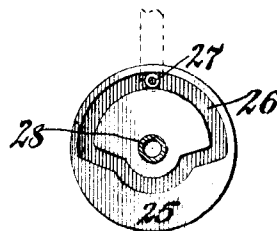
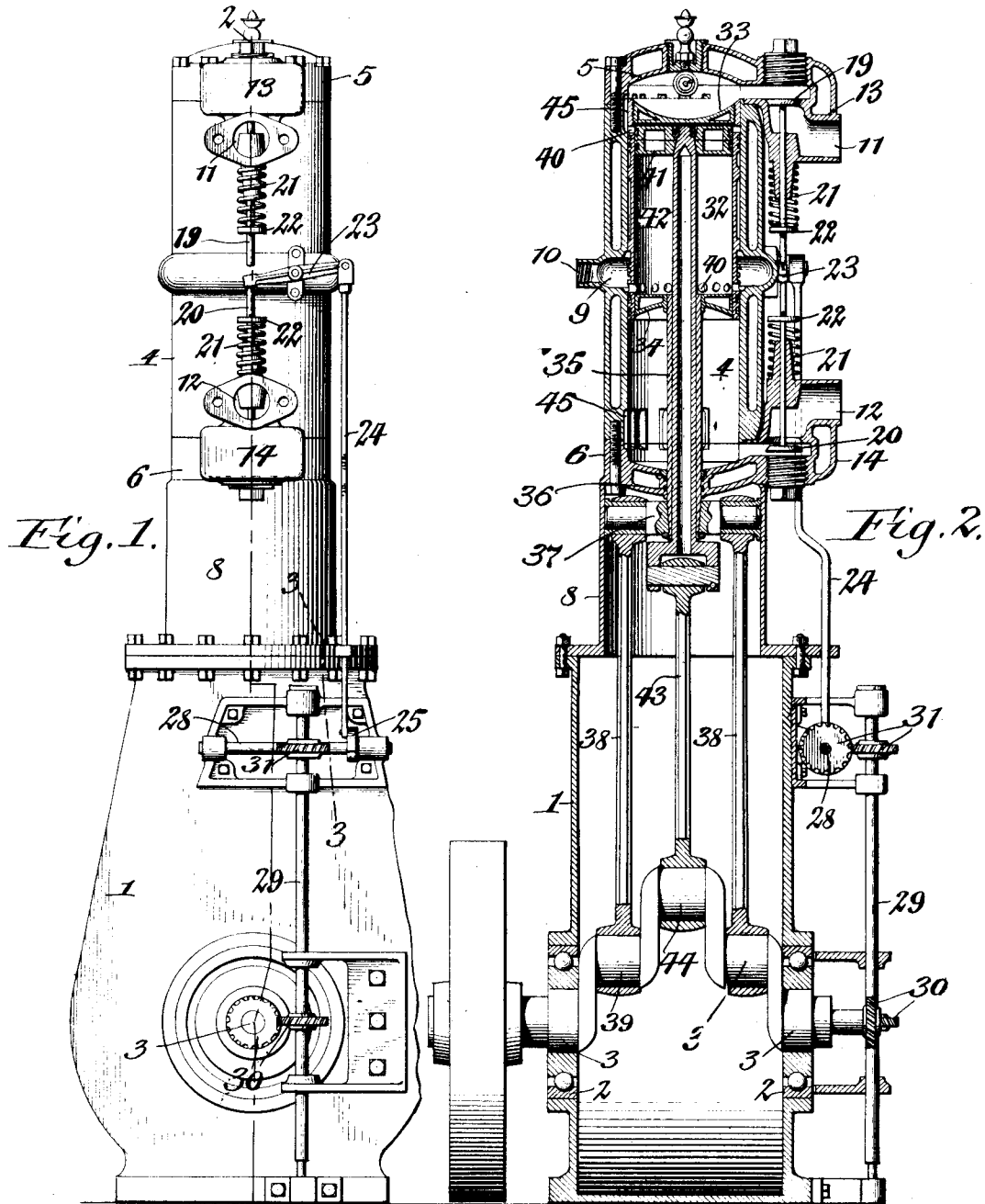


3 SHEETS—SHEET 1.



Witnesses;
Richard Soumerai
Leroy S. Hodges

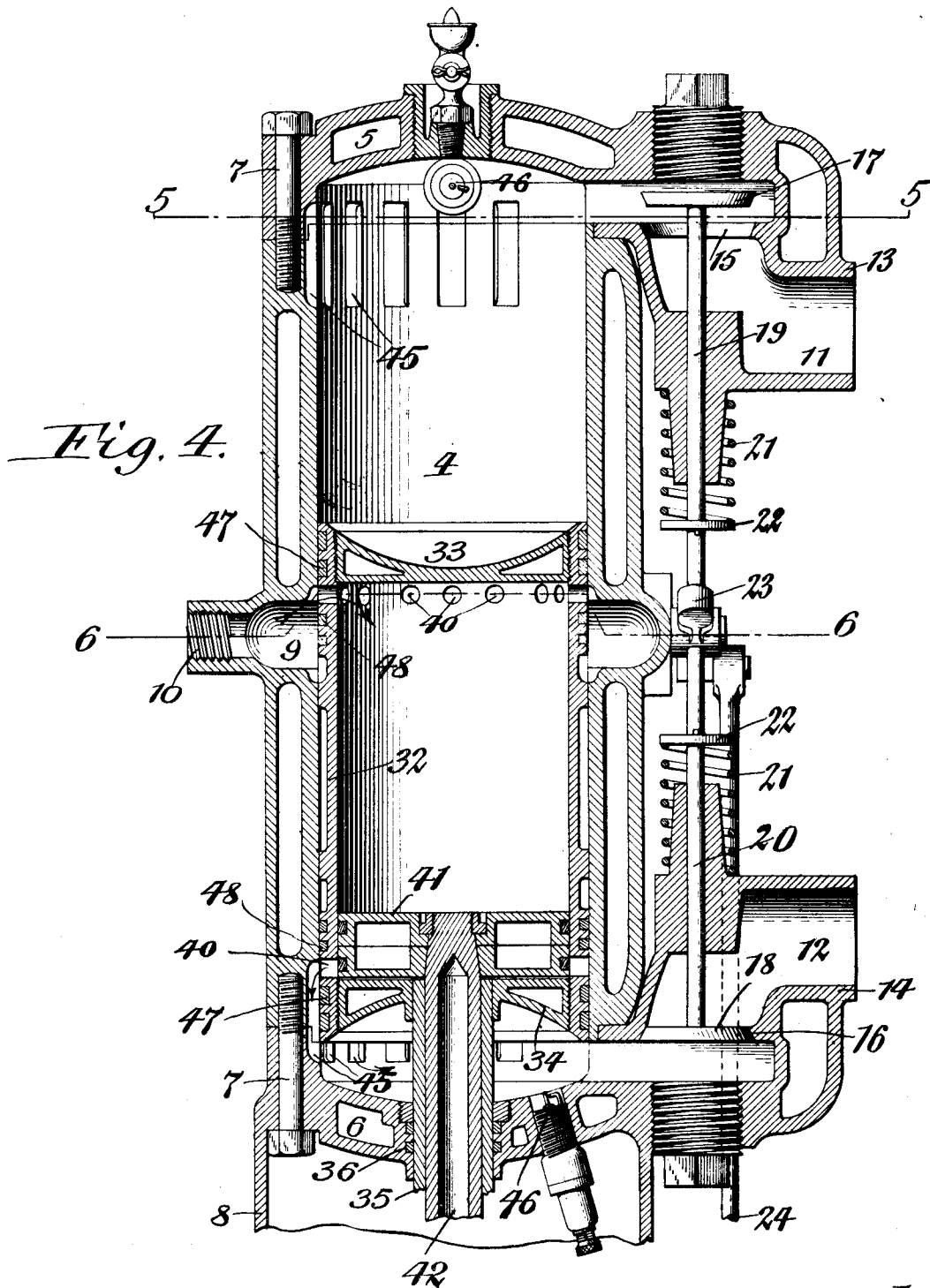
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C. W. ANDERSON.
INTERNAL COMBUSTION ENGINE.
APPLICATION FILED JUNE 14, 1911.

1,058,026.

Patented Apr. 8, 1913.

3 SHEETS—SHEET 2.



Witnesses:
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Patented Apr. 8, 1913.

3 SHEETS—SHEET 3.

1,058,026.

Fig. 5.

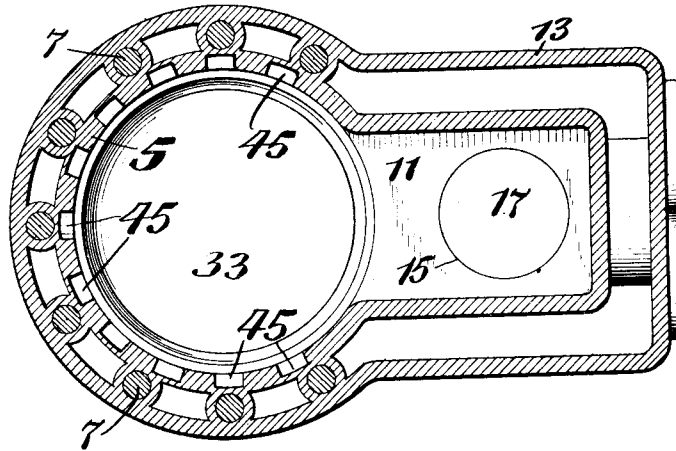
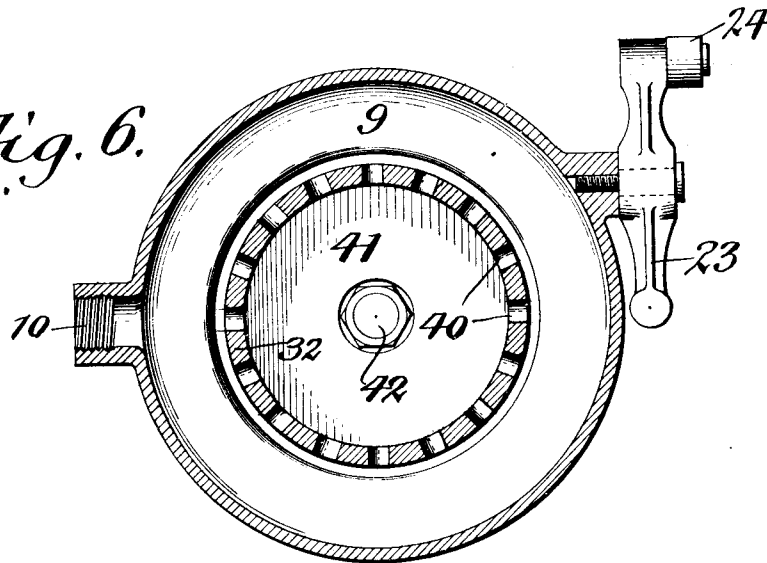


Fig. 6.



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UNITED STATES PATENT OFFICE.

CORY W. ANDERSON, OF BUFFALO, NEW YORK.

INTERNAL-COMBUSTION ENGINE.

1,058,026.

Specification of Letters Patent.

Patented Apr. 8, 1913.

Application filed June 14, 1911. Serial No. 633,052.

To all whom it may concern:

Be it known that I, CORY W. ANDERSON, a citizen of the United States, residing at Buffalo, in the county of Erie 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 an internal combustion engine of that type in which a power impulse is produced during each stroke of the working piston.

It is the object of this invention to produce an engine of this character in which thorough scavenging of the burnt or dead gases is effected before the new or live charge of gaseous fuel is admitted to the cylinder, which is so constructed that the live gas or fuel is admitted under high pressure during the last portion of the working stroke of the power piston in both directions, which provides for thoroughly mixing the live fuel while admitting the same to the working cylinder, and in which the admission of live fuel or gas and the discharge of spent or dead gas is effected positively and noiselessly and by the use of comparatively few parts which can be readily produced at low cost.

In the accompanying drawings consisting of 3 sheets: Figure 1 is a side elevation of a gas engine embodying my invention. Fig. 2 is a vertical longitudinal section thereof in line 2—2, Fig. 1. Fig. 3 is a fragmentary vertical section, on an enlarged scale, taken in line 3—3, Fig. 1 and showing the cam for operating the exhaust valves. Fig. 4 is a vertical longitudinal section of the engine cylinder and associated parts on a line corresponding to Fig. 2 but showing the piston and plunger at the opposite ends of their strokes. Figs. 5 and 6 are horizontal sections in the correspondingly numbered lines in Fig. 4.

Similar numerals of reference indicate corresponding parts throughout the several views.

Although my improvements may be embodied either in a horizontal or in a vertical engine, and either in a single cylinder or a multi-cylinder engine the same, for example, is represented in the drawings as embodied in a single cylinder upright engine.

1 represents the hollow base or main frame of the engine which is provided with bearings, 2 2 on its opposite sides, preferably of

the ball type, in which is journaled a horizontal crank shaft 3.

Above the base is arranged an upright working or explosion cylinder 4 the upper and lower ends of which are preferably closed by upper and lower heads 5, 6 which are detachably secured to the upper and lower ends of the cylinder by means of screws or bolts 7, as shown in Figs. 2 and 4, or by any other suitable means.

The lower head of the cylinder is preferably provided with a downwardly projecting pedestal 8 which is formed integrally therewith and which is secured at its lower end to the upper end of the hollow base and practically forms an upward extension of the latter.

Midway of the length of the working cylinder the same is provided with an annular fuel distributing inlet passage 9 which opens through the bore of the cylinder and which is provided with an inlet nipple 10 through which the explosive fuel may be supplied from any suitable source to the distributing passage.

The products of combustion or dead gases are withdrawn from opposite ends of the working cylinder through upper and lower exhaust passages 11, 12 which are preferably formed in lateral extensions 13, 14 of the upper and lower cylinder heads. These exhaust passages are adapted to be opened and closed alternately by a valve mechanism comprising upper and lower exhaust ports 15, 16 formed in the upper and lower exhaust passages, upper and lower valves 17, 18 adapted to move toward and from the upper and lower exhaust ports, respectively, upper and lower valve rods 19, 20 arranged vertically in line and guided in suitable ways on the head extensions 13, 14 said upper valve rod supporting the upper exhaust valve and the lower valve rod supporting the lower exhaust valve, and springs 21, 21 which operate to hold the exhaust valves yieldingly in their closed position, each of these springs being preferably of spiral form and bearing at one end against a collar or shoulder 22 on one of the valve rods while its opposite end bears against one of the cylinder head extensions.

Various means may be employed for opening and closing the exhaust valves but the means which are shown in the drawings and which are suitable comprise a vertically swinging rock lever 23 pivoted on a suitable

stationary part of the engine and having its front arm arranged between the opposite ends of the exhaust valve rods 19, 20, an upright shifting rod 24 guided on a stationary part of the engine and connected at its upper end with the rear arm of the rock lever 23, a cam 25 having a groove 26 which is engaged by a projection 27 on the lower end of the shifting rod 24, a horizontal transverse shaft 28 journaled on the base and carrying the cam 25, and an upright intermediate shaft 29 journaled in suitable bearings on the base and operatively connected by a lower pair of intermeshing spiral gears 30 with the crank shaft and also operatively connected with the cam shaft by means of an upper pair of intermeshing spiral gears 31, as shown in Figs. 1, 2 and 3. By means of this mechanism the exhaust valves are alternately held in an open and a closed position during about one half of a rotation of the main or crank shaft.

32 represents the working piston which reciprocates lengthwise within the working cylinder and which is itself of hollow or cylindrical form so as to constitute the barrel of a pump whereby the live gaseous fuel is supplied alternately to opposite ends of the working cylinder under high pressure. The working piston has its tubular body closed at its upper and lower ends by upper and lower heads 33, 34 which are preferably screwed into the upper and lower ends of the piston body. This piston may be operatively connected with the main or crank shaft of the engine in various ways but preferably by means of an upright piston rod 35 passing through a stuffing box 36 arranged centrally in the lower head of the working cylinder and connected at its upper end with the lower head of the piston, a vertically movable cross head 37 guided in suitable ways on the pedestal and connected centrally with the lower end of the piston rod, and two pitmen or connecting rods 38 which are pivotally connected at their upper ends with said cross head on opposite sides of the piston rod while their lower ends are pivotally connected with the wrists 39 of two cranks formed on the main or crank shaft within the hollow base. The length of the piston connecting rod and the pivotal connections between the same and the cross head and crank shaft are the same and therefore operate as one.

Near opposite ends of the working piston the same is provided with two rows of fuel transferring ports 40 extending from its periphery to the bore of the piston. In the uppermost position of the working piston its lower set of transfer ports 40 opens into the annular fuel distributing passage 9 of the cylinder as shown in Fig. 2, whereby fuel is permitted to enter the lower end of the hollow piston, and in the lowermost

position of this piston its upper annular row of fuel transfer ports opens into the annular fuel distributing passage, as shown in Fig. 4, so as to admit gaseous fuel into the interior of the hollow piston at the upper end thereof.

41 represents the pump plunger which reciprocates lengthwise within the hollow piston and whereby the fuel is alternately drawn into and expelled from opposite ends of the hollow piston. This plunger is positively reciprocated lengthwise of the piston which movement may be produced by any suitable means but preferably by the means which are shown in the drawings and which comprise an upright plunger rod 42 secured at its upper end to the plunger and passing lengthwise through the piston rod which latter is made hollow for this purpose, and a plunger connecting rod or pitman 43 pivotally connected at its upper end with the lower end of the plunger rod while its lower end is pivotally connected with the wrist 44 of a crank formed on the main or crank shaft between the wrists of the cranks which are connected with the piston.

The relative throw of the piston and plunger and the timing of these parts, is preferably such that the throw of the working piston is equal to one half of the throw of the pump plunger and the piston and plunger always move in the same direction although at different speeds. This relative movement of the piston and plunger is obtained by making the radial length or distance from the center of the crank shaft to the centers of the wrists 39 of the piston operating cranks equal to one half the radius or distance from the center of the crank shaft to the center of the wrists 44 of the cranks which operate the pump plunger. It follows from this construction and arrangement of the parts that while the piston is traveling from one end of the working cylinder to the opposite end thereof, the pump plunger will be moving in the same direction but at a higher speed and therefore move from one end of the hollow piston to the opposite end thereof by the time the latter reaches the end of its stroke.

Within the bore of the cylinder at opposite ends thereof the same is provided with a plurality of parallel longitudinal fuel inlet passages or grooves 45 which give these parts of the cylinder a fluted appearance. Each set of these grooves is preferably formed partly in the body of the cylinder and partly in the adjacent head thereof, as shown in Figs. 2 and 4. The arrangement of these two sets of fuel inlet passages or grooves relatively to the piston and the transfer ports therein is such that when a piston is in its uppermost position, as shown in Fig. 2, the upper set of transfer ports in the piston will be in register with the

lower ends of the upper set of fuel inlet grooves 45 while the upper end of the piston terminates below the upper end of these grooves so that fuel is permitted to pass from the upper end of the interior of the piston through the upper transfer ports thereof and the upper set of fuel passages into the upper end of the working cylinder.

When the piston reaches its lowermost position, as shown in Fig. 4, its lower set of transfer ports register with the upper ends of the lower set of fuel inlet grooves or passages 45 and the lower end of the piston stops short of the lower ends of these grooves, thereby permitting the fuel to pass from the interior of the piston at the lower end thereof through the lower set of transfer ports and fuel passages into the lower end of the working cylinder. After the piston has effected the initial portion of its stroke in one direction and before reaching the last part of its stroke in this direction both sets of transfer ports 40 at opposite ends thereof are closed by the solid portions of the bore of the working cylinder. This causes the plunger which is moving in the same direction as the piston, but at a greater rate, to produce a partial vacuum within the trailing end of the piston and to compress the fuel within the advancing end of the piston. This vacuum and compression in the trailing and advancing ends of the piston increases in tension until the piston and plunger have nearly completed their strokes in one direction. At the end of this stroke of the piston and plunger the transfer ports at the trailing end of the piston are brought into register with the fuel distributing passage 9 whereby a charge of fuel is drawn rapidly into the trailing end of the piston owing to the vacuum within this end of the piston and also owing to the plurality of fuel transfer ports being arranged around the circumference of the piston so that the fuel can enter the same from all of its sides.

At the same time that fresh fuel is being admitted into the trailing end of the piston the advancing set of fuel transfer ports are in line or in register with the fuel transfer passages arranged at that end of the cylinder toward which the piston is moved, thereby causing the gaseous fuel which has been compressed by the plunger within the advancing end of the cylinder to be rapidly discharged therefrom through the advancing transfer ports 40 and the respective longitudinal fuel passages into the companion end of the working cylinder.

The exhaust valve which controls the exhaust passage at that end of the cylinder toward which the piston and plunger are moving is so timed that it is opened during practically the entire stroke of the piston and plunger in this direction. By this

means the burnt or spent gases contained within that end of the cylinder toward which the piston is moving, are expelled almost entirely mechanically by the piston while the small remaining portion of spent gas still lying between the piston and the adjacent head of the cylinder at the end of the stroke of the piston is pushed out through the exhaust passage by the incoming stream of fresh fuel which enters this end of the cylinder under high pressure from the respective end of the hollow piston, thereby causing a complete scavenging of the spent gases by the combined mechanical action of the piston and pneumatic action of the compressed gases, whereby the least possible contamination of the fresh charge of fuel is possible and the maximum purity of the discharge is maintained.

The exhaust valves are so timed that when the piston reaches the end of its stroke in one direction the exhaust valve in the passage leading to the respective end of the cylinder is also closed, thereby preventing the escape of any live or fresh gaseous fuel through the exhaust at this time. It will thus be apparent that this engine can be run with a minimum waste of fuel and that practically all of the fuel is utilized in developing power, thereby enabling the fuel to be used economically and the greatest efficiency to be obtained for a given amount of fuel.

While the piston is at or near the end of its stroke in one direction the charge of fuel is ignited within the respective end of the cylinder so as to produce an explosion for effecting the next following working stroke of the piston in the opposite direction. Any suitable means may be provided for effecting the ignition of the compressed charges of fuel at opposite ends of the cylinder at the proper time, the means for this purpose shown in the drawings comprising spark plugs 46 which are secured in openings formed in the heads of the cylinder and which are associated with suitable and well known means for producing an electric jump spark at the proper time within the cylinder.

During the operation of the engine the cycle of operations just described is repeated during each successive stroke of the piston and plunger.

In order to avoid leakage from the transfer ports while the piston is moving through the intermediate portions of its strokes the periphery of the piston is provided with packing rings 47, 48 which are arranged on opposite sides of each set of transfer ports and engage with the bore of the cylinder.

As the fresh fuel passes from the piston through the longitudinal fuel grooves or passages into the ends of the cylinder this fuel is thoroughly mixed, thereby putting

the same in the best condition for obtaining the highest efficiency of the same.

Each set of fuel passages or grooves may be variously distributed around the bore of the cylinder but it is preferable to omit these grooves in that portion of the bore of the cylinder immediately adjacent to the exhaust passage and arrange the same remote from the exhaust passage. By this means the fuel from the hollow piston enters the cylinder at points remote from or opposite to the exhaust passage, whereby the previously burnt or spent charge or gas contained within the end of the cylinder are more effectively pushed out through the exhaust by the incoming fresh charge of a gaseous fuel and the possibility of fresh gas escaping with the spent gas is reduced to a minimum.

Inasmuch as the piston itself operates as a valve for controlling the admission of fuel into the piston and also the discharge from the same into the cylinder it is unnecessary to employ any check valves in the path of the fuel supply conduits, thereby materially simplifying the construction of the engine and reducing the cost of the same accordingly.

Inasmuch as two working impulses are produced by this engine during each complete rotation of the main or crank shaft the same runs very even and steady, thereby rendering the same particularly suitable for electric lighting and other purposes where a uniform speed is desirable.

I claim as my invention:

1. An internal combustion engine comprising a cylinder having exhaust passages at its opposite ends and a fuel inlet between its ends, a hollow piston reciprocating within the cylinder and adapted to have each end of its interior alternately connected with said fuel inlet and one end of said cylinder, and a plunger reciprocating within the piston.

2. An internal combustion engine comprising a cylinder having exhaust passages at its opposite ends and a fuel inlet between its ends, a hollow piston reciprocating within the cylinder and adapted to have each end of its interior alternately connected with said fuel inlet and one end of said cylinder, a plunger reciprocating within the piston, and means for causing positive relative movement of said piston and plunger.

3. An internal combustion engine comprising a cylinder having exhaust passages at its opposite ends, fuel passages arranged in the bore of the cylinder at opposite ends thereof and a fuel inlet arranged in the cylinder midway between its ends, a hollow piston reciprocating within the cylinder and having transfer ports at its opposite ends leading from the periphery of the piston to the bore thereof, said transfer ports being

so disposed that when the piston is at either end of its stroke the transfer ports at its advancing end will register with the fuel passages at the corresponding end of the cylinder and the transfer ports at the trailing end of the piston will register with said fuel inlet, and a plunger reciprocating within said piston.

4. An internal combustion engine comprising a cylinder having exhaust passages at its opposite ends, fuel passages arranged in the bore of the cylinder at opposite ends thereof and a fuel inlet arranged in the cylinder midway between its ends, a hollow piston reciprocating within the cylinder and having transfer ports at its opposite ends leading from the periphery of the piston to the bore thereof, said transfer ports being so disposed that when the piston is at either end of its stroke the transfer ports at its advancing end will register with the fuel passages at the corresponding end of the cylinder and the transfer ports at the trailing end of the piston will register with said fuel inlet, a plunger reciprocating within said piston, and a crank shaft having a short crank connected with said piston and a long crank connected with said plunger.

5. An internal combustion engine comprising a cylinder having exhaust passages at its opposite ends, fuel passages arranged in the bore of the cylinder at opposite ends thereof and a fuel inlet arranged in the cylinder midway between its ends, a hollow piston reciprocating within the cylinder and having transfer ports at its opposite ends leading from the periphery of the piston to the bore thereof, said transfer ports being so disposed that when the piston is at either end of its stroke the transfer ports at its advancing end will register with the fuel passages at the corresponding end of the cylinder and the transfer ports at the trailing end of the piston will register with said fuel inlet, a plunger reciprocating within said piston, a hollow piston rod connected with the piston, a plunger rod arranged within the hollow piston rod and connected with the plunger, and a crank shaft having a short crank connected with the piston rod and a long crank connected with the plunger rod.

6. An internal combustion engine comprising a cylinder having exhaust passages at its opposite ends and a fuel inlet between its ends, a hollow piston reciprocating within the cylinder and adapted to have each end of its interior alternately connected with said fuel inlet and one end of said cylinder, a plunger reciprocating within the piston, and valves for controlling said exhaust passages.

7. An internal combustion engine comprising a cylinder having exhaust passages at its opposite ends and a fuel inlet between

its ends, a hollow piston reciprocating within the cylinder and adapted to have each end of its interior alternately connected with said fuel inlet and one end of said cylinder, a plunger reciprocating within the piston, and means for controlling said exhaust passages comprising valves arranged in said passages and mounted on opposing valve stems, springs operating to hold said valves yieldingly in a closed position, and a rock lever arranged between said valve stems and adapted to engage the same alternately.

8. An internal combustion engine comprising a cylinder having exhaust passages at its opposite ends and a fuel inlet between its ends, a hollow piston reciprocating within the cylinder and adapted to have each end of its interior alternately connected with said fuel inlet and one end of said cylinder, a plunger reciprocating within the piston, and means for controlling said exhaust passages comprising valves arranged in said passages and mounted on opposing valve stems, springs operating to hold said valves yieldingly in a closed position, a rock lever arranged between said valve stems and adapted to engage the same alternately, a rotary cam, and a shifting rod connected with said lever and engaging with said cam.

9. An internal combustion engine comprising a cylinder provided at its opposite ends with exhaust passages and with longitudinal fuel passages, and midway of its length with an annular fuel distributing inlet passage, a hollow piston provided at each end with an annular row of fuel transfer ports which are adapted to register alternately with said longitudinal and annular fuel passages.

10. An internal combustion engine comprising a cylinder provided at each end with an exhaust passage and with a plurality of fuel conducting grooves arranged lengthwise in the bore of the cylinder, a hollow piston movable lengthwise in the cylinder and having an annular row of transfer ports at each end, said piston when at the end of its stroke in either direction having its end arranged short of the outer ends of said longitudinal fuel passages and its transfer ports registering with the inner ends of said longitudinal passages and a plunger reciprocating within the piston.

11. An internal combustion engine comprising a cylinder provided at each end with an exhaust passage and with a plurality of fuel conducting grooves arranged lengthwise in the bore of the cylinder, a hollow piston movable lengthwise in the cylinder and having an annular row of transfer ports at each end, said piston when at the end of its stroke in either direction having its end arranged short of the outer ends of said longitudinal fuel passages and its transfer ports registering with the inner ends of said longitudinal passages, and a plunger reciprocating within the piston, each of said exhaust passages opening into said cylinder on one side thereof and the companion longitudinal fuel passages being arranged in an annular row remote from said exhaust passage.

Witness my hand this 12th day of June, 1911.

CORY W. ANDERSON.

Witnesses:

E. M. GRAHAM,
ANNA HEIGIS.

DISCLAIMER.

1,058,026. — *Cory W. Anderson*, Buffalo, N. Y. INTERNAL-COMBUSTION ENGINE.
Patent dated April 8, 1913. Disclaimer filed July 18, 1918, by the assignee,
Gile Engine Company.

Enters this disclaimer—

“To that part of the claim in said specification which is in the following words
to wit:

“1. An internal combustion engine comprising a cylinder having exhaust passages at its opposite ends and a fuel inlet between its ends, a hollow piston reciprocating within the cylinder and adapted to have each end of its interior alternately connected with said fuel inlet and one end of said cylinder, and a plunger reciprocating within the piston.

“2. An internal combustion engine comprising a cylinder having exhaust passages at its opposite ends and a fuel inlet between its ends, a hollow piston reciprocating within the cylinder and adapted to have each end of its interior alternately connected with said fuel inlet and one end of said cylinder, a plunger reciprocating within the piston, and means for causing positive relative movement of said piston and plunger.

“3. An internal combustion engine comprising a cylinder having exhaust passages at its opposite ends, fuel passages arranged in the bore of the cylinder at opposite ends thereof and a fuel inlet arranged in the cylinder midway between its ends, a hollow piston reciprocating within the cylinder and having transfer ports at its opposite ends leading from the periphery of the piston to the bore thereof, said transfer ports being so disposed that when the piston is at either end of its stroke the transfer ports at its advancing end will register with the fuel passages at the corresponding end of the cylinder and the transfer ports at the trailing end of the piston will register with said fuel inlet, and a plunger reciprocating within said piston.

“6. An internal combustion engine comprising a cylinder having exhaust passages at its opposite ends and a fuel inlet between its ends, a hollow piston reciprocating within the cylinder and adapted to have each end of its interior alternately connected with said fuel inlet and one end of said cylinder, a plunger reciprocating within the piston, and valves for controlling said exhaust passages.

“9. An internal combustion engine comprising a cylinder provided at its opposite ends with exhaust passages and with longitudinal fuel passages, and midway of its length with an annular fuel distributing inlet passage, a hollow piston provided at each end with an annular row of fuel transfer ports which are adapted to register alternately with said longitudinal and annular fuel passages.

“10. An internal combustion engine comprising a cylinder provided at each end with an exhaust passage and with a plurality of fuel conducting grooves arranged lengthwise in the bore of the cylinder, a hollow piston movable lengthwise in the cylinder and having an annular row of transfer ports at each end, said piston when at the end of its stroke in either direction having its end arranged short of the outer ends of said longitudinal fuel passages and its transfer ports registering with the inner ends of said longitudinal passages and a plunger reciprocating within the piston.

“11. An internal combustion engine comprising a cylinder provided at each end with an exhaust passage and with a plurality of fuel conducting grooves arranged lengthwise in the bore of the cylinder, a hollow piston movable lengthwise in the cylinder and having an annular row of transfer ports at each end, said piston when at the end of its stroke in either direction having its end arranged short of the outer ends of said longitudinal fuel passages and its transfer ports registering with the inner ends of said longitudinal passages, and a plunger reciprocating within the piston, each of said exhaust passages opening into said cylinder on one side thereof and the companion longitudinal fuel passages being arranged in an annular row remote from said exhaust passage.”