W. I. TWOMBLY.

INTERNAL COMBUSTION ENGINE.

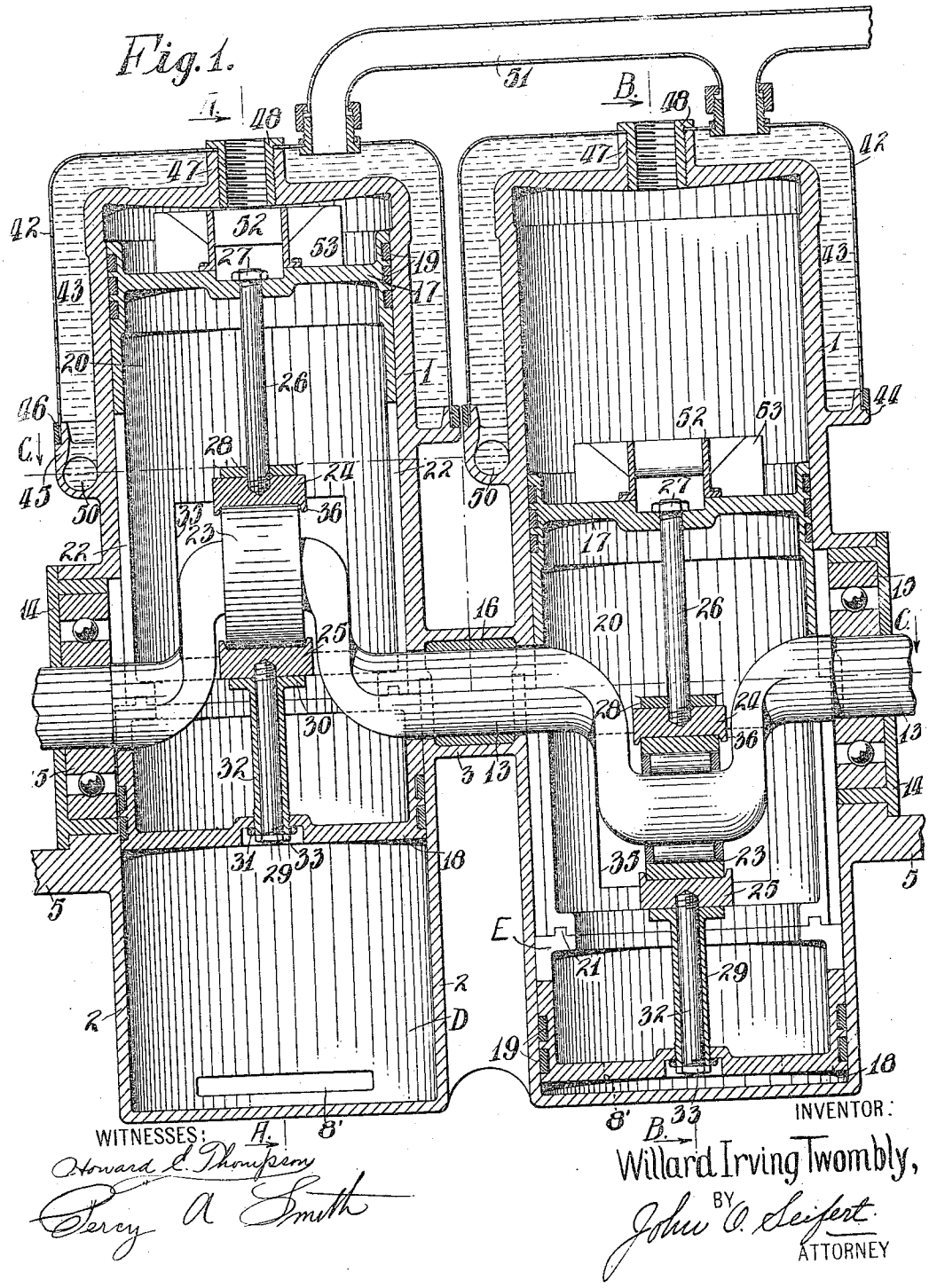
APPLICATION FILED OCT. 5, 1910.

Patented Oct. 29, 1912

1,042,505.

4 SHEETS—SHEET 1.

Fig. 1.



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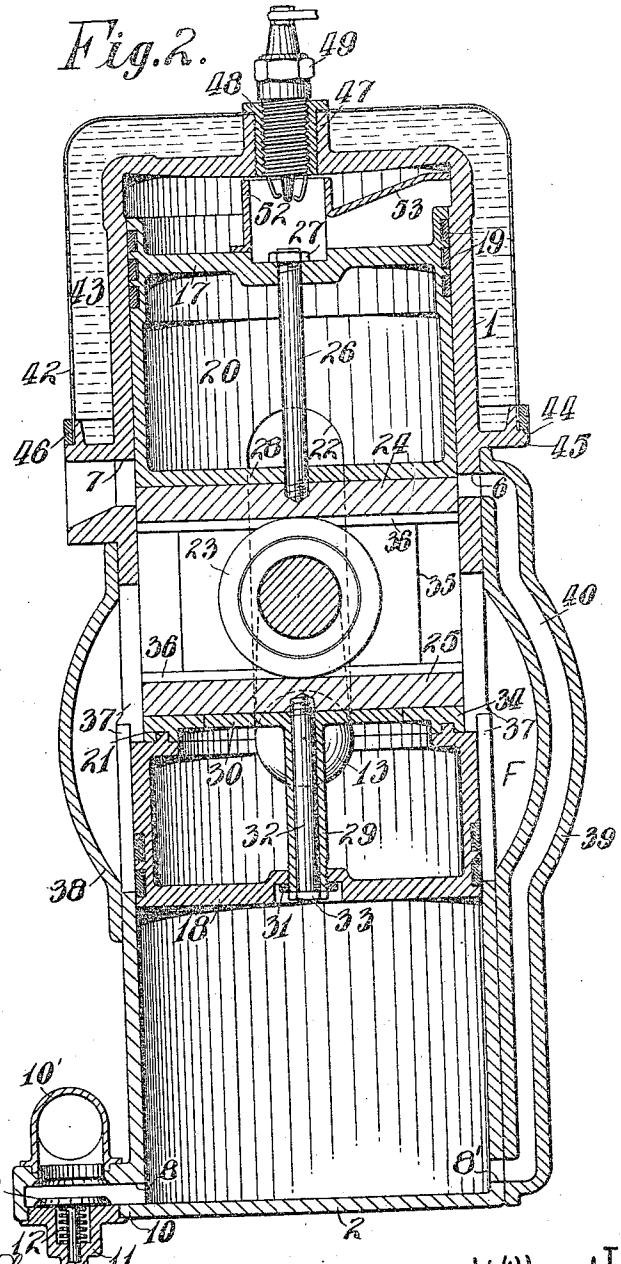
4 SHEETS—SHEET 2.

Fig. 2.



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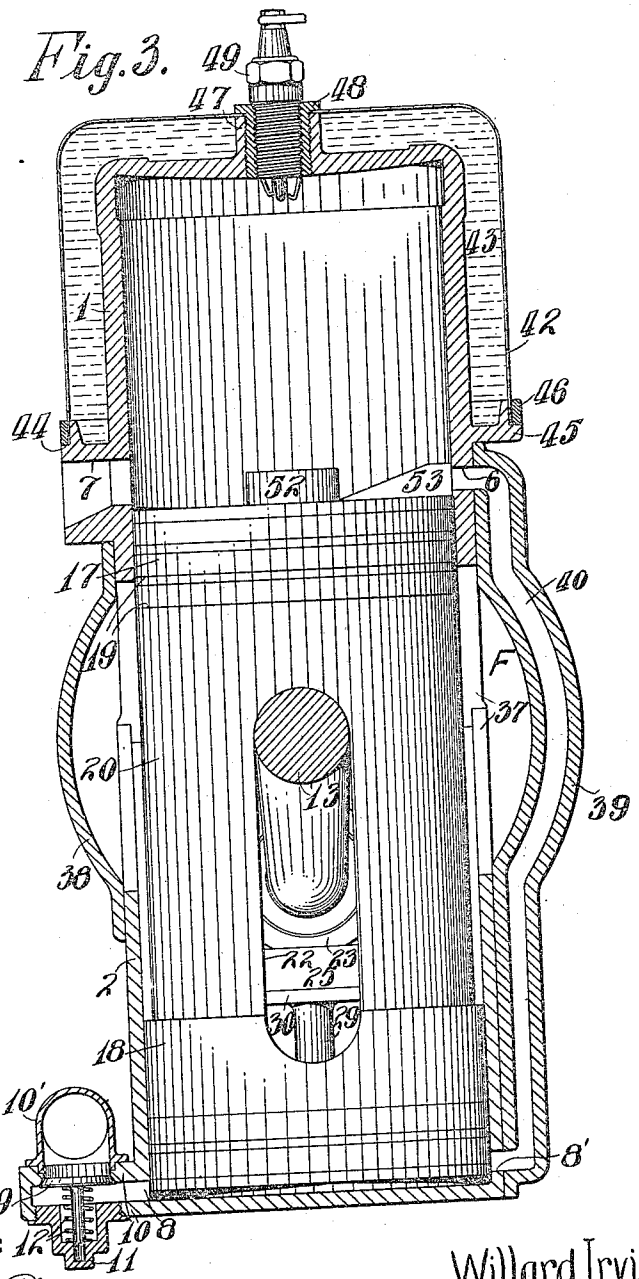
4 SHEETS—SHEET 3.

Fig. 3.



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4 SHEETS—SHEET 4.

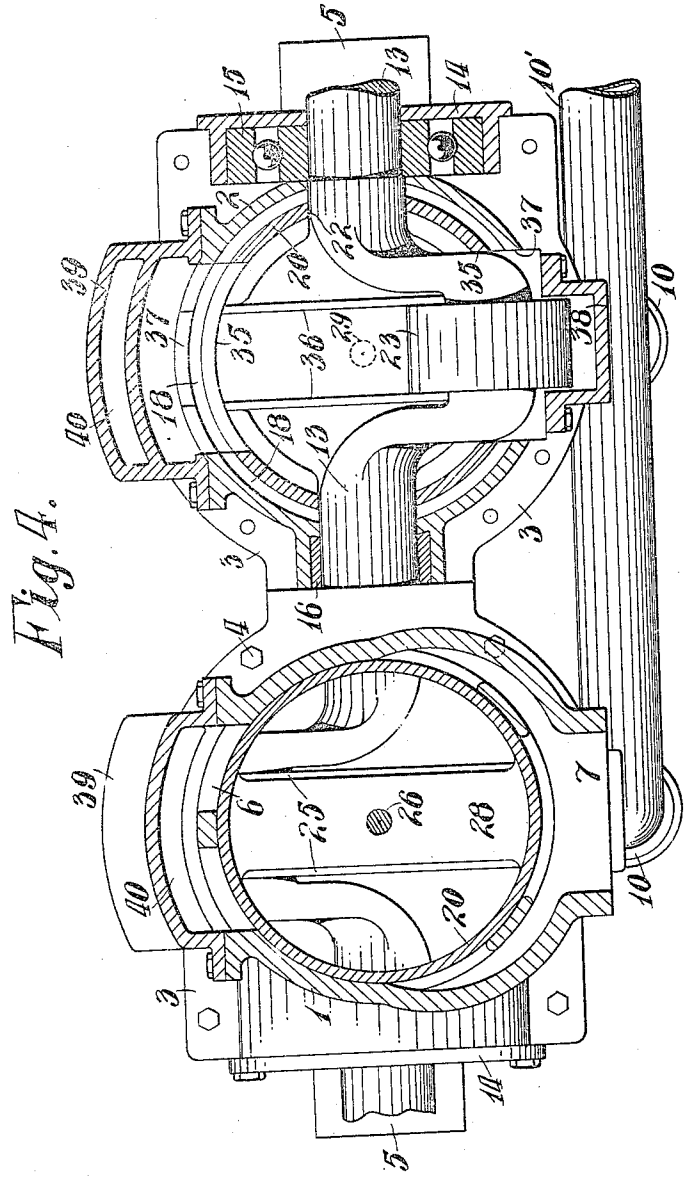

Fig. 4.

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INTERNAL-COMBUSTION ENGINE.

1,042,505. Specification of Letters Patent. Patented Oct. 29, 1912.

Application filed October 5, 1910. Serial No. 585,369.

To all whom it may concern:

Be it known that I, WILLARD IRVING TWOMBLY, a citizen of the United States, residing in the borough of Manhattan, in the city, county, and State of New York, have invented new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal combustion engines of the two cycle type, in which, during a single revolution of the crank shaft, there is a compression of combustible mixture or fuel, a power stroke as the result of the combustion of said compressed fuel, the exhaust of the spent gases of combustion from said chamber, and the supplying of a fresh charge of combustible material or fuel.

In this type of engine as heretofore constructed it has been customary to provide a crank case and connect the piston cylinder thereto with the bore communicating with said crank case, a trunk piston working in the cylinder and connected to the crank shaft by a connecting rod, the said piston head dividing the cylinder into two chambers, one chamber constituting the combustion or explosive chamber, and the other in conjunction with the crank case constituting a fuel pumping and compressing chamber. In engines thus constructed, owing to the large clearance in the crank case, it is impossible to compress the fuel to have a pressure of more than two to three pounds to the square inch, which is entirely inadequate for the efficient operation of an engine. Also, there is considerable loss of fuel due to leakage at the crank-shaft journals as the fuel is compressed which leakage increases with the wear of the engine. To overcome this disadvantage engines have been constructed with a separate fuel chamber in the crank case communicating with the compression chamber of the cylinder, and the admission of fuel controlled by a slide valve, which also serves as a partition between the cylinder and the crank case, the connecting rod passing through said valve and operating the same, thus adding a number of working parts to the engine. Furthermore, owing to the comparative thinness of the metal of the wall of the piston head the heat generated by the combustion of fuel in the combustion chamber is transmitted therethrough to the fuel pumping chamber heating the incoming fuel, such heating expanding or increasing the volume of said gases, and thus decreasing the combustible value of the charge injected into the combustion chamber.

It is the primary object of the present invention to overcome the above disadvantages and to provide an engine of this character which is simple, compact and light in construction, and at the same time efficient in operation, comprising a small number of parts so arranged as to be readily accessible and in which there is a complete and perfect utilization of the explosive charge, as well as a thorough scavenging of the combustion chamber of the burnt gases. For this purpose I construct the engine in the form of a cylinder, or a multiple of cylinders, comprising a pair or pairs of opposed and axially alined sections, one section constituting the combustion or explosive chamber having a fuel inlet and an exhaust outlet, the other section constituting a fuel pumping and compressing chamber having a fuel-inlet valve and a fuel outlet, the capacity of the latter being somewhat greater than that of the combustion chamber, thus assuring a full charge of fresh combustible mixture to said latter chamber, means being provided exterior of the cylinder to conduct the compressed fuel from the fuel compressing chamber to the combustion chamber. A single piston, in the nature of a double piston, operates in a pair of cylinder sections, the crank shaft passing transversely through said cylinder and piston with the cranked portion directly connected to the piston within the working portion thereof. The intermediate portion of the cylinder sections constitutes the crank case in which the crank shaft revolves, the bores of the cylinder sections having no communication with each other from the interior nor with said intermediate portion when the piston is mounted therein. By this construction it is possible to compress the fuel in the compressing chamber to a pressure of at least from eight to nine pounds to the square inch, and as the fuel-inlet and exhaust ports of the combustion chamber are uncovered by the piston assuring the thorough scavenging of said chamber of the burnt gases and a fresh charge of combustible mixture supplied thereto. Furthermore, owing to the construction of the piston and the intermediate portion of the cylinder sections

only a comparatively small portion of the heat generated by the combustion of fuel in the combustion chamber will be transmitted to the fuel pumping chamber, with the result that the incoming fuel will not be heated and the consequent expansion of the same, assuring a rich charge of fuel mixture to the combustion chamber the bulk of which will be mainly expanded as it is ignited in said chamber thus increasing the power of the engine.

In the drawings accompanying and forming a part of this specification, Figure 1 is a sectional side elevation of my improved engine. Fig. 2 is a sectional end elevation taken substantially on the line A—A of the cylinder at the left of Fig. 1 looking in the direction of the arrow. Fig. 3 is a sectional end elevation of the cylinder at the right of Fig. 1, the section being taken substantially on the line B—B looking in the direction of the arrow with the piston shown in full; and Fig. 4 is a sectional view taken on the line C—C of Fig. 1 and looking at the top thereof.

Similar characters of reference designate like parts throughout the different views of the drawings.

For the purposes of illustration I have shown the engine as consisting of a pair of vertical cylinders, but it will be obvious that only one or more than two cylinders may be employed without departing from the scope of the invention.

The engine consists of one or more cylinders each comprising a pair of opposed heads or sections 1, 2 having a mating connection, the lower sections 2 of which are preferably cast *en bloc* as clearly shown in Fig. 1 by means of a rib between the sections. In the present instance the diameter of the cylinder section 2 is somewhat greater than that of the section 1, whereby the capacity of said section will be such as to assure a full charge of fuel mixture to the combustion chamber, although it will be obvious that the both cylinder sections may be of the same diameter. The mating connection of the cylinder sections provides a cylinder having a continuous bore, thus providing a support or bearing for the piston for the entire length of its stroke. The said cylinder sections have abutting flanges 3 and secured together by bolts 4 passing through said flanges, the sections 2 also having hanger arms 5 whereby the engine may be supported, as, for instance, in the frame of a motor vehicle.

The cylinder section 1 constitutes the combustion or work developing chamber and has a fuel inlet 6 and an exhaust port 7 substantially opposite the port 6. The cylinder section 2 constitutes the fuel-pumping chamber in which the fuel is compressed prior to the injecting thereof into the combustion chamber, said section 2 having a port 8 communicating with the source of fuel supply which is normally cut off by means of a spring seated valve 9 in a portion 10 projecting out from the lower end of cylinder section, and to which is connected a fuel supply pipe 10′. The valve is placed in position through an opening in the projecting portion 10 in which is screw threaded a plug 11, the stem of the valve being slidably mounted in said plug 11 and a spring 12 to maintain the valve closed coiled about the valve stem and confined between the valve and a recess in said plug 11. The section 2 also has a fuel outlet 8′, means being provided communicating with said outlet and the inlet of the combustion chamber to conduct fuel from the pumping to the combustion chamber, to be fully described hereinafter.

A crank shaft 13 extends transversely between the cylinder sections, and is journaled at the ends thereof in bushings 14 in the connection between said sections by means of ball bearings 15, and when two or more cylinders are employed the crank shaft is also journaled between the cranked portions thereof by suitable bushings, as 16, between the cylinder sections.

A piston, in the nature of a double piston, engages in both of said cylinder sections, and comprises a pair of releasably connected heads 17, 18 provided with the usual piston rings 19 and oil grooves. The head 17 has an integral sleeve portion 20 with which the head 18 has a tongue-and-groove connection 21. The sleeve portion 20 is provided with a pair of oppositely-disposed slots 22 cut through the end thereof to permit of the placing of the piston upon the crank shaft and the reciprocation thereof transversely to the axis of said shaft, and also tends to prevent rotation of the piston in the cylinder sections.

The crank shaft 13 passes transversely through, and is connected to, the piston within the working portion thereof, and is in the nature of a crank and yoke connection doing away with lateral thrust on the piston, said connection comprising a roller bearing 23 upon the wrist pin of the crank shaft having a rolling engagement with a pair of tracks 24, 25 carried within the piston at opposite sides of said bearing. The track 24 is connected to the head 17 by means of a tie-rod 26 screw threaded into the back of the track and projecting through said head 17, a jam nut 27 on the projecting end of said rod outside of the piston head serving to draw and lock the track up against a rib 28 extending across and constructed integral with the sleeve portion 20. The track 25 is adjustably secured to the head 18 within the sleeve portion 20 by means of a tubular member 29 having a screw threaded engagement with

the head 18 and an enlarged portion 30 abutting against the back of the track, a lock nut 31 engaging with said member 29 outside of the head 18 to lock it in adjusted position. A tie-rod 32 passes through the member 29 and is screw threaded into the back of the track 25 the other end projecting through the head 18 where it is engaged by a jam nut 33 to draw and lock the track up against the enlarged portion 30 of the member 29 and a pair of inwardly-projecting ears or lugs 34 on the sleeve 20. The said enlarged head 30 of the tubular member 29 also engages between said lugs 34 to prevent endwise movement of the track 25. The sleeve portion 20 is also provided with a second pair of oppositely-disposed openings 35 substantially at right angles to the slots 22, in which the ends of the tracks engage, the said openings permitting the passage of the bearing on the wrist pin of the crank shaft through its orbit of movement, which in the present instance is greater than the cross sectional dimension of the piston. The tracks may be provided with ledges or guides 36 between which the bearing roll 23 engages to prevent rotation of the piston in the cylinder. The cylinder sections are also provided in their mating ends with oppositely-disposed recesses to form openings 37, corresponding with the opening 35 in the piston to permit of the passage of the roller bearing on the wrist pin of the crank shaft through its orbit of movement. The cylinder sections are provided with outwardly bulging removable plates or covers 38, 39 for the openings 37, the cover 39 having a chamber or duct 40 communicating with the fuel outlet of the cylinder section 2 and with the fuel inlet of the combustion chamber 1 in which the fuel may be compressed and to conduct the fuel from the chamber 2 to the combustion chamber 1.

The intermediate portion of the cylinder sections (designated in a general way by F,) when the piston is mounted in the cylinder has no communication whatever with either the combustion or pumping chamber, and when the plates 38, 39 are in place constitutes an entirely closed compartment or chamber in which the crank shaft revolves. Furthermore, when the piston is mounted in the cylinder, owing to the construction of the piston and the intermediate portion of the cylinder sections, the combustion chamber will be isolated, so to speak, from the pumping chamber, and the liability of the heat generated by an explosion of combustible material in the combustion chamber being transmitted to the pumping chamber is reduced to a minimum, with the result that the volume of the fuel mixture will not be heated to any appreciable extent and expanded, with the consequent decreasing of the combustible value of the charge injected into the combustion chamber as would be the case should the fuel be drawn into a heated chamber thus decreasing the combustible value of such fuel, and while such heated mixture will serve to expel the air and burnt gases from the combustion chamber as it is injected into said chamber, the charge is not as rich nor of such great power generating value as if it were injected in a comparatively cool state. Furthermore, the charge being in a comparatively cool state as it is injected into the heated combustion chamber will expand slightly increasing in volume and tend to thoroughly scavenge, and assure a full charge of combustible mixture to said chamber. It will thus be obvious that as the fuel injected into the combustion chamber has been expanded only to an inappreciable extent, the expansive force of the charge as it is ignited will be greatly enhanced with the consequent increase of the power of the engine.

A jacket 42, consisting of a wall of thin sheet metal, preferably of light spun copper, surrounds the combustion chamber 1 and spaced therefrom to form a water chamber 43. This jacket is snugly fitted in an angular portion 44 of an annular flange 45 on the combustion chamber casting and then has shrunk thereover a steel ring 46 so as to form a water tight joint. A boss 47 projects outwardly from the upper end of the combustion chamber, and has an opening communicating with said chamber in which a hollow bushing 48 has a screw threaded engagement, the bushing 48 passing through an opening in the head of the jacket 42 in such manner as to clamp the edges of said opening between an annular flange on said bushing and the end of the boss 47 in a water-tight joint. The bushing 48 is provided with a screw threaded opening in which engages a spark plug 49 so that the sparking points project into the combustion chambers. A water circulation may be maintained through the water chamber 43 by a pipe (not shown) leading from the source of supply and connected to an opening 50 in the jacket supporting flange 45 communicating with the water chamber 43, and an outlet pipe 51 connected to the top of the jacket leading back to the source of supply.

The piston head 17 is provided with a fuel-inlet device 52, shown in the present instance as removably connected to the piston head, although it will be obvious that the same may be cast integral therewith. The said device 52 is so constructed as to form a pocket at the top of the piston, and has a spout 53 extending to the side of the piston, the opening of which is adapted to register with the fuel inlet 6 in the combustion chamber when the piston is in its lowermost position, causing the fuel to be deflected toward

the top of the combustion chamber where it will mushroom and descend in such a manner as to force the burnt gases out through the exhaust port 7. Furthermore, a portion of the fresh charge will be retained in the pocket during the up stroke of the piston, which will not mix with any of the burnt gases which may be left in such chamber, and by making the spark plug extend sufficiently into said pocket the same will always be in a fresh mixture at the time of firing and in turn will fire any poor mixture which may be in the combustion chamber.

The operation of my improved engine is substantially as follows. As already stated for the purpose of illustration I have shown in the present instance two cylinders and will describe the operation of the engine as thus constructed, referring to the cylinders as D and E, respectively. Assuming the pistons to be in the positions illustrated in Fig. 1, the piston in cylinder D having sucked or drawn fuel into the pumping chamber 2, the piston being at the end of its sucking stroke with the valve 9 seated by its spring 12, the charge having been compressed in the combustion chamber 1 and about to be fired. Combustion of fuel has taken place in the cylinder E and the burnt gases exhausting therefrom through port 7, and a fresh charge of fuel or combustible material, previously compressed in the chambers 2 and 40 entering through port 6 by way of the deflector 52. As combustion takes place in the cylinder D, the piston moves down compressing the fuel in the chambers 2 and 40 the fuel control valve having been closed by its spring 9. When the piston head 17 has moved down to uncover the exhaust port 7 the burnt gases rush out through said port 7, and as the piston descends still farther the inlet port 6 will be uncovered and the fuel, which has been compressed during the downward stroke of the piston section 18 in the chambers 2 and 40, will rush through the port 6 into the chamber 1 by way of the deflector 52, said deflector directing the fuel toward the top of the chamber where it will mushroom in such manner as to force out any burnt gases remaining in said chamber. This upward stroke of the piston in the cylinder D will cause the crank shaft to revolve approximately 180 degrees, and during said revolution of the crank shaft, the fuel previously injected into chamber 1 of the cylinder E will be compressed and a fresh charge of combustible mixture sucked into chamber 2 through port 8, the vacuum created by the sucking action of the piston 18 unseating the fuel-control valve 9 when the cycle of operations will be repeated.

The cranked portion of the crank shaft for one of the cylinders is diametrically opposite to the cranked portion for the other cylinder, and by this arrangement during the cycle of operations as set forth, there will be two power strokes for every revolution of the crank shaft.

Variations may be resorted to within the scope of my invention.

Having thus described my invention, I claim:

1. A two cycle internal combustion engine, comprising a piston cylinder consisting of a pair of axially alined and separably connected heads having a mating connection to form a cylinder with a continuous bore, each of the heads having laterally projecting flanges whereby they are secured together, a piston to work in the bore of both of said heads, said piston separating the cylinder into two chambers having no communication with each other from the interior, one chamber constituting a combustion chamber having fuel-inlet and exhaust ports, and the other constituting a fuel-pumping and compression chamber having valved fuel-inlet and outlet ports; a crank shaft passing transversely through said cylinder and piston and having a crank and yoke connection with the latter, and journaled in the connecting flanges of the cylinder sections, that portion of the cylinder sections in which the crank shaft revolves having no communication with the heads when the piston is in the cylinder; and said cylinder and piston provided with oppositely-disposed openings to permit of the passage of the crank of the shaft through its orbit of movement; and removable outwardly-bulging covers for the openings in the cylinder, one of said covers provided with a chamber communicating with the outlet-port in the fuel-compressing chamber and the inlet-port of the combustion chamber, serving as a fuel-compressing chamber and to conduct the fuel from the pumping to the combustion chamber.

2. A two cycle internal combustion engine, comprising a number of vertical piston cylinders, said cylinders each consisting of axially separable sections, the lower sections of the cylinders cast *en bloc* and constituting the fuel pumping and compressing chambers having valved fuel-inlet and outlet ports, the other sections releasably connected thereto and constituting the combustion chambers having fuel-inlet and exhaust ports, the said cylinder sections having mating connections to form cylinders each having a continuous bore, and each of the cylinder sections having laterally projecting flanges whereby they are secured together; a piston for each cylinder, said pistons separating the combustion chambers and fuel-pumping chambers of the cylinders so that they will have no communication with each other from the interior thereof; a crank shaft passing transversely through

the cylinders and pistons and having a crank and yoke connection with the pistons, said shaft journaled in the connecting flanges of the cylinder sections; and means exterior of the cylinders and communicating with the outlet ports of the fuel-compressing chambers and the inlet ports of the combustion chambers to conduct fuel to the latter chambers.

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