997,258.

F. X. BACHLE & J. C. L. KREBS.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED NOV. 11, 1909.

Patented July 11, 1911.

3 SHEETS—SHEET 1.

Fig. 1.

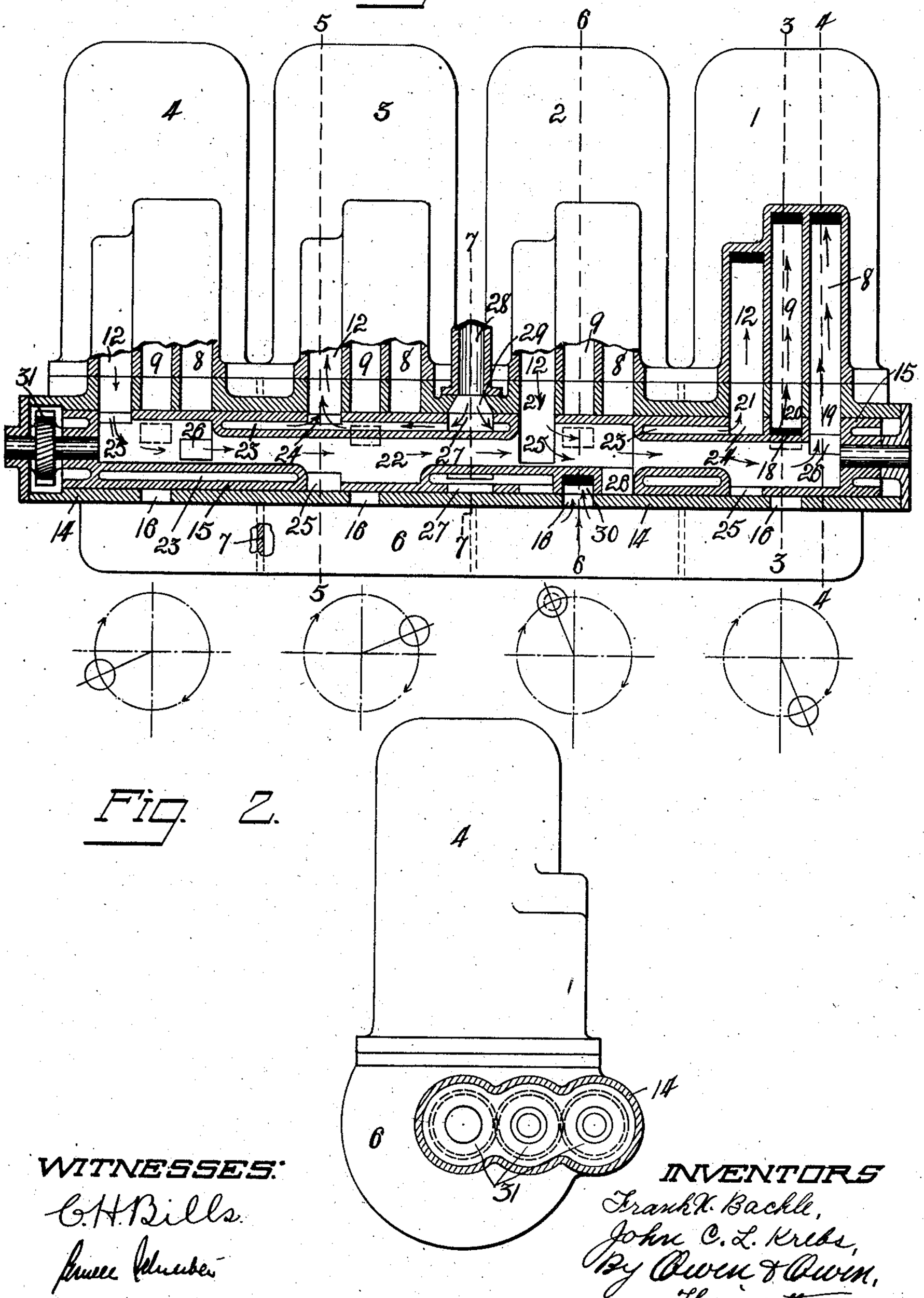

Fig. 2.

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3 SHEETS—SHEET 2.

Fig. 3.

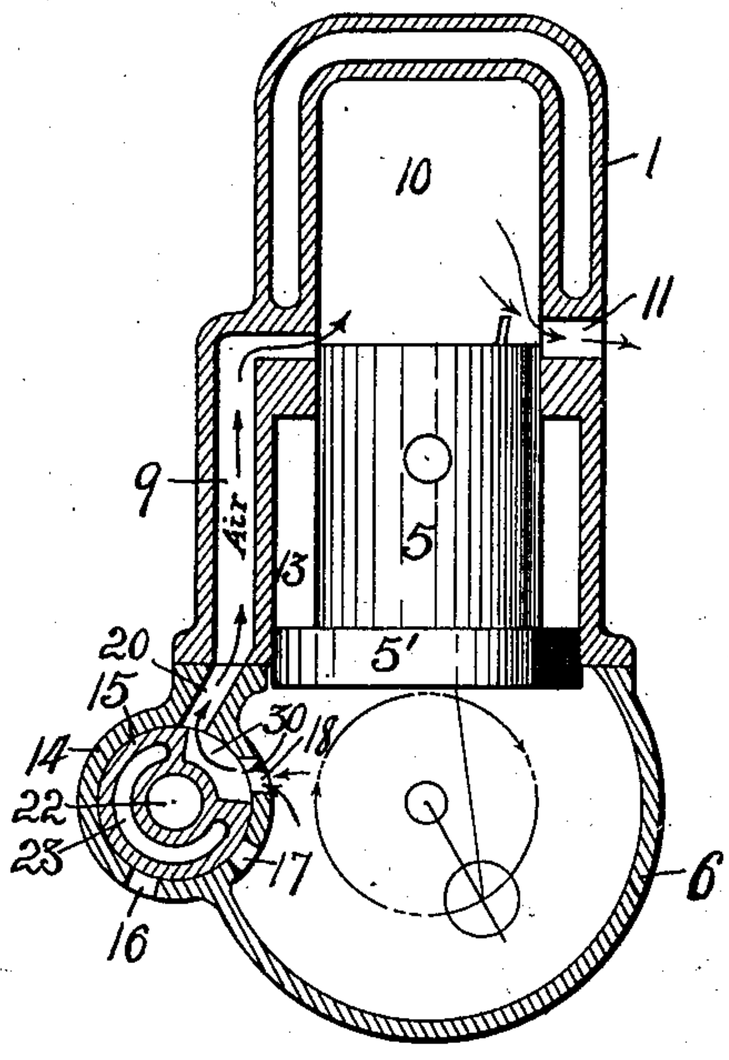


Fig. 4.

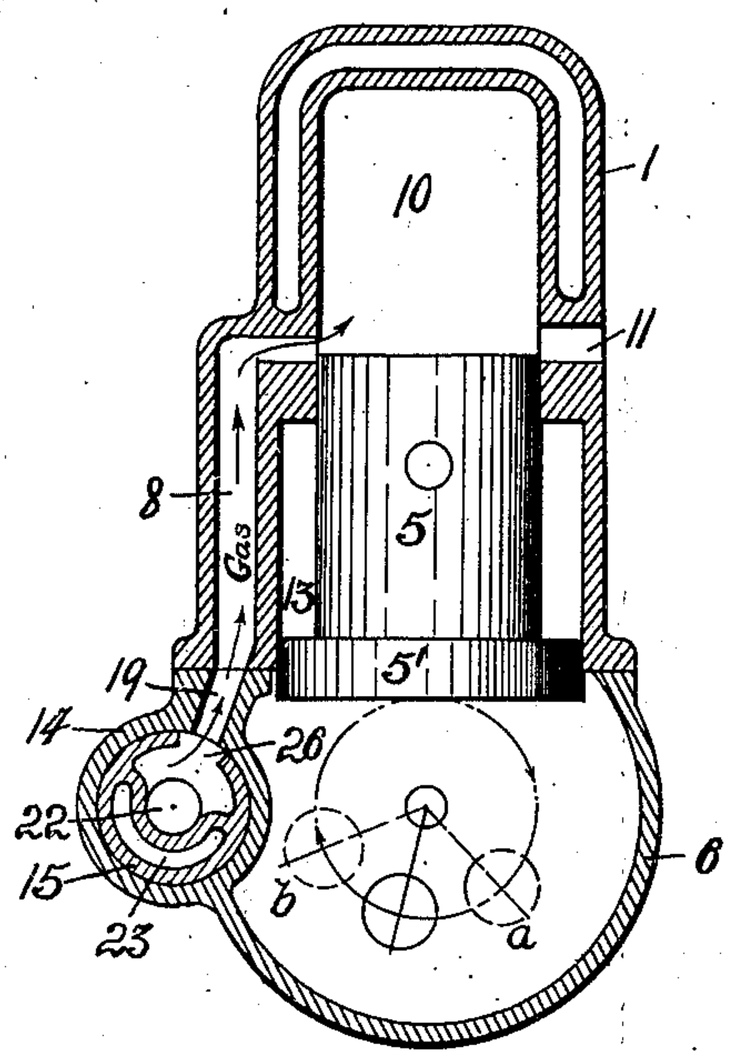


Fig. 5.

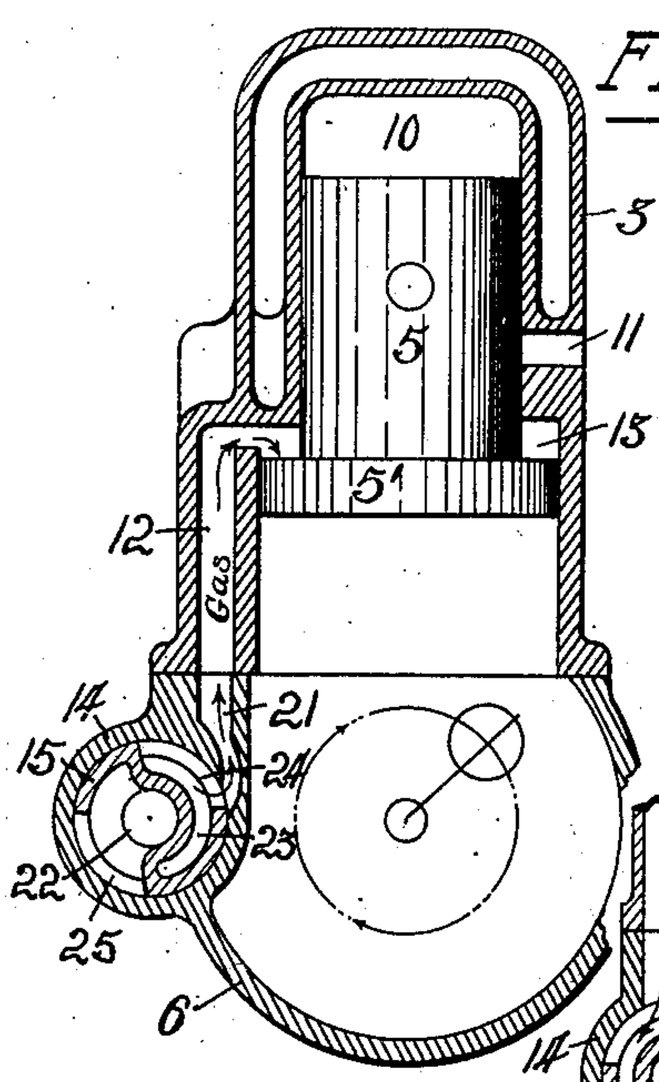


Fig. 7.

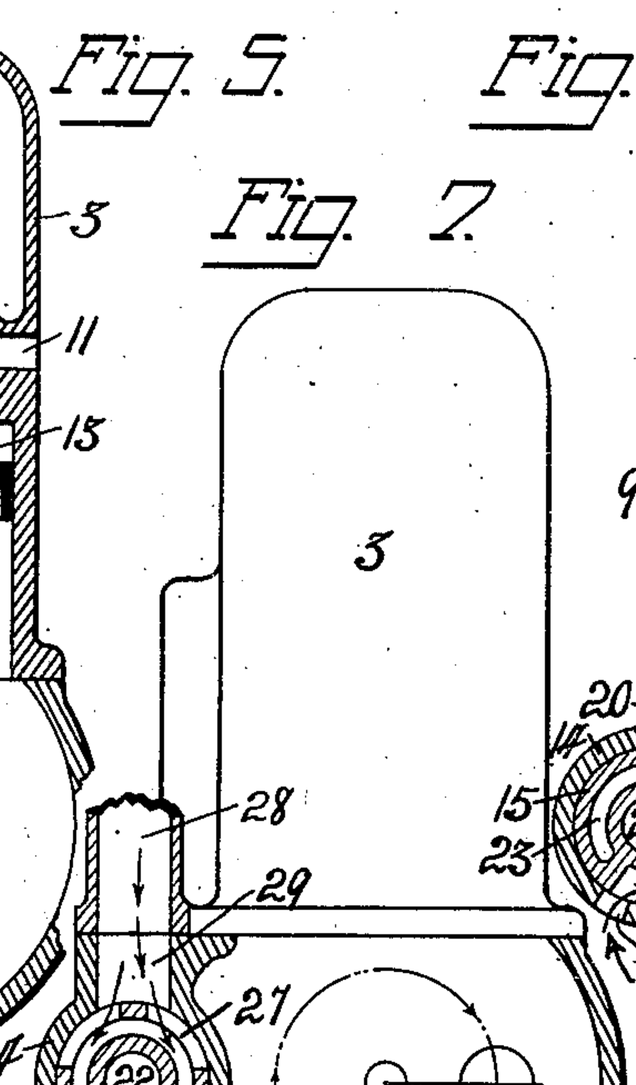
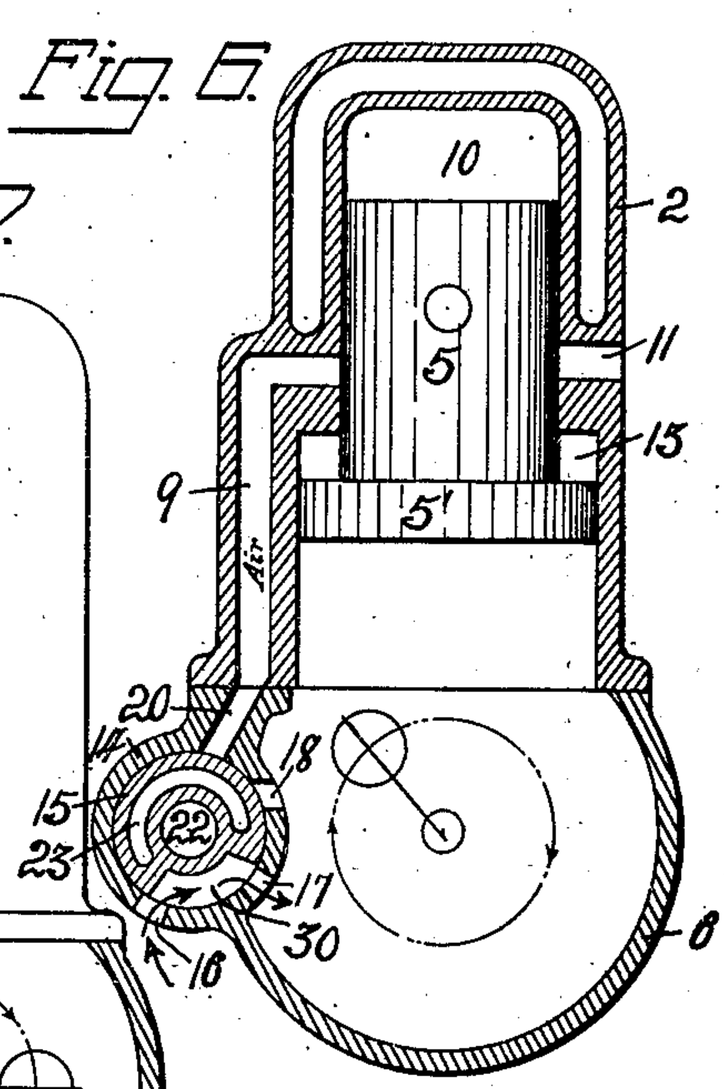


Fig. 6.



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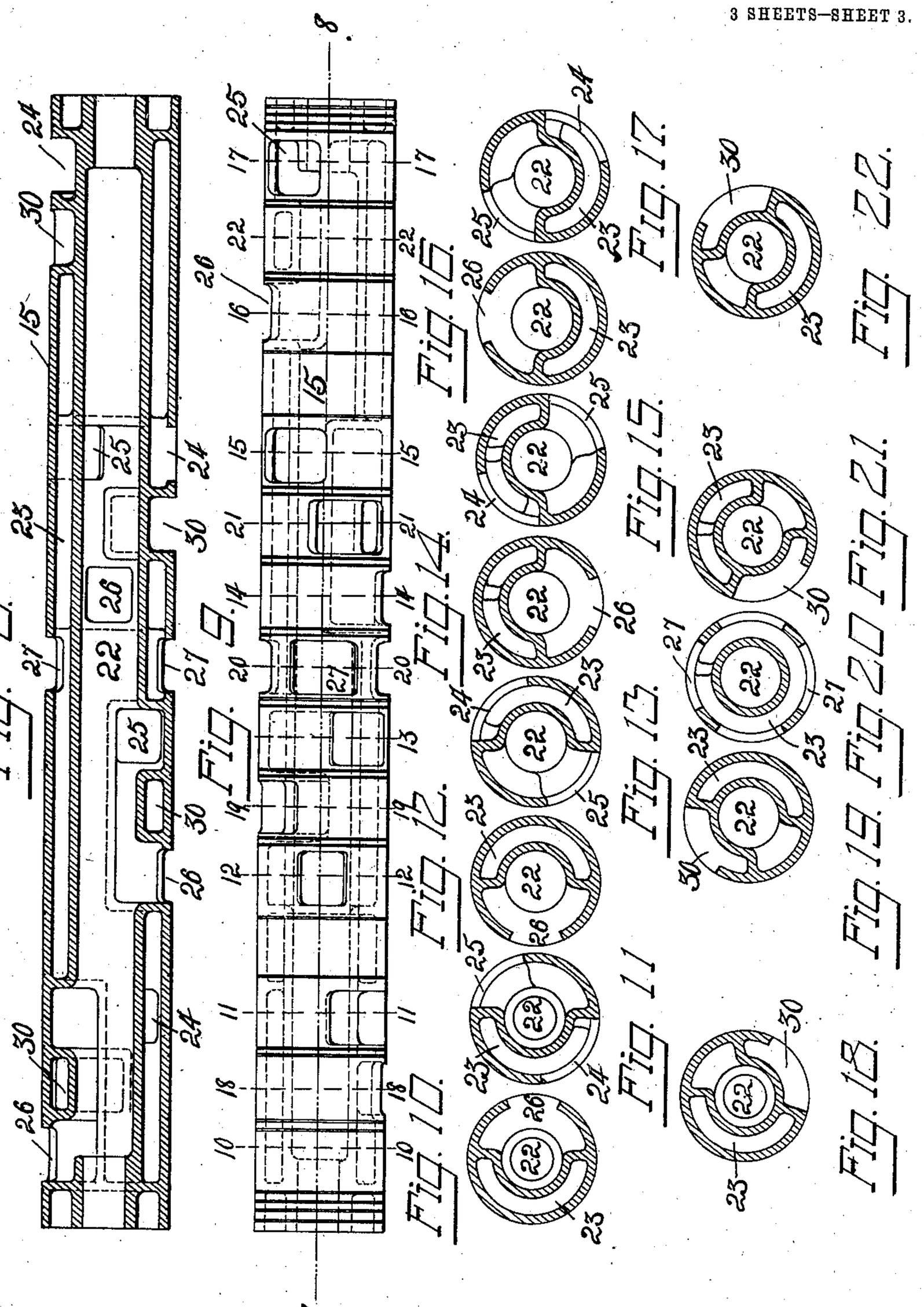
3 SHEETS—SHEET 3.



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UNITED STATES PATENT OFFICE.

FRANK X. BACHLE AND JOHN C. L. KREBS, OF CLYDE, OHIO.

INTERNAL-COMBUSTION ENGINE.

997,258. Specification of Letters Patent. Patented July 11, 1911.

Application filed November 11, 1909. Serial No. 527,560.

To all whom it may concern:

Be it known that we, FRANK X. BACHLE and JOHN C. L. KREBS, citizens of the United States, and residents of Clyde, in the county of Sandusky and State of Ohio, have invented a certain new and useful Internal-Combustion Engine; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the figures of reference marked thereon, which form a part of this specification.

Our invention relates to rotary valves for use in conjunction with multiple cylinder internal combustion engines, and is particularly applicable to engines of the two-cycle type, but is not restricted to use in such connection.

The primary object of our invention is to improve upon the apparatus covered by United States Letters Patent No. 880,958 granted jointly to us on March 3, 1908, by the provision therein of means for pumping a scavenging charge of air into each cylinder immediately prior to or during the pumping of a gas charge therein whereby to free the cylinder clearance of noncombustible or burned gases and thus increase the working efficiency of the engine.

Further objects of our invention will be apparent from the following description.

The operation, construction and arrangement of the parts of our invention are fully described in the following specification, and while the invention in its broader aspect is susceptible of embodiment in numerous forms, a preferred form of the same is illustrated in the accompanying drawings, in which,—

Figure 1 is a side elevation of a four-cylinder two-cycle engine with portions of the cylinders in section and with a diagrammatical longitudinal sectional view of an embodiment of our valve associated therewith, and also with the relative positions of the cranks indicated below the respective cylinders. Fig. 2 is an end view of the same. Figs. 3, 4, 5, 6 and 7 are vertical cross-sections on the lines 3—3, 4—4, 5—5, 6—6, and 7—7, respectively, in Fig. 1, with the section in Fig. 4 taken when the valve is slightly advanced from the position shown in Fig. 1. Fig. 8 is a central longitudinal section of the valve taken on the line 8—8 in Fig. 9. Fig. 9 is a side elevation of the valve, and Figs. 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21 and 22 are cross-sections taken, respectively, on the lines 10—10, 11—11, 12—12, 13—13, 14—14, 15—15, 16—16, 17—17, 18—18, 19—19, 20—20, 21—21, and 22—22 in Fig. 9.

Referring to the drawings, 1, 2, 3 and 4 designate in order from right to left the several cylinders of a two-cycle four-cylinder engine, 5 the piston operating therein, and 6 the crank-case, which is divided by partitions 7 into separate non-communicating compartments for each cylinder.

Each cylinder is provided in its walls with the ports or ducts 8 and 9 for gas and air, respectively, leading into the lower portion of the combustion chamber 10 thereof, with the exhaust port 11 leading from such chamber in the usual manner, and with the port or duct 12 leading to the upper end of the pumping-chamber 13 thereof. The pistons 5 are provided at their lower ends with enlargements 5′ which operate in the lower enlarged ends of the cylinders to coöperate therewith to form the pumping-chambers 13, and are connected by piston-rods to a crank-shaft in the usual manner, with the cranks of cylinders 1 and 2 on opposite sides of the shaft and at right angles to the opposing cranks of cylinders 3 and 4.

Formed lengthwise on the side of the crank-case 6 adjacent the ports 8, 9 and 12 is a housing or valve-case 14, which is provided with a longitudinal cylindrical chamber for receiving the rotary valve 15. This housing, for each cylinder or separate unit of the engine, is provided with a port 16 from the atmosphere to the interior thereof, the ports 17 and 18 leading, respectively, to and from the interior of each crank-chamber, and ports or passageways 19, 20 and 21, which respectively lead to and open communication between the interior of such housing and the cylindrical ports or ducts 8, 9 and 12, as best shown in Fig. 1, each set of ports 16, 17, 18 and 20 being arranged in a common plane successively around the housing, as best shown in Figs. 3 and 6.

The valve 15, which is circular in cross-section, is provided throughout its length with a central cylindrical chamber 22, and with a surrounding chamber 23, which two chambers for convenience may be termed gas-distributing and supply chambers, re-

spectively. Both ends of these chambers are closed.

A group of ports 24, 25 and 26 is provided in the valve for each cylinder, the ports 24 and 25 being arranged in circular series to successively register with the port 12—21 to the pumping-chamber 13 of the associated cylinder, while the port 26 is arranged to register with the port 8—19 to the combustion chamber 10 of the cylinder as the valve is rotated. The valve 15 also has a series of circularly arranged ports 27, shown in the present instance as being disposed centrally thereof which provide continuous communication between the supply-chamber 23 and a pipe 28 leading to the usual carbureter through the medium of the registering port 29 in the housing 14.

The ports 24 open communication with the supply-chamber 23 of the valve, being the discharging ports from such chamber, and are so relatively arranged that each registers with the port 12—21 of its cylinder on the down or out-going stroke of the associated piston, as shown in Fig. 5, to permit such piston to draw a charge into the associated pumping-chamber 13 from the carbureter through the supply-chamber 23; the ports 25 open communication with the distributing-chamber 22 and are so arranged that each registers with its port 12—21 on the up or compression stroke of the associated piston, as shown at the left of Fig. 1, to permit the charge in the pumping-chamber 13 of such cylinder to be forced into the distributing-chamber 22; and the ports 26 open communication with the distributing-chamber of the valve, and are so arranged that each registers with the port 8—19 to the associated cylinder during the period that the same is uncovered by its piston, as shown in Fig. 4, to admit a charge to the combustion end of the cylinder.

A notch or channel 30 is provided in the side of the valve 15 for each cylinder, and is adapted on a rotation of the valve to successively open communication between the crank-case port 18 and the cylinder port 9—20 as shown in Fig. 3, and the two ports 16 and 17 in the housing 14, as shown in Fig. 6. The notches or channels 30 have no communication with either of the chambers 22, 23 of the valve and are so relatively arranged that each opens communication between its ports 18 and 9—20 when the associated piston is uncovering its cylinder port 9—20 to admit a scavenging charge of air to the cylinder from the crank-chamber, and opens communication between the ports 16 and 17 when the associated piston is near the limit of its up or compression stroke to admit atmospheric-air to the crank-chamber.

The valve 15 is geared to rotate in unison with and at the same speed as the crank-shaft by a train of gears 31, see Figs. 1 and 2. These gears are preferably of the spiral type to facilitate an adjustment of the valve relative to the crank-shaft to admit a charge early or late as it may be desired to increase or reduce the speed of the engine.

The operation of our invention is as follows:—Assuming that the piston in No. 1 cylinder is near the end of its down or pumping stroke or just uncovering the gas and air ports 8 and 9 of such cylinder, the valve port 26 for such cylinder will be open to the gas charging port 8—19 to admit a charge which is being pumped into the distributing-chamber 22 of the valve from the pumping-chambers 13 of Nos. 2 and 4 cylinders on the upstrokes of their respective pistons, the valve port 25 of No. 2 cylinder being just about to close to its cylinder port 12—21 while the valve port 25 of No. 4 cylinder is just opening to its cylinder port 12—21, as shown in a diagrammatical way in Fig. 1, as a true central vertical section would not show all of the valve ports as indicated. It is thus seen that the charge compressed in No. 1 cylinder comprises the residue or last portion of the charge pumped from No. 2 cylinder and the major portion of the charge pumped from No. 4 cylinder. In like manner Nos. 2, 3 and 4 cylinders receive the major portions of their charges from the pumping chambers 13 of Nos. 3, 1 and 2 cylinders, respectively, and the residue of their charges from Nos. 1, 4 and 3, cylinders respectively, the valve ports of the several groups being properly arranged for such purpose. At the same time No. 1 cylinder is taking its charge it is also receiving a scavenging charge of air from the associated crank-chamber, due to the valve notch or channel 30 of such cylinder opening communication between the crank-chamber and the compression end of the cylinder through the medium of the ports 18 and 9—20. The notches 30 are preferably so arranged relative to the ports 26 of the associated group that the air charge is admitted to the cylinder slightly in advance of the gas charge. It is thus apparent that the crank-case compression of each cylinder is utilized to force the scavenging charges of air into its combustion chamber, instead of forcing the gas charges thereto as has heretofore been commonly the case. Gas is admitted to the compression end of each cylinder during the approximate movement of its crank between the points *a b* of its cycle, while the scavenging charge of air is admitted thereto slightly in advance of and during the first portion of such movement, see Figs. 3 and 4. A charge is also drawn into the pumping-chamber 13 of each cylinder on the down-stroke of its piston due to the associated valve port 24 moving into register with its cylinder port 21—12 and opening communi-

cation between such chamber and the valve supply-chamber 23 which is always in communication with the carbureter. On the upstroke of each piston, the associated valve port 25 moves into register with the pumping-port 21—12 of its cylinder to permit the gas drawn into the associated pumping-chamber 13 to be forced therefrom into the valve-chamber 22 to be distributed thereby to the proper cylinders. When a piston is near the completion of its up or compression stroke the associated valve notch 30 has moved to open communication with the ports 16 and 17 in the valve housing to admit air to the associated crank-chamber from the atmosphere, such air being quickly drawn into such chamber due to the vacuum created therein on the upstroke of the piston. This air is compressed in the crank-chamber on the down-stroke of the piston, and thereby caused to quickly rush into the compression end of the associated cylinder when it is liberated due to its valve notch 30 opening communication between said crank-chamber and the compression end of the cylinder through the ports 18 and 9—20.

It is apparent from the foregoing that on each down-stroke of a piston, the compression end of its cylinder is scavenged of all burned or non-combustible gas, a fresh gas charge is pumped therein by one or more of the other pistons of the engine, and a charge is drawn into the pumping-chamber 13 from the carbureter. Also that on each upstroke of a piston the charge in the upper end of its cylinder is compressed, the charge in the pumping-chamber 13 is forced into the valve distributing-chamber 22 and is directed thereby to the proper cylinders, and the scavenging charge of air is admitted to the associated crank-chamber.

It is evident that the invention may be employed in connection with an engine comprising two or more cylinders, as the cycle of operations of each group of valve ports will be approximately the same, but differently timed relative to the other groups to suit the number of cylinders employed.

We wish it understood that our invention is not limited to any specific construction or arrangement of parts and location and size of ports except in so far as such limitations are specified in the claims.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent, is,—

1. A multiple cylinder engine having its cylinders each provided with a pumping chamber, a combustion chamber and an air compressing chamber, the pumping chamber having one port leading thereto and the combustion chamber having two ports leading thereto, one of such two ports leading from the associated air compressing chamber, a rotary valve coöperating with said ports to admit gas to and from the pumping chambers and then to the combustion chambers through one of the ports of each combustion chamber, and to admit scavenging charges of air to each combustion chamber from its compression chamber, substantially as described.

2. A multiple cylinder two-cycle engine having its cylinders each provided with a combustion chamber, a gas pumping chamber, and an air compressing chamber, a single rotary valve disposed at a side of the engine and having a gas-supply chamber and a gas-distributing chamber, and having means for controlling the admission of air to the compression chambers, said engine having ports provided in the walls of said chambers which coöperate with the valve to control the admission of gas to each pumping chamber and from it to the combustion chamber of another cylinder, the admission of air to each compression chamber and the passage of a scavenging charge of air from each compression chamber to the associated combustion chamber at predetermined points in a cycle of operations of the machine, and means for operating the valve.

3. A multiple cylinder engine having its cylinders each provided with a pumping and a combustion chamber, the pumping chambers each having one port communicating therewith and the combustion chambers each having two ports communicating therewith, a rotary valve operative to control the passage of gas to and from each pumping chamber through its port and then to one of the combustion chambers through one of its ports, and means controlled by said valve for admitting scavenging charges of air to the combustion chambers through the other ports thereof, substantially as described.

4. A multiple cylinder engine having its cylinders each provided with a pumping and a combustion chamber, said chambers each having a gas port communicating therewith, and the combustion chambers each having an air port, a rotary valve having a series of ports in communication with a source of fuel supply and adapted to successively register with the different pumping chamber ports as the valve is rotated and also having a distributing chamber provided with a double series of ports, one series of which registers with the pumping chamber ports and the other with the combustion chamber gas ports when the valve is rotated, said valve also having portions channeled to control the admission of a scavenging charge of air to each cylinder through its air port, and means for operating the valve.

5. A multiple cylinder engine having its cylinders each provided with a pumping and a combustion chamber, the former having a gas port communicating therewith and the latter having a gas port and an air port

communicating therewith, a rotary valve forming a distributing chamber and having a series of ports for each cylinder operative to open communication between the pumping chamber and a fuel supply, the pumping chamber and said distributing chamber, and the distributing chamber and the combustion chamber at predetermined points in a rotation of the valve, said valve also having passages which permit the intermittent admission of scavenging air to each combustion chamber through its air port, and means for operating the valve.

6. A multiple cylinder engine having its cylinders each provided with a pumping and a combustion chamber, the former having a gas port and the latter having a gas port and an air port, a rotary valve forming a distributing chamber and having a series of ports for each cylinder operative at predetermined points in the rotation of the valve to open communication between the pumping chamber and a source of fuel supply between the pumping chamber and said distributing chamber, and between the distributing chamber and the combustion chamber, said valve being also provided with means to control the admission of scavenging air to each combustion chamber through its air port at a predetermined point in the rotation of the valve, means for forcing said air charge into the combustion chamber, and means for operating the valve.

7. A multiple cylinder engine having its cylinders each provided with a pumping and a combustion chamber, ports leading to said chambers, a rotary valve coöperating with said ports to control the admission of gas to and from the pumping chamber and to the combustion chamber of each cylinder, a crank case forming a crank chamber for each cylinder, said crank chamber and the associated combustion chamber having a communicating passage and said crank chamber having a passage in communication with the atmosphere, said valve being associated with such passages and having means acting to control the admission of air to each crank chamber and the discharge of air from each crank chamber to its combustion chamber, substantially as described.

8. A multiple cylinder engine having its cylinders each provided with a pumping and a combustion chamber and ports leading to such chambers, air pumping means in communication with the combustion chambers, a rotary valve for controlling the passage of gas through said ports to and from the pumping chambers and to the combustion chambers and the admission of a scavenging charge of air to each combustion chamber from said pumping means, and means for operating said valve.

9. A multiple cylinder engine having its cylinders each provided with a pumping and a combustion chamber, a gas port for each of such chambers and an air port for each combustion chamber, a rotary valve for controlling the passage of gas to the pumping chambers through their gas ports, the passage of gas from the pumping chambers to the combustion chambers through the gas ports of such chambers, and the passage of air through said air ports to the combustion chambers, and means for rotating the valve.

10. A multiple cylinder two cycle engine having its cylinders each provided with a combustion chamber having two ports leading thereto and with an air compressing chamber having an exit port, a single valve for controlling the admission of gas through one port of each combustion chamber and the admission of air through the other port of each combustion chamber from the associated compression chamber at predetermined intervals, and means for operating the valve.

11. A multiple cylinder two cycle engine having its cylinders each provided with a combustion chamber and a plurality of ports leading thereto, air pumping means in communication with each chamber through one of its ports, gas supply means in communication with each chamber through the other of its ports, a single valve coöperating with said ports to control the admission of gas and air to the several combustion chambers at predetermined intervals, and means for operating the valve.

12. A multiple cylinder engine having its cylinders each provided with a gas pumping and a combustion chamber each having a port in communication therewith and each combustion chamber having communication with a source of air supply, a rotary member adapted to coöperate with said ports at different periods in a rotation thereof to open communication between the pumping chambers and a source of gas supply, between each pumping chamber and the combustion chamber of another cylinder, and having means for opening communication between each combustion chamber and its source of air supply at predetermined intervals, and means for rotating said member.

13. A multiple cylinder engine having its cylinders each provided with a gas pumping and a combustion chamber each having a port communicating therewith and each combustion chamber having a port in communication with a source of air supply, a rotary valve associated with the cylinders and having a gas supply chamber in communication with a source of gas supply and a gas distributing chamber, and adapted when rotated to successively open communication between the pumping chambers and said supply chamber, also to successively open communication through said distributing chamber between the pumping and combustion chambers, the communicating pump-

ing and combustion chambers being disposed in different cylinders, and to admit air to the combustion chamber of each cylinder to scavenge the same, and means for rotating such valve, substantially as described.

14. In a multiple cylinder two cycle engine, the combination with the several cylinders each having a pumping and a combustion chamber therein and ports leading thereto, of a member having a gas supply chamber provided with ports for intermittently registering with the pumping chamber ports and a gas distributing chamber having ports for intermittently registering with the pumping chamber ports and for intermittently registering with the combustion chamber ports when said member is moved, said member also having means for controlling the admission of scavenging air to the combustion chamber of each cylinder through one of its ports, a source of gas supply, said supply chamber having communication intermediate its ends with said source of gas supply, and means for moving said member.

15. In a multiple cylinder engine, the combination with the several cylinders each having a pumping and a combustion chamber therein and air compressing means associated therewith said chambers and means having ports communicating therewith, of a rotary member having a gas supply chamber, and a gas distributing chamber, a source of gas supply in lateral communication with the supply chamber intermediate its ends, said member having a series of ports for each cylinder which operate to open communication between said supply and pumping chambers, said pumping and distributing chambers, said compressing means and combustion chambers, and said distributing and combustion chambers at predetermined points in a rotation of said member, and means for rotating said member.

16. In a multiple cylinder engine, the combination with the several cylinders each having a pumping and a combustion chamber, and air suction and compressing means with ports leading to said pumping chamber and means and a plurality of ports leading to the combustion chamber, of a rotary valve having a supply chamber in lateral communication with a source of gas supply and from which the charges of the several cylinders are successively drawn to the pumping chambers through the ports leading thereto, said valve also having a distributing chamber located within the supply chamber and into which the charges are forced from the pumping chambers through their ports and then delivered to predetermined ones of the combustion chambers through less than the full number of ports leading thereto, and having means for admitting air to the compressing means and from the compressing means to the associated combustion chambers through a portion of the ports leading to such chambers at predetermined points in a cycle of operation, and means for rotating the valve.

17. In a multiple cylinder engine, the combination with the several cylinders each having a pumping chamber with at least one port leading thereto and a combustion chamber and with a plurality of ports leading thereto, of a valve member having a gas supply chamber in communication with a source of gas supply and from which the charges of the several cylinders are successively drawn into the pumping chambers thereof through the pumping chamber ports, said member also having a distributing chamber into which the charges are successively forced from the pumping chambers of the cylinders through the pumping chamber ports and delivered to the combustion chambers of cylinders other than those forcing charges into said member through at least one of the combustion chamber ports, and said member also having means for controlling the admission of scavenging charges of air to the several cylinders through the remainder of the combustion chamber ports.

18. A multiple cylinder engine having each of its cylinders of two different diameters and provided with a crank case compression-chamber, a piston working in each cylinder and having portions of two different diameters to correspond to the different diameters of the cylinders whereby to divide the cylinders into combustion and pumping chambers, separate air and gas ports leading to each combustion-chamber, the former from the associated compression-chamber, a gas port leading to each pumping chamber, a rotary valve for controlling the admission of gas to and from the pumping chambers and to the combustion-chambers and the admission of air from the compression-chambers to the combustion-chambers at predetermined intervals, and means for operating the valve.

19. In an internal combustion engine, the combination of a plurality of working cylinders, a plurality of pump cylinders, a plurality of crank chambers, a valve chamber common to all of said cylinders and said crank chambers and having passages leading to each of said cylinders and said crank chambers, and rotary means arranged in said valve chamber for controlling all of said passages.

20. In an internal combustion engine, the combination of a plurality of working cylinders, a plurality of pump cylinders, a plurality of crank chambers, a valve chamber common to all of said cylinders and said crank chambers and having passages leading to each of said cylinders and said crank

chambers, and a single rotary valve arranged in said chamber for controlling all of said passages, said valve having inner and outer chambers one serving as a gas supply chamber and the other as a gas distributing chamber.

In testimony whereof, we have hereunto signed our names to this specification in the presence of two subscribing witnesses.

FRANK X. BACHLE.
JOHN C. L. KREBS.

Witnesses:
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JOHN C. LETSON.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."