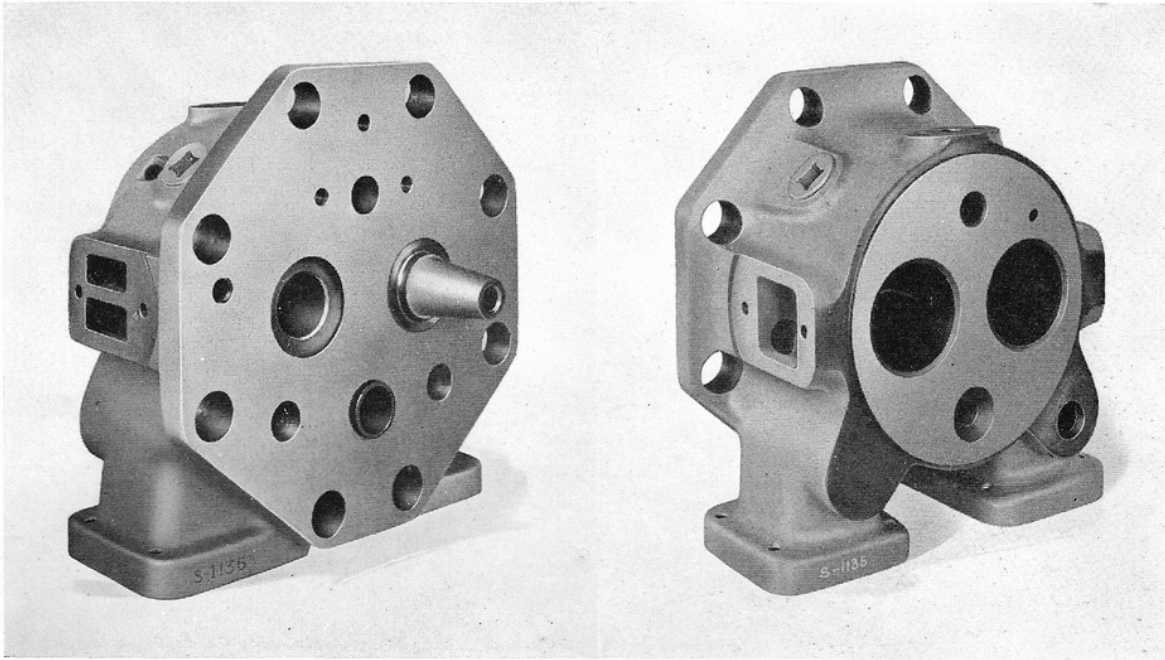
velocities result and dead pockets are prevented. This is necessary to produce uniform cooling. In detail, the arrangement is as follows: Each cylinder liner is surrounded by an individual and symmetrical water jacket. Each of these jackets has two large cleaning holes thru which a man's arm can enter and reach all around the liner for cleaning. After passing through these jackets, the water enters the cylinder head through a visible outside connection which can be tightened should it leak.

The cylinder head jackets are accessible all around thru cleaning holes. The water is carried in guided flow to all points, especially past the valve seats. From the cylinder heads the water crosses over to the individual exhaust elbows and then to the main manifold jacket which it leaves in one common outlet. Modifications are possible, suiting individual installations.

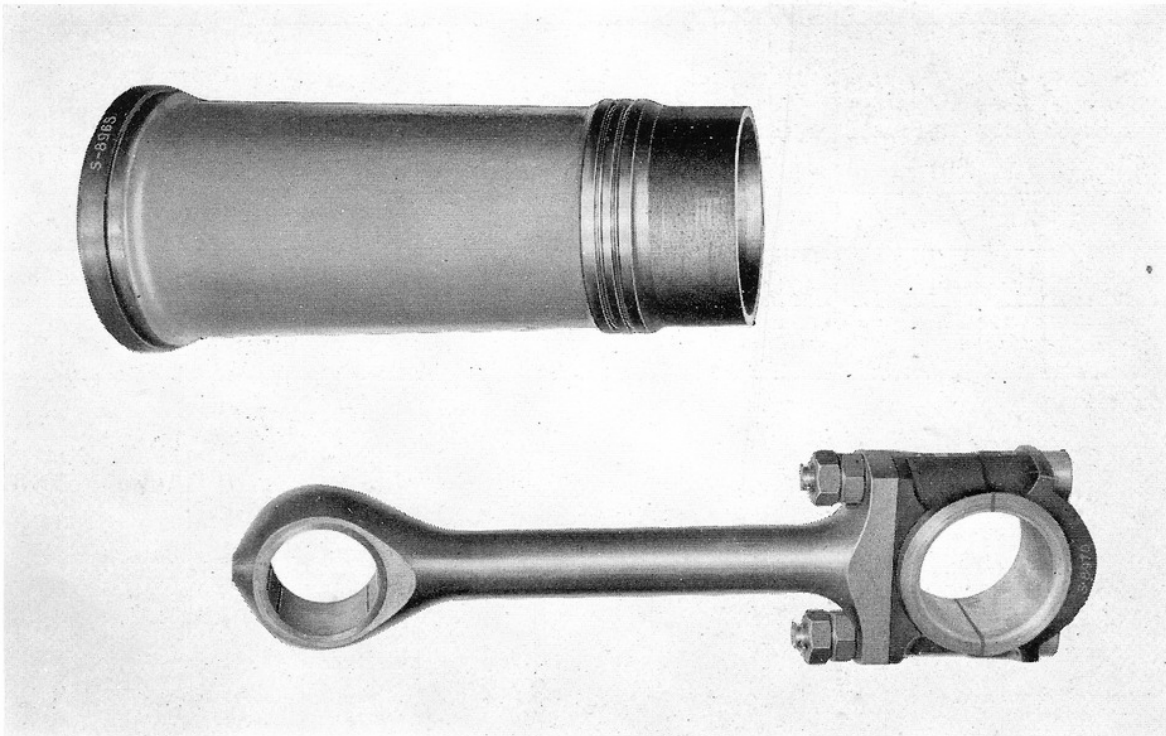
The result of all this is: Cool castings, absence of heat stresses and good cylinder lubrication.



Type BG engine frame



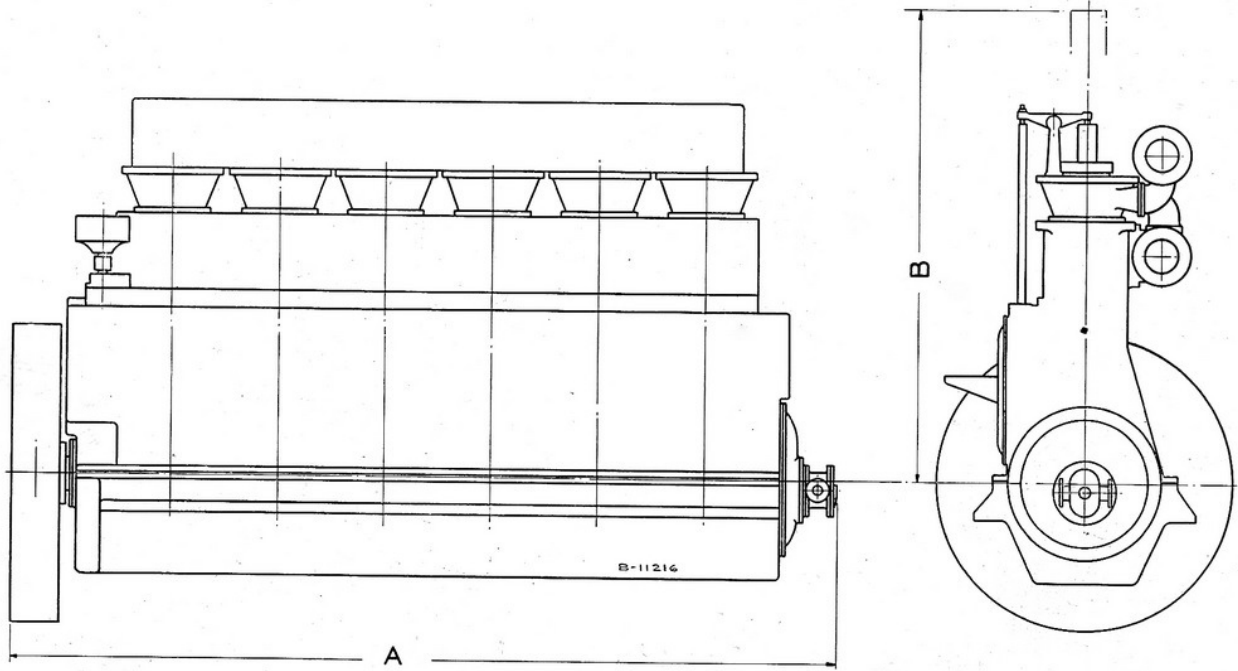
Cylinder head—top and bottom views



Cylinder liner and connecting rod



Overall Dimensions for Types BG, CG, DG, EG Engines



DIMENSION TABLE

Type	BG 2	BG 3	BG 4	BG 5	BG 6	CG 3	CG 4	CG 5	CG 6	DG 3	DG 4	DG 5	DG 6	EG 3	EG 4	EG 5	EG 6
Number of cylinders	2	3	4	5	6	3	4	5	6	3	4	5	6	3	4	5	6
A	5'0"	6'3"	7'6"	9'3"	10'6"	8'5"	10'3"	11'11"	13'7"	9'10"	12'0"	14'1"	16'2"	11'7"	14'1"	16'6"	18'11"
B	6' 10"					7' 8"				9' 4"				12' 6"			
R.p.m.	514					400				327				300			
*H.p.	60	90	120	150	180	180	240	300	360	270	360	450	540	330	440	550	660

*Natural gas ratings.

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