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

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED FEB. 8, 1912.

1,115,481.

Patented Nov. 3, 1914.

2 SHEETS—SHEET 1.

Fig. 1.

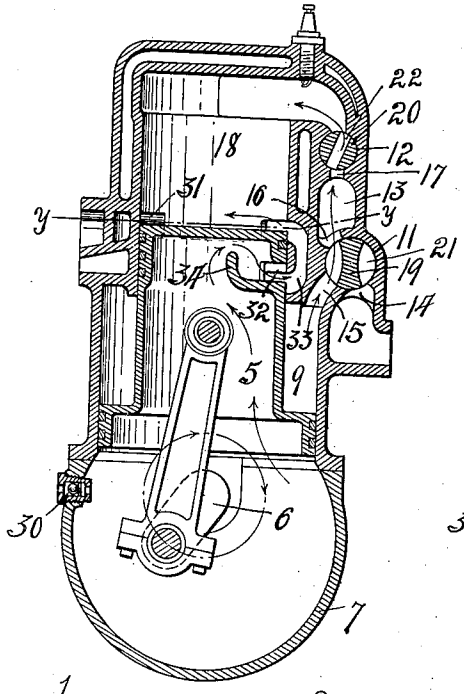
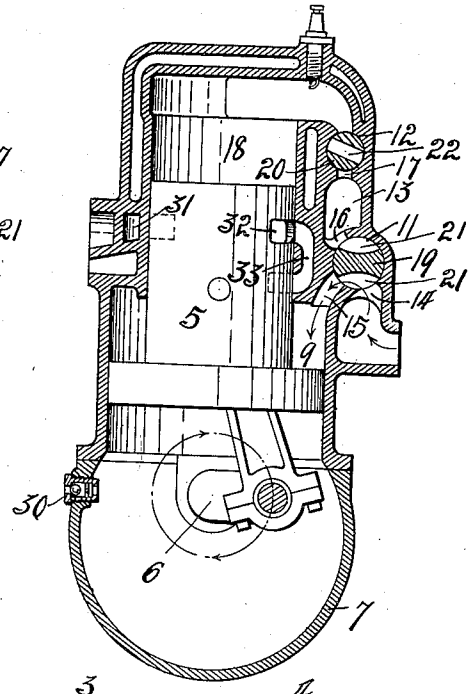


Fig. 2.



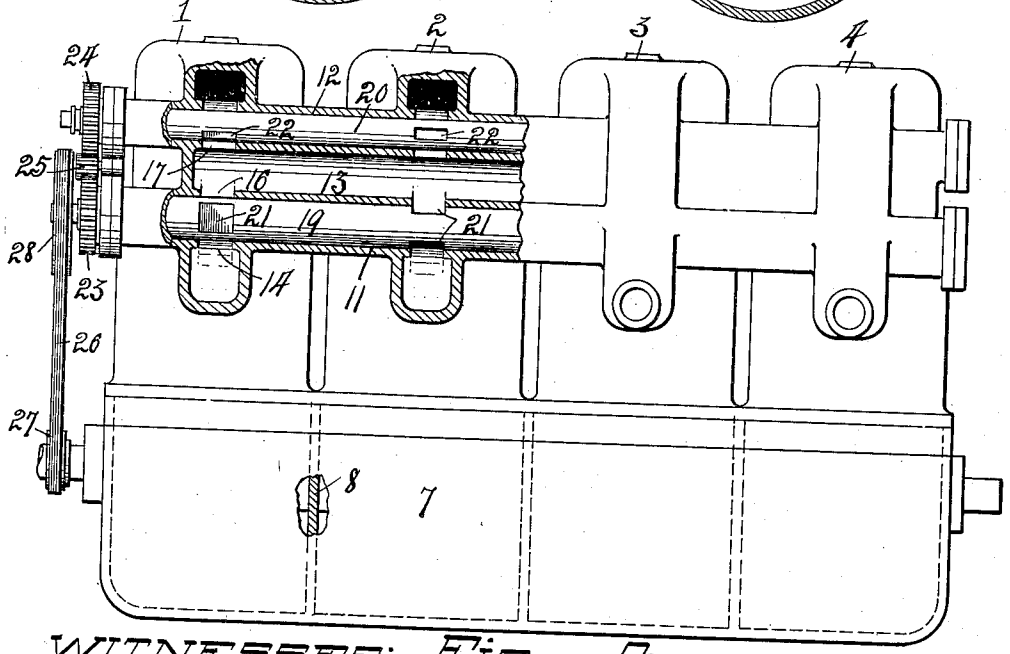


Fig. 3.

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2 SHEETS—SHEET 2.

Fig. 4.

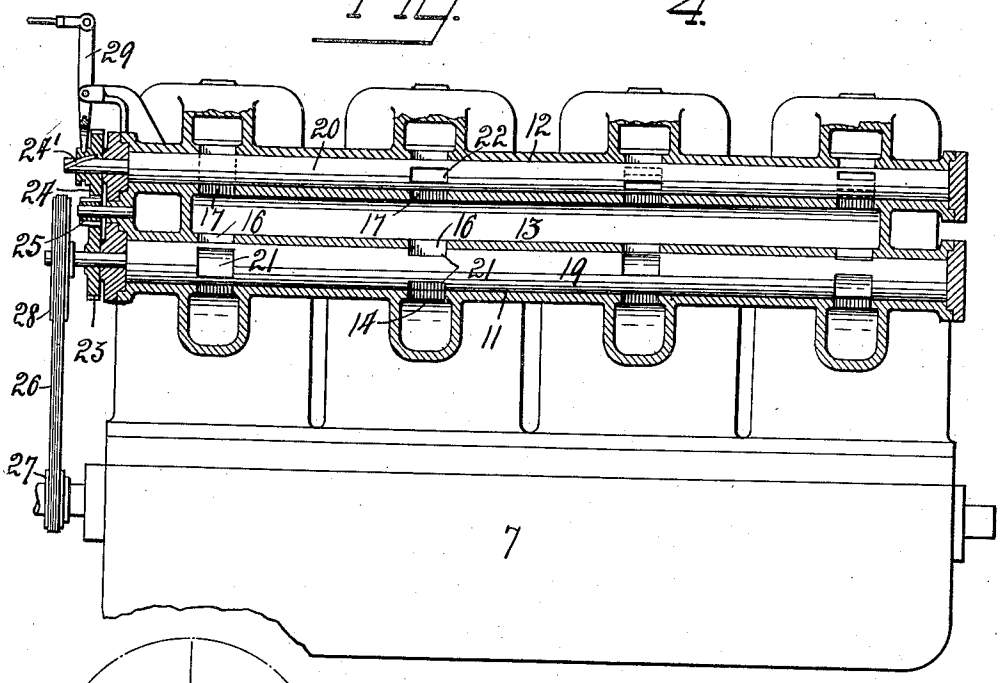


Fig. 5.

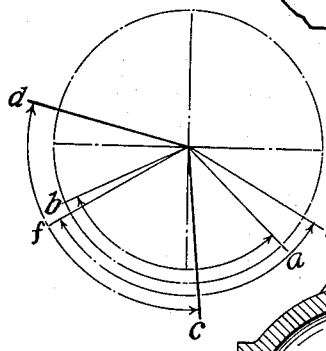
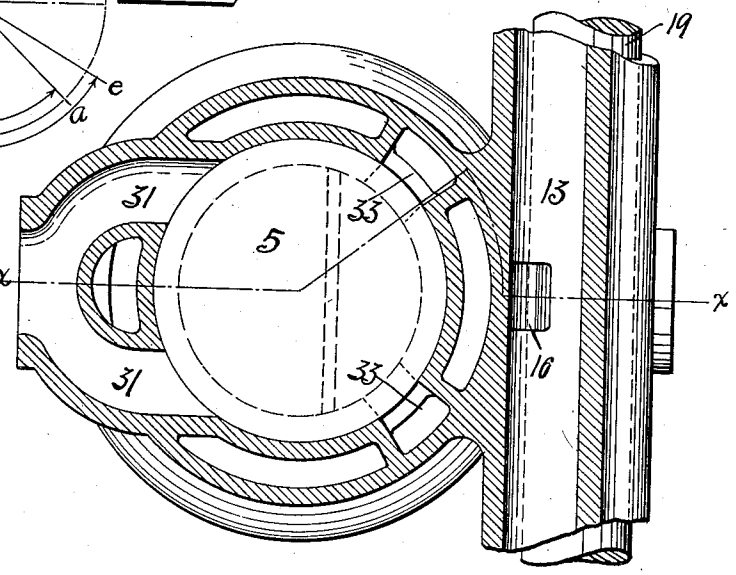


Fig. 6.



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UNITED STATES PATENT OFFICE.

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

INTERNAL-COMBUSTION ENGINE.

1,115,481. Specification of Letters Patent. Patented Nov. 3, 1914.

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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 internal combustion engines, and particularly to that class of engines of the two cycle type.

The object of our invention is the provision of improved charge pumping, distributing and controlling means in engines of this character, whereby the working and power efficiency thereof is materially increased, and the fuel consumption, when the engine is running idle or under a light load is reduced to a minimum.

The invention is fully described in the following specification, and while, in its broader aspect, it is capable of embodiment in numerous forms, a preferred embodiment thereof is illustrated in the accompanying drawings, in which,—

Figures 1 and 2 are vertical sections through a cylinder of an engine embodying the invention, on substantially the line *x x* in Fig. 5, with the movable parts in different positions. Fig. 3 is a side elevation of a four-cylinder two-cycle engine embodying the invention, with a part of the valve casing and gas distributing chamber in section. Fig. 4 is a similar view thereof with the valve casing and gas distributing chamber entirely in section. Fig. 5 is an enlarged cross-section on the line *y y* in Fig. 1, and Fig. 6 is a diagram showing the periods of opening of the gas inlet and exhaust ports for full load and idle running.

Referring to the drawings, 1, 2, 3 and 4 designate in order from left to right the several cylinders of a four-cylinder two-cycle engine, 5 the piston of each, 6 the crank-shaft, the crank-arms of which are connected to the respective pistons, and 7 the crank-case, which is divided by partitions 8 into separate non-communicating compartments, one for each cylinder. Each piston has its lower or inner end enlarged and working in a correspondingly enlarged portion of its cylinder to coöperate therewith to form a pumping chamber 9, as is well understood in the art.

On one side of the cylinders lengthwise of the engine is a casing, in the present instance being shown as cast integral therewith, which forms the superimposed cylindrical valve-chambers 11 and 12, and the interposed charge-distributing-chamber 13.

The chamber 11, for each cylinder of the engine, has a set of ports or passages 14, 15 and 16, the ports 14 leading to the chamber from any suitable source of fuel supply, the ports 15 opening communication between the valve-chamber and respective pumping-chambers 9, and the ports 16 leading from the chamber 11 to the distributing-chamber 13, which latter is common to all the ports 16. The valve-chamber 12 has a port or passage 17 opening communication therethrough between the distributing-chamber 13 and the outer end portion of the combustion-chamber 18 of each cylinder to permit the passage of charges from one to the other thereof.

Mounted in the valve-chambers 11 and 12 for rotation therein are the valves 19 and 20, respectively, the former of which may be termed the "pump-valve", and the latter the "distributing valve". The valve 19 is shown in the present instance, as being provided in opposite sides thereof, in register with each set of ports 14, 15 and 16, with a transverse notch or recess 21, each of which, upon a revolution of the valve, successively opens communication between the associated ports 14 and 15 and then the ports 15 and 16, to permit the inlet of charges to the pumping-chambers 9 upon the down or out strokes of the respective pistons, and the forcing of charges from the pumping-chambers to the distributing chamber 13 upon the up or in strokes of the respective pistons. The valve 20 has a single passage or port 22 provided therethrough for each cylinder, which port at each half revolution of the valve, opens communication between the distributing-chamber 13 and associated cylinder-chamber 18 through the registering port 17, as is apparent.

The valves 19 and 20 are provided without the casing at one end thereof with like gears 23 and 24, respectively, which are caused to rotate in unison in the same di-

rection by an interposed idler gear 25. A chain 26 connects sprocket-wheels 27 and 28 on the crank-shaft and end of the valve 19, respectively, such pulleys being of suitable proportion, in the present instance, to communicate a half revolution to each valve from a complete revolution of the crank-shaft. It will be understood, however, that the relative speed of running of the crank-shaft and valves in a two-cycle engine depends upon the number of notches or recesses 21 provided in the valve 19 for each cylinder, and the arrangement of the ports 14, 15 and 16, as a notch 21 is intended to open communication both between the associated ports 14 and 15 and the ports 15 and 16 at each revolution of the crank-shaft.

It is preferable in practice to time the opening of the inlet ports to the respective cylinders when operating under full load so that such ports will be open during approximately the portion *a*—*b* of a revolution of the respective crank relative to the period of opening of the associated exhaust port, which takes place during approximately the portion *e*—*f* of a revolution of the crank, see Fig. 6, while when operating under no load the period of opening of the inlet ports will be retarded to take place approximately during the portion *c*—*d* of a revolution of the respective cranks.

In order to provide for a variable compression of the charges and an admission of the charges to the cylinders in variable quantities as an idle or full load running of the engine may require, I make the distributing-valve 20 rotatively adjustable relative to the valve 19, by any suitable means as hereinafter described, to permit an early or late admission of the charges to the cylinders for such purpose.

Upon a later opening of the distributing valve ports to the cylinders than is required for full load running, the amount or quantity of the charges admitted to the cylinders will be reduced in proportion to the lateness of such opening, as a charge will cease to flow into a cylinder when the compression within the cylinder occasioned by the upstroke of the associated piston equals or becomes greater than the compression or charge feeding force within the distributing-chamber 13. It is thus apparent that the greater the compression within the respective cylinders at the time of opening of the gas inlet ports thereto the less will be the charges pumped therein, and also that if the inlet ports are still open when the pressure in the respective cylinders overcomes that in the distributing-chamber 13, portions of the charges which have been forced into the cylinders will be forced back into such chamber, so that the engine will run under very light charges. It is evident that this advancing and retarding of the time of opening of the distributing-valve ports to the respective cylinders permits of a variable compression of the charges both in the distributing-chamber and the combustion-chambers of the cylinders, as a late opening of the valve-ports will cause a greater compression of the gases within the distributing chamber and a less compression thereof within the cylinders, while an early opening of the ports will admit charges in greater volume to the cylinders and effect a greater compression of such gases due to the greater length of the compression strokes of the respective pistons after the closing of the inlet ports.

The means shown in the present instance for accomplishing an adjustment of the distributing valve 20 relative to the pumping valve 19 for advancing or retarding the periods of opening of the inlet ports to the respective cylinders consists in making the gear 24 longitudinally shiftable upon a spiral feather 24′ as shown in Fig. 4 and making the idler gear 25 of sufficient length to accommodate the shifting movements of the gear 24. A shift-lever 29 may be fulcrumed to a convenient part of the cylinder casing and have its inner end in forked engagement with a peripheral groove in the hub of the gear 24 for shifting the gear.

The scavenging air, which is drawn into each crank case chamber through a valve 30 upon the instroke of the associated piston, is compressed therein during the down stroke of the piston and is liberated to the combustion end of the associated cylinder in opposition to the exhaust ports 31 therein, during approximately the period of opening of such ports, through a port 32 in the piston and a port or ports 33 in the cylinder wall. The pistons 5, which are of hollow construction have their ports 32 located adjacent their inner ends, while the ports 33 are shown as having their outlet ends branched and opening into the cylinders in opposition to the exhaust ports and as having their inlet ends disposed in position to register with the piston ports 32 during the exhaust period.

In order to cause the scavenging air in its passage from each crank-chamber to have contact with the inner end wall of the piston for the purpose of cooling the same, a deflecting wall or flange 34 is formed within each piston in position to deflect the air in its outward passage against each piston end. The placing of the outlet ends of the ports 33 in opposition to the exhaust ports 31 causes the scavenging air to rush across the tops of the pistons to serve both to cool the inner piston ends and to effectually clear the combustion chamber of burned gases.

It is to be understood that while we have

illustrated the features of our invention in connection with a four-cylinder two-cycle engine a lesser or greater number of cylinders can be used if desired, and also that we do not limit our invention to any specific construction of the parts or arrangement or times of opening and closing of the 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. In a multiple cylinder two-cycle engine, a charge-distributing chamber common to all of the cylinders, pistons working in the cylinders and operable to draw charges from a source of supply and force them into said chamber, a single rotary valve intermediate said chamber and the cylinders for controlling the admission of charges to the cylinders and being adjustable to regulate the time of admission of such charges, and means for driving the valve.

2. In a multiple cylinder two-cycle engine, a charge-distributing chamber common to the combustion ends of all of the cylinders, pistons working in the cylinders and operable to pump charges from a source of supply and into said chamber during a running of the engine, valve means for controlling the pumping of said charges into said chamber, and rotary valve means for controlling the admission of charges to the combustion ends of the cylinders and being adjustable to regulate the time of admission of such charges.

3. In a multiple-cylinder two-cycle engine, a charge-distributing chamber common to all of the cylinders, pistons working in the cylinders, a crank shaft driven by said pistons, means coöperating with the pistons for controlling the pumping of charges from a source of supply into said chamber, rotary means for controlling the admission of charges to the combustion ends of the respective cylinders from said chamber, said means being adjustable to regulate the time of admission of such charges to the cylinders, and means for communicating rotation from the crank shaft to said rotary means.

4. In a multiple-cylinder internal combustion engine having its cylinders provided with pumping and combustion chambers, a charge-distributing chamber common to all of said cylinder chambers, a rotary valve for controlling the admission of charges to the pumping chambers of the several cylinders from a source of supply and the admission of charges from the pumping chambers to the distributing chamber, a rotary valve for controlling the admission of charges to the combustion chambers from said distributing chamber, said latter valve being adjustable to regulate the time of admission of charges to the cylinders, and means for driving said rotary valves in unison.

5. In an internal combustion engine, a cylinder, a compound piston working within the cylinder and coöperating therewith to form a combustion-chamber and a pumping-chamber, means for conducting a gaseous fluid from a source of supply to the pumping-chamber and from the pumping-chamber to the combustion-chamber, a valve operable to open communication between the source of fluid supply and the pumping-chamber during a portion of the movement of the engine and to open communication between the pumping and combustion chambers during another portion of the movement of the piston, a second valve operable to open communication between the pumping and combustion chambers during a portion of the movement of the piston, and means for operating said second valve and adjustable to regulate the time of opening of the communication between the pumping and combustion-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:
J. O. SCHELL,
A. H. WICKS.