H. R. RICARDO.

INTERNAL COMBUSTION ENGINE.

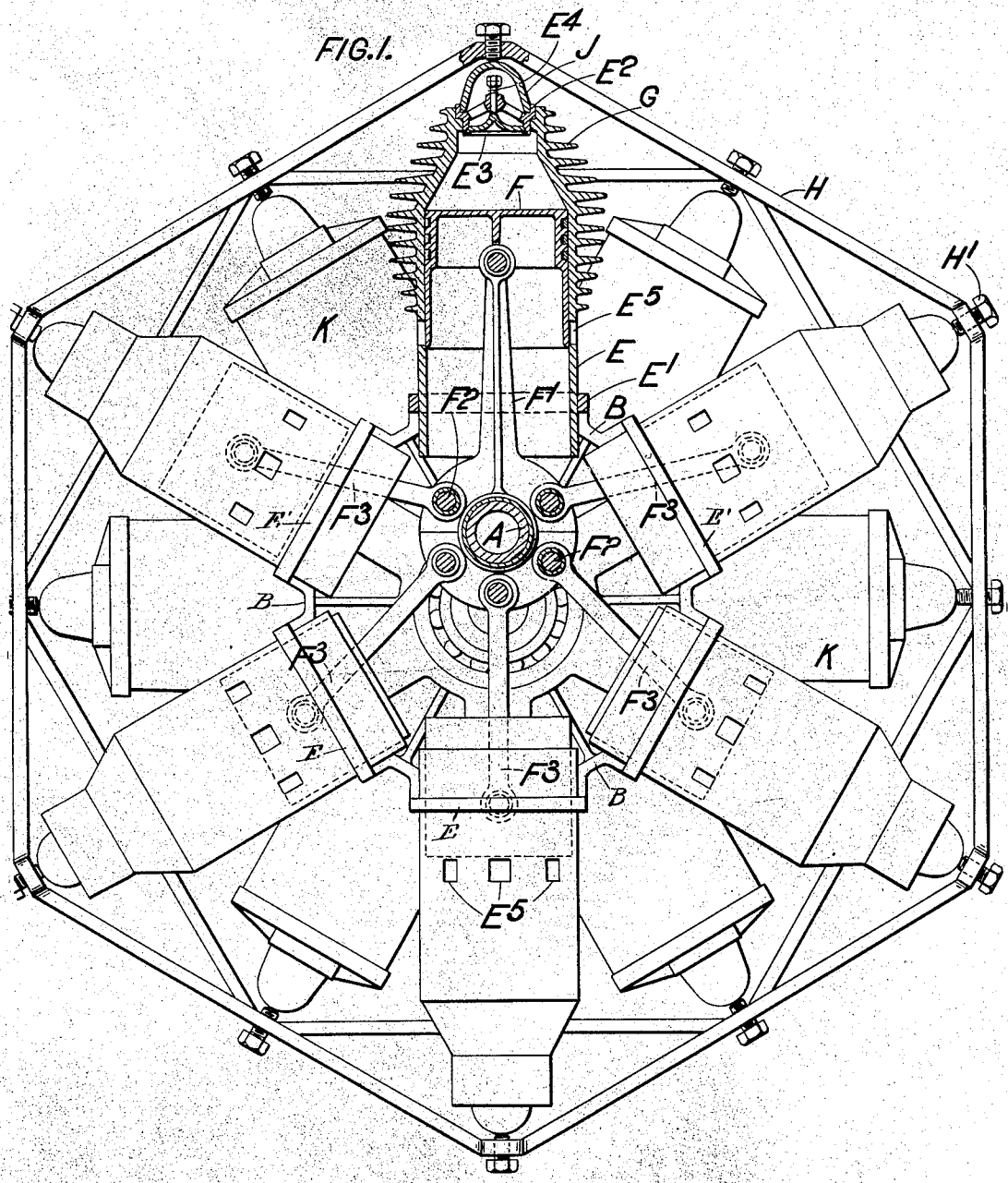
APPLICATION FILED NOV. 11, 1910.

1,027,278.

Patented May 21, 1912.

3 SHEETS—SHEET 1.

FIG. 1.



WITNESSES.

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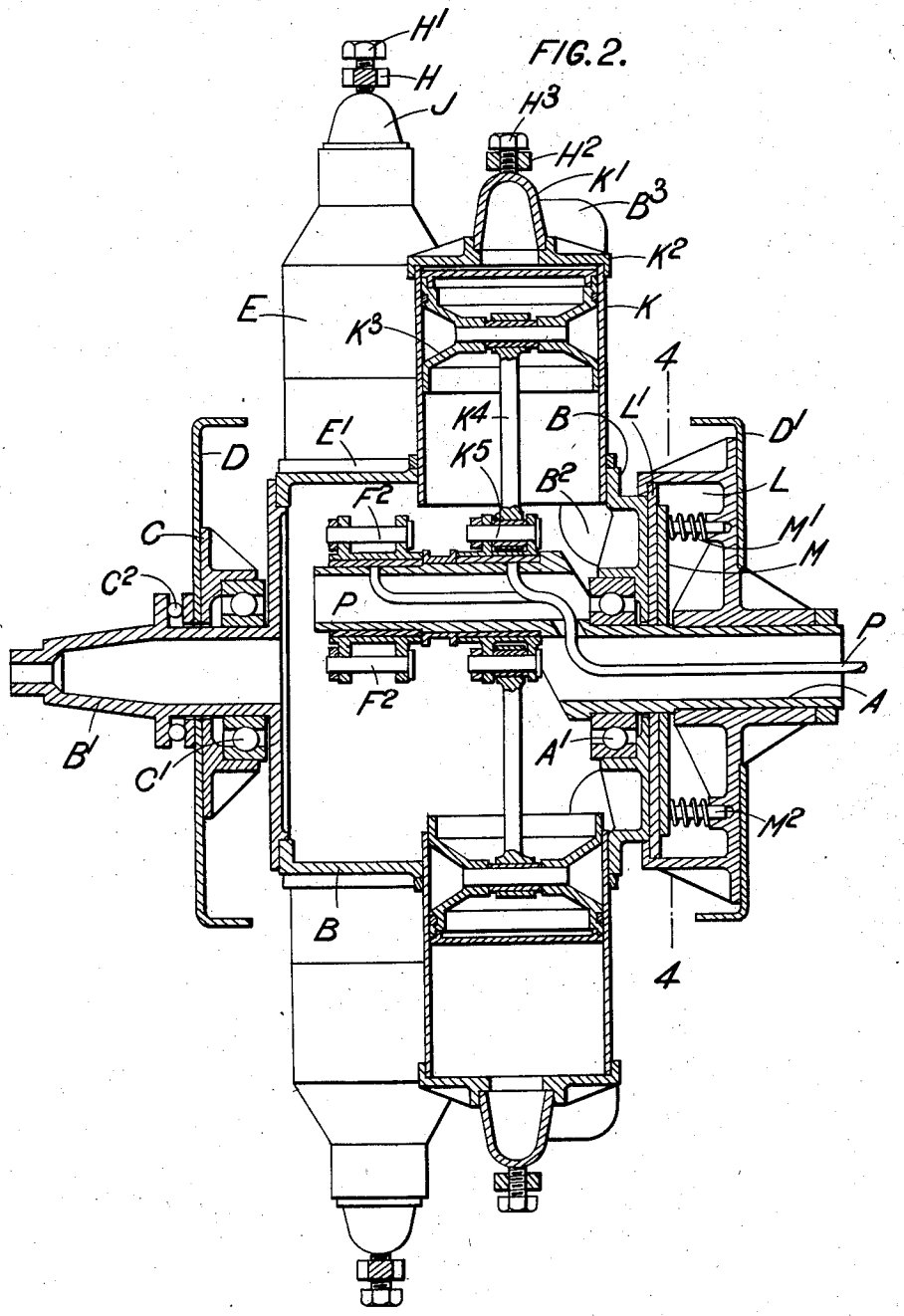
3 SHEETS—SHEET 2.

FIG. 2.



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3 SHEETS—SHEET 3.

FIG. 3.

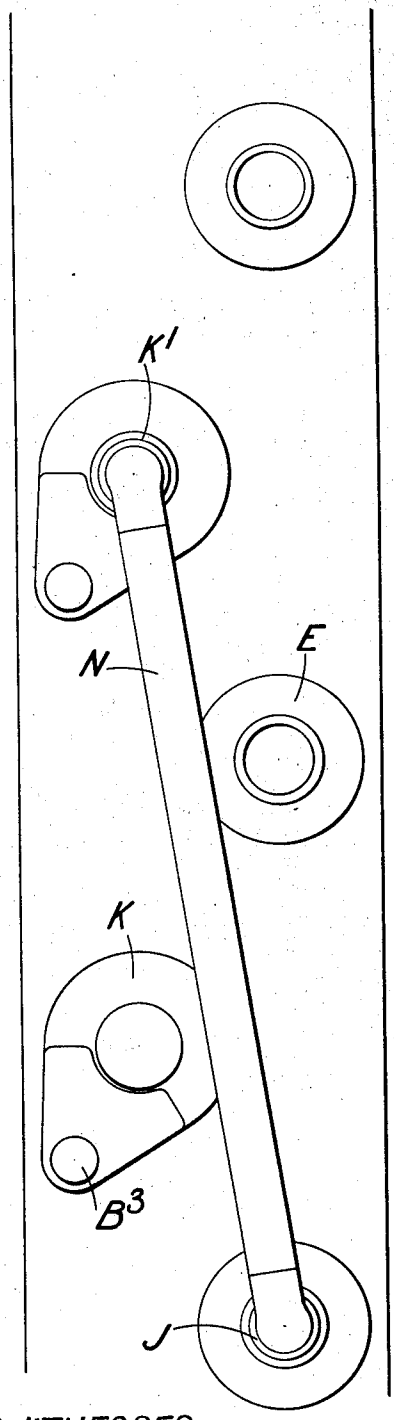


FIG. 4.

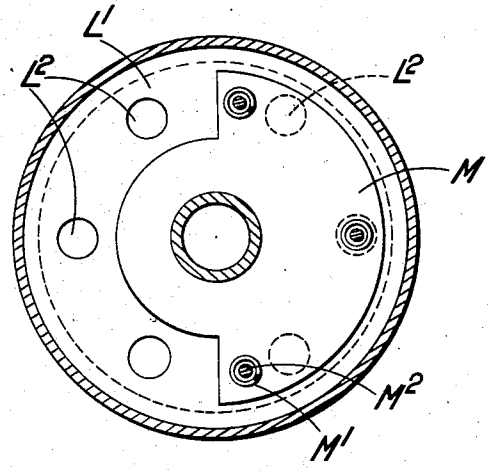
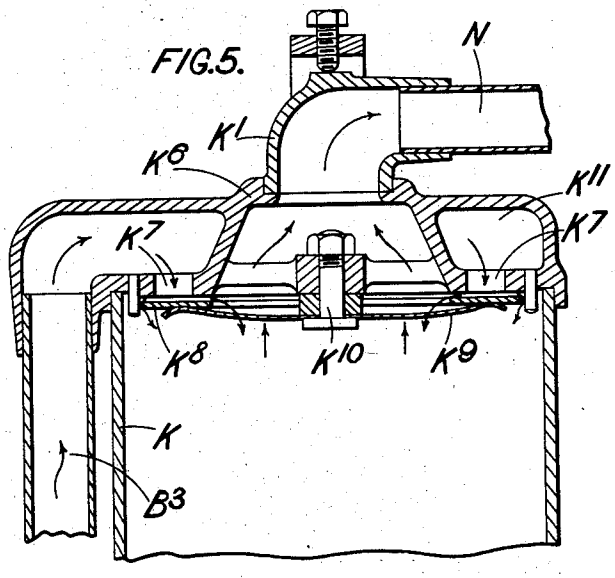


FIG. 5.



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UNITED STATES PATENT OFFICE.

HARRY RALPH RICARDO, OF LONDON, ENGLAND.

INTERNAL-COMBUSTION ENGINE.

1,027,278. Specification of Letters Patent. Patented May 21, 1912.

Application filed November 11, 1910. Serial No. 591,810.

To all whom it may concern:

Be it known that I, HARRY RALPH RICARDO, subject of the King of England, residing at London, in England, have invented certain new and useful Improvements in or Relating to Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal combustion engines and has for its object to produce an engine of simple and light construction capable of normally running at high speed and more especially suitable for aerial navigation.

According to this invention the engine which works on the two-stroke cycle has a series of working cylinders disposed radially about a fixed crank axle a series of pump cylinders being similarly disposed beside the working cylinders and all rotating about the crank axle. A central box casing carried on bearings constitutes a crank chamber and has peripheral apertures into which are secured the working and pump cylinders, the cylinders being preferably held in place and the principal strain taken by one or more shrouding rings formed of suitable dimensions and material. Preferably one of these rings encircles the set of working cylinders while another ring encircles the set of pump cylinders. These rings bear on the outer ends of the cylinders with set-screws or in some other manner permitting of adjustment and conveniently the head of each cylinder carries a spring-controlled inlet valve the head of the cylinder being kept in place by the shrouding ring so that on removal of this ring the head of the cylinder can be lifted off and the valve inspected while the cylinder itself can then be readily detached from the crank casing. Exhaust ports are made at suitable points in the walls of the cylinders the exhaust taking place directly into the air.

The working and pump cylinders are preferably arranged so that while lying with their axes in separate planes the cylinders alternate and each pump cylinder is connected to a working cylinder. The connection between each working cylinder and its pump comprises a pipe rigidly connected to both the head of the working cylinder and a cap covering an orifice in the head of the pump cylinder. Thus detachable connections are avoided and by removing the shrouding rings the head of a working cylinder with its inlet valve, the cap on the head of its pump cylinder and the connecting pipe are all removed as one piece.

The pump cylinders may be valveless the supply of fuel being drawn through an opening in the head of the pump cylinder which communicates by a passage conveniently formed in the wall of the cylinder. This passage terminates in a port formed in a plate constituting one end of the crank chamber. Against the outer face of this plate bears a fixed disk or plate also ported and disposed in a supply chamber. As the engine rotates the supply ports are successively uncovered and fuel sucked from the common supply chamber into the pump cylinder and thence when the supply port is closed by the rotation of the engine the charge is forced through the inlet valve into the working cylinder.

The fuel supply passages are so arranged that after the shrouding rings have been removed the head of the pump cylinder may be lifted off and the cylinder itself readily detached from the crank casing.

Other methods of controlling the supply of fuel may be employed either of the rotary disk valve or other types. As an example a controlling valve may be disposed in the head of each pump cylinder an arrangement such as the following being employed. The head of each cylinder is formed hollow with an opening to which is connected the inlet pipe and on the inside a series of ports preferably disposed in a circle. These ports are covered by a disk or flat annulus which at the suction stroke of the pump is lifted against a spring conveniently of the leaf type. The head of the cylinder is provided with a central opening closed by a cap which cap together with the whole head of the cylinder is held in place by the shrouding ring bearing on the cap. The fuel drawn in through the hollow head of the cylinder and past the flat valve is expelled through the central orifice and cap to the working cylinder. This construction may be modified in various ways as for instance in the construction of the head of the cylinder and inlet ports together with the valve.

Lubrication is maintained by a supply forced through passages formed in the fixed

crank to the main bearings whence lubricant finds its way by centrifugal force to the gudgeon pins and pistons.

Any convenient known system of ignition may be used, some electric system being preferable with a suitable arrangement of contacts.

As the shrouding rings can be simply and lightly constructed of material amply strong enough to withstand the strain thrown on them and as the construction allows of the main strains being referred to the shrouding rings it is possible to lighten the structure of the cylinders and the crank casing since no very strong method of connection is necessary between these parts. Further ready accessibility of the parts of the engine is gained with avoidance of studs, nuts, bolts, set-screws and the like.

There is preferably one main connecting rod to pins on the big end of which are coupled lighter connecting rods from the pistons of the other cylinders. There is thus a single main crank pin for each set of cylinders.

The crank casing is preferably carried on ball bearings the fixed crank axle passing through one end of the casing and a stud axle being mounted on the opposite end of the crank casing.

It is to be noted that it is possible to employ comparatively light springs to control the inlet valves of the working cylinders owing to the action of centrifugal force aiding the closing of these valves. This force is thus taken advantage of to assist in the operation of the valves and to enable the construction of the engine to be lightened by throwing the strains on to simple members namely the shrouding rings which can easily be constructed of material particularly suitable for the purpose.

The cycle on which the engine works comprises the indrawing of a charge into the pump cylinder and its delivery into the working cylinder just after exhaust has taken place the charge being then compressed and fired and subsequently exhausted through the ports in the wall of the cylinder.

Suitable radiation ribs are preferably provided on the working cylinders and it is desirable in some cases to fit sheet metal scoops or collectors which will as the engine rotates produce a flow of air over the heads of the working cylinders, this air being directed to flow around the cylinders and away in a manner so as to carry off the exhaust.

It will be understood that though a separate shrouding ring is preferably employed for each set of cylinders one ring may be used in common between them the structure being however preferably as light as possible consistent with the necessary strength.

In the accompanying drawings, Figure 1 is an elevation with parts in section, showing one construction of internal combustion engine according to this invention. Fig. 2 is a vertical section, showing the crank chamber and pump cylinders in section and the working cylinders in elevation. Fig. 3 is a diagram similar to a developed plan, showing the connection between a working cylinder and its pump cylinder. Fig. 4 is a section on the line 4—4 of Fig. 2, showing in elevation the disk valve controlling the fuel supply, and Fig. 5 is a sectional view, showing the head of a pump cylinder of modified construction and provided with a valve.

With reference first to Figs. 1 and 2, A is a fixed hollow crank shaft supporting on ball-bearings A^1 one end of a rotatable crank chamber B. The other end of this crank chamber is furnished with a projecting hollow portion B^1 forming a stud-axle supported by ball-bearings C^1, C^2 in a fixed member C which forms part of the stationary girder or frame D. A similar girder or frame D^1 forms the support for the stationary crank shaft A. Set around the crank chamber B are six working cylinders E each having a piston F and radiator fins G. These working cylinders E fit into openings made to receive them in the crank chamber B and are provided with collars or shoulders E^1 fitting on to corresponding flanged portions of the crank chamber. As preferred and shown in the drawing the cylinders are simply fitted into the openings, but it will be understood that some screw or other engagement may be provided to assist in keeping them in place. Whatever this arrangement may be, the cylinders are held in position mainly, or in some instances entirely, by a shrouding ring H having set-screws H^1 which can be screwed down on to caps J which bear upon the cylinder heads E^2. These cylinder heads contain inlet valves E^3 controlled by springs E^4 and, as the heads are kept in position solely by the shrouding ring, they can be at once removed and the valve inspected when the ring is taken off. Exhaust ports E^5 are provided in the cylinder walls. As shown in Fig. 1, the piston of one cylinder—that shown in section—is provided with a connecting rod F^1. The big end of this rod is connected to the crank shaft A by appropriate bearings, and on the big end are pins F^2 serving as points of connection for the connecting rods F^3 of the other five pistons. Pump cylinders K are also set around the crank chamber B, the method of their fitting, as shown in Fig. 2, being similar to that described with reference to the working cylinders. The pump cylinders K are held mainly or entirely in position against the crank chamber by means of a shrouding ring H^2 having set-screws H^3. These screws

bear upon caps K^1 placed centrally upon the cylinder heads K^2. The pump pistons K^3 are connected to the crank shaft A by means of connecting rods K^4 and pins K^5, the arrangement being similar to that employed for the working cylinders. As will be seen from the drawings it is preferred to set the pump cylinders so that they are staggered or alternate with the working cylinders.

The supply of fuel to the pump cylinders comes from a chamber L mounted upon the fixed member D^1 (Fig. 2), this chamber being itself in communication with a carbureter which is not shown but which may be of any convenient type and may be mounted on the chamber L. One wall of this chamber is formed by a disk valve plate L^1 attached to and forming a face-plate on the end wall of the crank chamber B. This plate is shown in elevation in Fig. 4 and it is provided with holes L^2 leading through corresponding holes in the end wall of the crank chamber B to cored passages B^2 in the crank chamber. These passages lead to other passages B^3 which may be formed in the walls of the pump cylinders K and lead into the upper ends of those cylinders. The plate L^1 coöperates with a fixed plate M shaped as shown in Fig. 4 and kept pressed against the plate L^1 by means of springs M^1 which are mounted on guide pins M^2. As shown in Fig. 4, the arrangement is such that, as the valve plate L^1 rotates, the holes L^2 come from under the plate M and are uncovered, allowing fuel to be sucked through them and through the passages B^2 B^3 into the pump cylinders where suction is being produced by the downward movement of the piston. As shown in Fig. 4, three holes are uncovered and the other three are covered, these covered holes belonging to the pump cylinders where the pistons on their upward strokes are driving the charges into the working cylinders.

The connection between each working cylinder and its pump cylinder is by means of a pipe N (see Fig. 3) connecting the caps J and K^1. The two caps and the connecting pipe N may be so arranged that they can be removed bodily when the shrouding rings H and H^2 are taken off. The working cylinders are intended to operate on the two-stroke cycle, the incoming charge from the pump cylinders driving out the products of combustion at the exhaust ports E^2 when the working piston F has descended.

Any convenient method of ignition may be employed. An electric ignition is suitable but is not illustrated as the details of construction form no part of the present invention.

In the arrangement shown in Figs. 1 and 2, the pump cylinders are valveless, the supply of fuel being controlled in the manner described by the disk valve L^1 M, but this disk valve may be dispensed with and inlet valves provided in the heads of the pump cylinders. One such construction is shown in Fig. 5 where the head K^6 of the pump cylinder K is provided with inlet ports K^7 controlled by an annular valve K^8 and spring K^9. This spring K^9 is mounted on a central support K^{10} and tends to cause the valve K^8 to keep the openings K^7 closed. Under the action of the suction, the valve uncovers the holes and the charge is drawn in through hollow spaces K^{11} in the head. These spaces communicate with the pipe B^3 leading to the fuel supply chamber. In this construction the outlet for the charge is, as shown in Fig. 5, through a central opening in the head to the cap K^1 and thence as before through the pipe N to the working cylinder.

As shown in the drawing one end of the crank is unsupported, but it will be understood that the construction may be modified so that a bearing is provided for it in the hollow stud B^1, thus stiffening the crank and keeping it in alinement.

The lubrication is maintained by a supply forced through pipes P which pass through the crank shaft and lead out to the main bearings of the connecting rods. From thence the lubricant finds its way by centrifugal force to the gudgeon pins and the pistons F and K^3.

The invention has been described as applied to an engine of the type in which the crank chamber and cylinders rotate relatively to a fixed crank shaft but, obviously, the construction may be so modified without departing from the spirit of the invention that the crank shaft would rotate, the crank chamber and cylinders either remaining stationary or rotating in the opposite direction.

What I claim as my invention and desire to secure by Letters Patent is:—

1. In an internal combustion engine, the combination of a crank chamber having a plurality of peripheral apertures, a crank shaft within said chamber, a plurality of cylinders set into said apertures and having collars bearing upon the chamber, pistons within said cylinders, operative connections between the pistons and crank shaft, a shrouding ring surrounding the cylinders, and adjustable means between the outer ends of the cylinders and the shrouding ring for detachably holding the cylinders to the crank chamber.

2. In an internal combustion engine the combination of a crank chamber, a crank shaft within such chamber, a plurality of working cylinders mounted upon the crank chamber, a plurality of pump cylinders also mounted upon the crank chamber, pistons within the working and the pump cylinders, operative connections between the pistons and the crank shaft, removable heads to the

working cylinders and to the pump cylinders, conduits connecting the heads of the working and pump cylinders and shrouding rings surrounding each set of cylinders and acting to hold them in position.

3. In an internal combustion engine, the combination of a crank chamber, a crank shaft within such chamber, a plurality of working cylinders mounted upon the crank chamber, a plurality of pump cylinders also mounted upon the crank chamber, pistons within the working and pump cylinders, operative connections between the pistons and the crank shaft, removable heads to the working cylinders, valves within such removable heads, removable heads to the pump cylinders each having inlet ports disposed around a central outlet port, a cap covering each of such outlet ports, conduits connecting the caps with the removable tops of the corresponding working cylinders and shrouding rings acting to hold the working cylinders and the pump cylinders in position.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HARRY RALPH RICARDO.

Witnesses:
B. E. DUNBAR KILBURN,
ARCHBALD J. FRENCH.