B. READ.
INTERNAL COMBUSTION ENGINE.
APPLICATION FILED AUG. 10, 1910.

1,041,162. Patented Oct. 15, 1912.

3 SHEETS—SHEET 1.

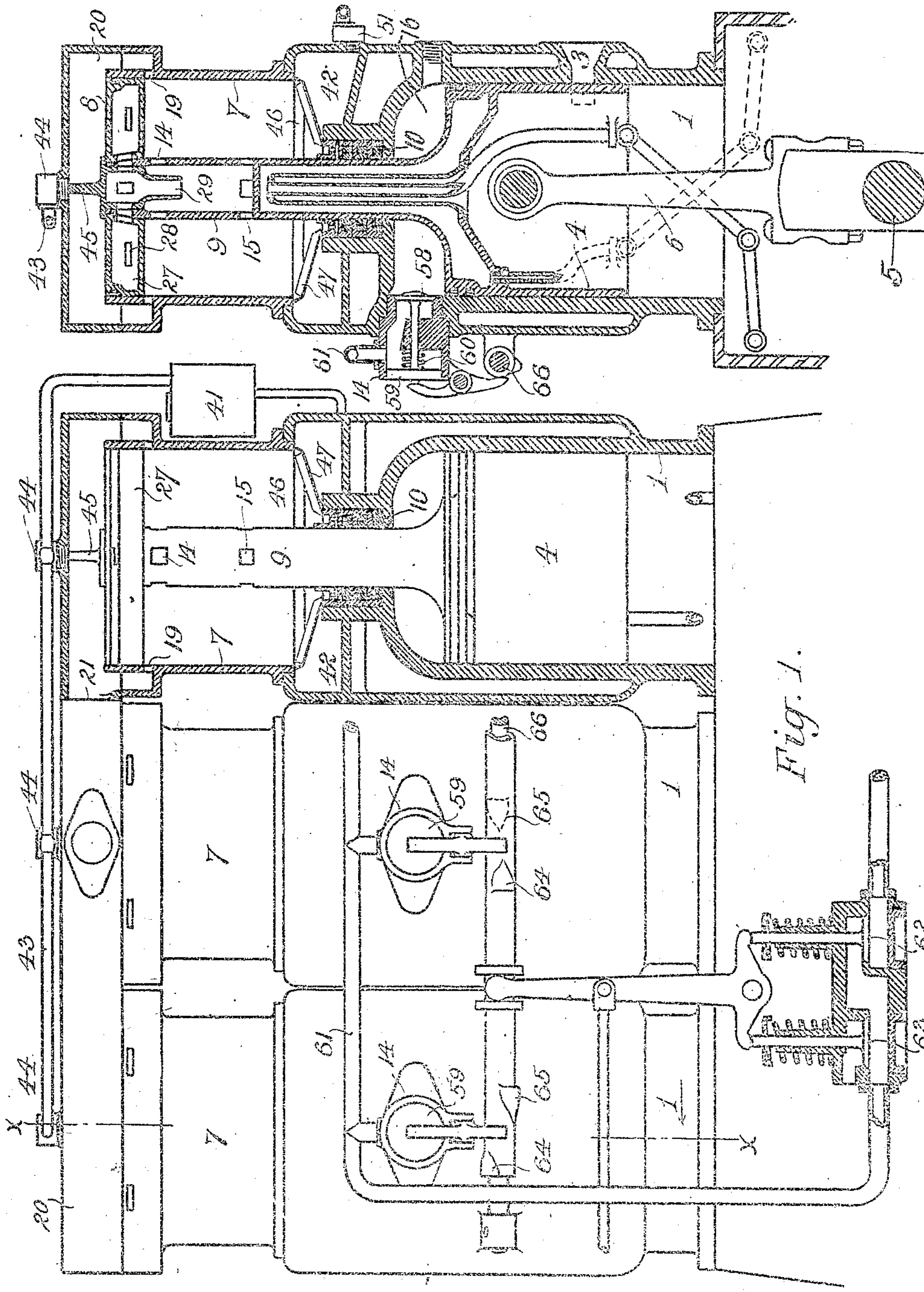

Fig. 1.

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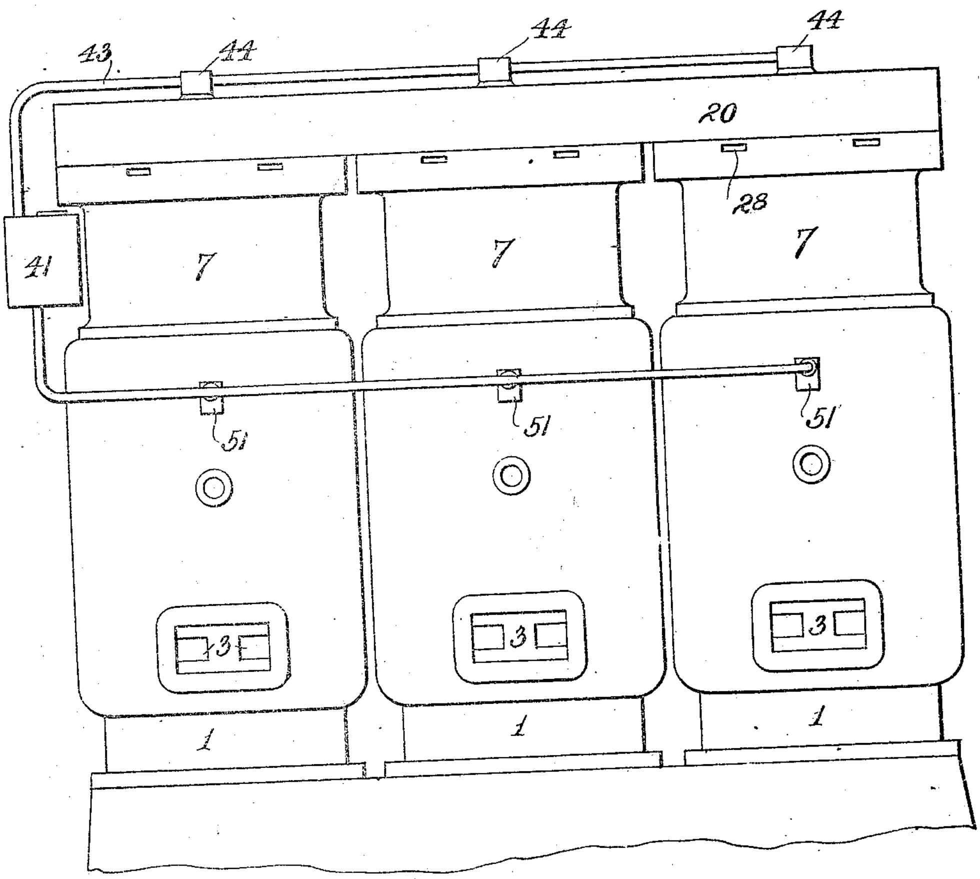
3 SHEETS—SHEET 2.

Fig. 3.



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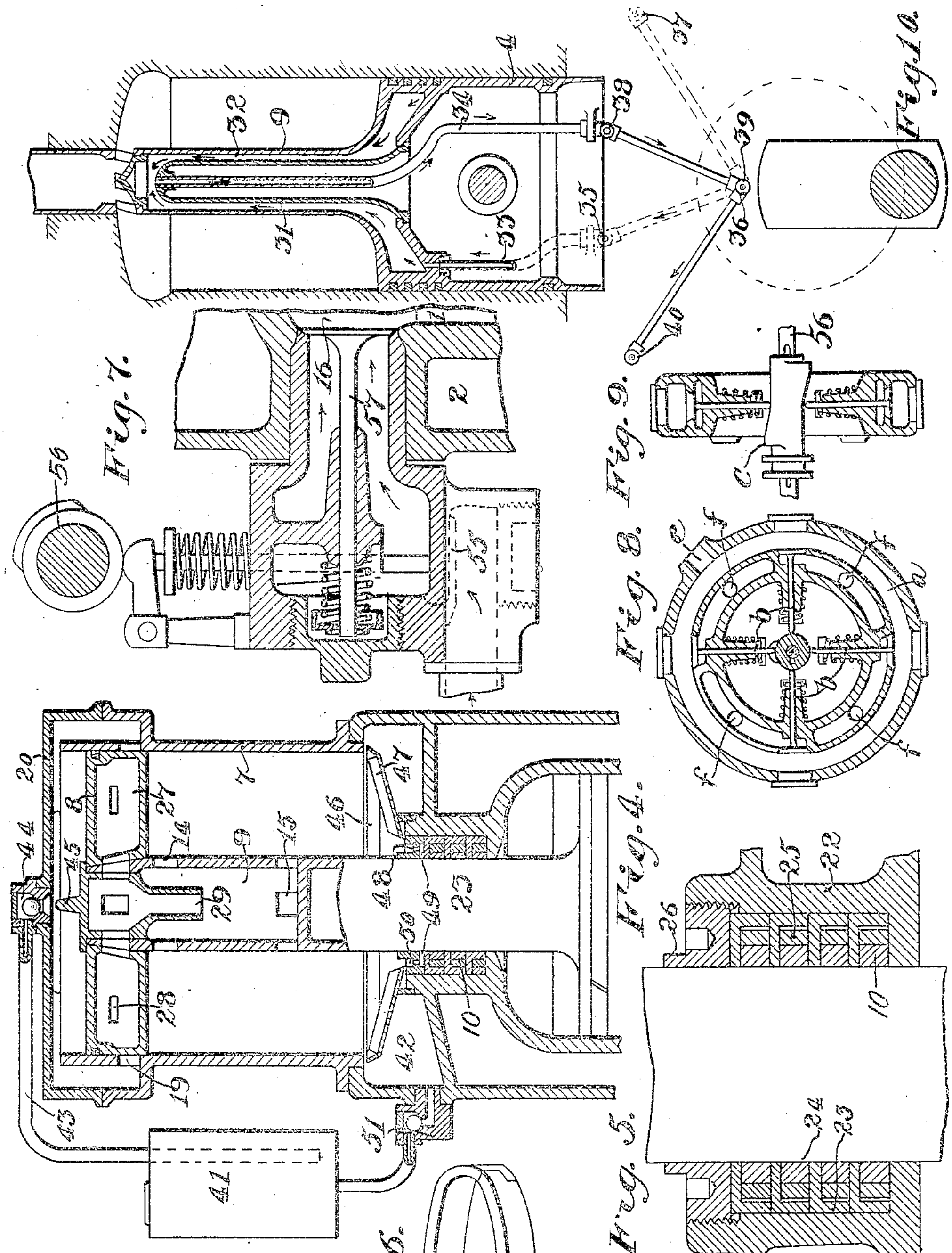

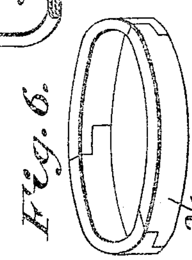

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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

1,041,162. Specification of Letters Patent. Patented Oct. 15, 1912.

Application filed August 10, 1910. Serial No. 576,435.

To all whom it may concern:

Be it known that I, BALFOUR READ, of 11 Conduit road, Bedford, in the county of Bedford, England, have invented certain new and useful Improvements in and Relating to Internal-Combustion Engines, of which the following is a specification.

This invention relates to improvements in that class of combustion engine in which the work stroke is effected in the cylinder, or in each of them if there are several, for every revolution of the crank, and especially to that type in which the pumping cylinder is in line with the working cylinder and behind it, and in which the charge enters the combustion chamber from the pump through ports in a hollow sleeve connecting the motor and pump pistons.

The invention is primarily intended for marine propulsion but is very suitable, in its simplest form, when it may be made very light, for aerial purposes.

In an engine made in accordance with this invention the working piston is connected to the pumping piston, by a hollow sleeve working in a stuffing box.

The invention is illustrated in the accompanying drawing which shows the application of the invention to a vertical single cylinder engine.

Figure 1 is a part sectional elevation of an engine embodying the invention, and showing a method of starting by compressed air and using the engine as a brake when applied to road traction. Fig. 2 is a section on line x—x Fig. 1. Fig. 3 is a back view of Fig. 1, means being shown for returning oil from the cylinders. Fig. 4 is a section showing a scavenging arrangement and system of lubrication. Fig. 5 is a section showing the packing. Fig. 6 is a detail of a packing ring. Fig. 7 is an enlarged sectional detail. Figs. 8 and 9 are details of a means for operating the compressed air starting valves. Fig. 10 shows an arrangement for cooling the sleeve.

The cylinder 1 is shown provided with a water jacket 2, but may be air cooled. It may be fitted with any suitable form of ignition device—not shown—by which the explosive charge is fired at the appropriate point of the stroke. Exhaust ports 3 are formed in the walls of the cylinder as shown in Figs. 2 and 3 and are uncovered by the piston 4 toward the end of the outward stroke. The piston 4 is preferably of the open trunk type, and articulated to the crank 5 by the connecting rod 6. The cylinder may be supported in any approved manner, but is shown in Figs. 1 and 2 bolted to a crank case. The pumping cylinder 7 is in line with the working cylinder 1 and above or behind it. The pumping piston 8 is rigidly connected to the working piston 4 by the hollow prolongation 9 of the latter. The sleeve 9 works in a stuffing box 10 and has two separate series of ports 14 and 15 cut in its walls. Ports 15 are in such a position that they are open to the combustion chamber 16 shortly after the exhaust ports 3 have been uncovered by the piston 4. The upper ports 14 serve to admit the charge from the pumping cylinder 7 to the hollow sleeve 9.

In the case of two or four cylinder engines with adjacent cranks at 180° and also with three cylinder engines with cranks at 120° the back ends of the pumping cylinders may be closed by a cover 20 with a passage 21, or passages for intercommunication, forming a single closed chamber. The inclosed volume is then nearly constant for all points of the cycle. The chamber incloses the port 19 and is connected to the air or gas supply.

The action is as follows:—On the upstroke the ports 15 and 3 commence to close simultaneously by the top of the combustion chamber and the piston 4 respectively—and a charge is compressed in the working cylinder 1. Simultaneously a fresh charge enters the pumping cylinder 7 beneath the piston 8. Ignition takes place in the working cylinder 1 at or near the top of the stroke. On the down stroke the burned gases expand and do work upon the piston 4. Near the end of the stroke the exhaust ports 3 are uncovered and the spent gases escape. Just afterward the inlet ports are uncovered and a fresh charge enters from the pumping cylinder, driving the remaining spent gas before it and filling the cylinder 1. The cycle is then repeated.

The charge from the pump may consist of carbureted air, or pure air only. In the latter case, the fuel is injected separately by the upstroke.

The packing and stuffing box comprises a casing 22 annular flanged disks 23 disposed within the casing, packing rings 24 disposed in the housing formed between two flanged disks 23, 23 or between a flanged disk 23 and the casing, a spring ring 25 disposed at the back of each packing ring 24 and a retaining cap 26 adapted to keep the packing in position. The packing ring 24 may be made in segments the ends of which overlap as shown in Fig. 6 so as to break joint and avoid gaps. The segments have no resilience in themselves and are therefore not liable to spring into the ports, hence this form of packing is particularly applicable to engines made in accordance with this invention.

Means for scavenging the explosion cylinder where no separate inlet valves are provided as shown in Figs. 1 and 4, comprises the pumping piston 8 made with a chamber 27 and provided with ports 28 which are coincident with ports in the pumping cylinder when the piston is near the top of the stroke. Said ports in the pumping cylinder communicate with the atmosphere, ports 19 in the pumping cylinder communicate with the chamber within the cover 20 said chamber being in communication with the explosive mixture, and a tube 29 leads from the hollow pumping piston to the interior of the sleeve 9.

The action is as follows:—On the upstroke of the piston a partial vacuum is formed beneath the pumping piston 8. Near the top of the stroke ports 28 coincide with the pure air supply ports in the cylinder thus admitting a charge of fresh air to the interior of the sleeve 9; immediately afterward the explosion mixture is admitted by ports 19. The effect of this is that the contents of sleeve 9 consists mainly of pure air so that before the charge of explosive mixture enters the cylinder 1 it is preceded by a small charge of pure air, forming a cushion between the burned gases and the fresh explosive mixture.

The sleeve 9 may be separately connected to the piston 4 and sleeve and piston may be cooled by water circulation or forced air draft, as may be found desirable in large engines. One method of cooling the sleeve and piston is shown in Fig. 10 diagrammatically. Within the piston 4 and the lower portion of the sleeve 9 is disposed a casing 31, leaving a space 32 connected to the water circulating system by an inlet pipe 33 and an outlet pipe 34. The path of the water is indicated by arrows. The pipes 33 and 34 have hollow knuckle joints, 35, 36, 37, 38, 39 and 40 to allow for the movement of the piston.

Means for lubricating the cylinder and packing comprises an oil reservoir 41, in which the pressure is maintained by the air pressure in the pump chamber 42, a supply pipe 43 leading from the oil reservoir 41 to the top of the cover 20, a non-return valve 44, and means for raising said non-return valve to admit a drop of oil into the pumping cylinder at each stroke of the engine or otherwise comprising a projection 45 on the piston 8. The feed may be regulated by a needle valve in the oil supply pipe 43. The drainage from the pump cylinder 7 is caught by a circular trough 46 and led by two or more tubes or gutters 47 to the upper surface of the stuffing box cap 48. The cap 48 is dished for the purpose of retaining the oil the inner edge being made higher than the outer edge. The lower surface of the cap 48 is formed so that only the outer portion bears on the uppermost flanged disk 23. The inner portion of the retaining ring is recessed so as to provide a small clearance 49 which communicates with the upper surface of the ring by a number of holes or passages 50 whereby a film or small quantity of oil is always in contact at its inner edge with the sleeve 9 to be lubricated, and oil over-flowing the outer edge of the retaining ring 48 falls into the sump of the pump-chamber 42 and is blown through the non-return valve 51 to the oil reservoir 41.

The engine may be started by compressed air and the method of starting in either direction is as follows: The compressed air is admitted to the combustion chamber 16 from a receiver by suitable piping—not shown—either through two valves disposed separately as shown in detail in Fig. 7 or by a single balanced valve, mechanically operated. The valve 55 is mechanically operated by a cam on the countershaft 56 which is driven at the same speed as the crank shaft, and valve 57 is automatically opened by the air pressure behind it. The valve 55 is timed to open and admit compressed air a short period after the commencement of the down stroke and close before the exhaust ports 3 are uncovered. The pressure in the cylinder then falls, and a charge is delivered through the ports 15. On the upstroke the charge is compressed and fired, ignition being preferably timed to take place at a point between the top of the stroke and the opening of the valve 55 so that the valve 57 is kept closed by the pressure in the cylinder. When it is desired to start the engine in the reverse direction, the counter shaft 56 is slid along by a lever and another set of cams—not shown—brought into operation. When running under power, the valve 55 is normally between the two sets of cams, and inoperative.

The valves 55 of a multicylinder engine may be disposed in a separate casing *a*, as shown in Figs. 8 and 9, and arranged radially in the same plane at equal angles, the stems *b* pointing inward. In such an arrangement the shaft 56 would be provided with two cams *c* and *d* only and would pass through the center of the casing *a* and operate each valve 55 in correct sequence. The air admission pipe *e* would be led to the casing *a* and from thence the air would be distributed by each valve 55 by suitable piping *f* to its respective valve 57.

By another arrangement for starting the engine by compressed air the cylinders 1 are each provided with a mechanically operated valve 58 which is adapted to be returned to its seat by the piston 59 and spring 60. Compressed air is admitted to these valves by a piping 61 from a controlling mechanism, the controlling mechanism is provided with an inlet valve 62 from the compressed air supply and an exhaust valve 63 and cams 64 and 65 on shaft 66. The cams are adapted to be slid into or out of operative position to open and close the compressed air inlet valves 58 in their correct sequence but normally said cams 64 are in inoperative positions. The cams may be slid in unison with the opening and closing of the valves of the controlling mechanism or independently thereof and at the same time the ignition may be cut out.

In operation the cams 64 which are driven at the same speed as the crank shaft of the engine are slid to operate the inlet valves 58, at the same time the inlet valve 62 of the controlling mechanism is opened to the compressed air supply. The engine is then caused to rotate by compressed air the valves opening and closing in their correct sequence, the exhaust taking place through the ordinary exhaust ports 3 of the engine. For the purpose of utilizing the engine as an efficient brake another set of cams 65 is provided in the shaft which are adapted to operate the air inlet valves 58 when the inlet valve 62 of the controlling mechanism is closed and the exhaust valve 63 thereof is opened.

In operation on the forward stroke of the engine air is drawn in to the cylinder the valves are shut near the end of the stroke and the air confined in the cylinder is compressed until the top of the stroke is reached when the air inlet valve 58 is opened and the compressed air escapes through the exhaust 63 in the controlling mechanism, thus producing a braking action during the operation the sparking device may be cut out.

The carbureter may be arranged to supply air only when the braking operation is in use.

The details described may of course be modified in various ways while reserving the main features of my invention.

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

1. An internal combustion engine comprising a plurality of working cylinders and pistons, an equal number of pumping cylinders and pistons in alinement with said working cylinders, a stuffing box between each working cylinder and respective pump cylinder, a sleeve connecting each pair of pistons and working in one of said stuffing boxes, ports in said sleeves for admitting the charge from each pump to the respective working cylinder, a casing adapted to inclose all the back ends of the pumping cylinders, and means for admitting the explosive mixture to the pumping cylinders from said casing.

2. An internal combustion engine comprising a plurality of working cylinders and pistons, and an equal number of pumping cylinders and pistons in alinement with their respective working cylinders, a stuffing box between each working cylinder and respective pump cylinder, a sleeve connecting each pair of pistons and working in one of said stuffing boxes, ports in said sleeves, inlet ports in the walls of the pump cylinders, a casing adapted to inclose said inlet ports and all the back ends of the pumping cylinders, forming a single closed chamber which is in communication with the explosive mixture supply.

3. An internal combustion engine comprising a plurality of working cylinders and pistons, an equal number of pumping cylinders and pistons in alinement with said working cylinders, a stuffing box between each of said working cylinders and respective pump cylinder, a sleeve connecting each pair of pistons and working in one of said stuffing boxes, ports in said sleeves for admitting the charge from each pump to the respective working cylinder, and a casing adapted to inclose all the back ends of the pumping cylinders, an oil reservoir, connections between the oil reservoir and each pump chamber to maintain pressure in the said reservoir, a branched supply pipe leading from the oil reservoir to the casing over the back ends of the pumping cylinders, non-return valves in each branch of the supply pipe, a projection on each pump piston to raise said valves, a circular trough in each pump chamber, a dished stuffing box cap on each stuffing-box, a gutter leading from each trough to upper surfaces of the respective stuffing box caps, non-return valves in said connection between the oil reservoir and the pump chambers for returning surplus oil from each pump chamber to the reservoir, and means for admitting the explosive mixture to the pumping cylinders from said casing.

4. An internal combustion engine comprising a plurality of working cylinders and pistons, and an equal number of pumping cylinders and pistons in alinement with their respective working cylinders, a stuffing box between each working cylinder and respective pump cylinder, a sleeve connecting each pair or pistons and working in one of said stuffing boxes, ports in said sleeves, inlet ports in the walls of the pump

cylinders, a casing adapted to inclose said inlet ports and all the back ends of the pumping cylinders, forming a single closed chamber which is in communication with the explosive mixture supply, an oil reservoir, connections between the oil reservoir and each pump chamber to maintain pressure in the said reservoir, a branched supply pipe leading from the oil reservoir to the casing over the back ends of the pumping cylinders, non-return valves in each branch of the supply pipe, a projection on each pump piston to raise said valves, a circular trough in each pump chamber, a dished stuffing box cap on each stuffing box, a gutter leading from each trough to the upper surfaces of the respective stuffing box caps, and non-return valves in said connections between the oil reservoir and the pump chambers for returning surplus oil from each pump chamber to the reservoir.

5. An internal combustion engine comprising a plurality of working cylinders and pistons, and an equal number of pumping cylinders and pistons in alinement with their respective working cylinders, a stuffing box between each working cylinder and respective pump cylinder, a sleeve connecting each pair of pistons and working in one of said stuffing boxes, ports in said sleeves, inlet ports in the walls of the pump cylinders, and a casing adapted to inclose said inlet ports and all the back ends of the pumping cylinders, forming a single closed chamber which is in communication with the explosive mixture supply, said pumping piston being hollow and having ports therein, and said pumping cylinders having corresponding ports in the walls thereof communicating with the atmosphere, and tubes leading from the hollow pump pistons to the interior of the sleeves.

6. An internal combustion engine comprising a plurality of working cylinders and pistons, an equal number of pumping cylinders and pistons in alinement with said working cylinders, a stuffing box between each working cylinder and respective pump cylinder, a sleeve connecting each pair of pistons and working in one of said stuffing boxes, ports in said sleeves for admitting the charge from each pump to the respective working cylinder and a casing adapted to inclose all the back ends of the pumping cylinders, means for admitting the explosive mixture to the pumping cylinders from said casing, and means for admitting air to the interior of sleeves for scavenging.

7. An internal combustion engine comprising a plurality of working cylinders and pistons, an equal number of pumping cylinders and pistons in alinement with said working cylinders, a stuffing box between each working cylinder and respective pump cylinder, a sleeve connecting each pair of pistons and working in one of said stuffing boxes, ports in said sleeves for admitting the charge from each pump to the respective working cylinder, and a casing adapted to inclose all the back ends of the pumping cylinders, means for admitting the explosive mixture to the pumping cylinders from said casing, a casing within the lower portions of each sleeve and within each power piston, and means for circulating water between the casing and the sleeve or piston.

8. An internal combustion engine comprising a plurality of working cylinders and pistons, and an equal number of pumping cylinders and pistons in alinement with their respective working cylinders, a stuffing box between each working cylinder and respective pump cylinder, a sleeve connecting each pair of pistons and working in one of said stuffing boxes, ports in said sleeves, inlet ports in the walls of the pump cylinders, a casing adapted to inclose said inlet ports and all the back ends of the pumping cylinders, forming a single closed chamber which is in communication with the explosive mixture supply, a casing within the lower portions of the sleeve and within the power piston and means for circulating water between the casing and the sleeve or piston.

In witness whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

BALFOUR READ.

Witnesses:

ROBERT MILTON SPEARPOINT,

HERBERT D. JAMESON.