R. G. CLARK.

INTERNAL COMBUSTION ENGINE.

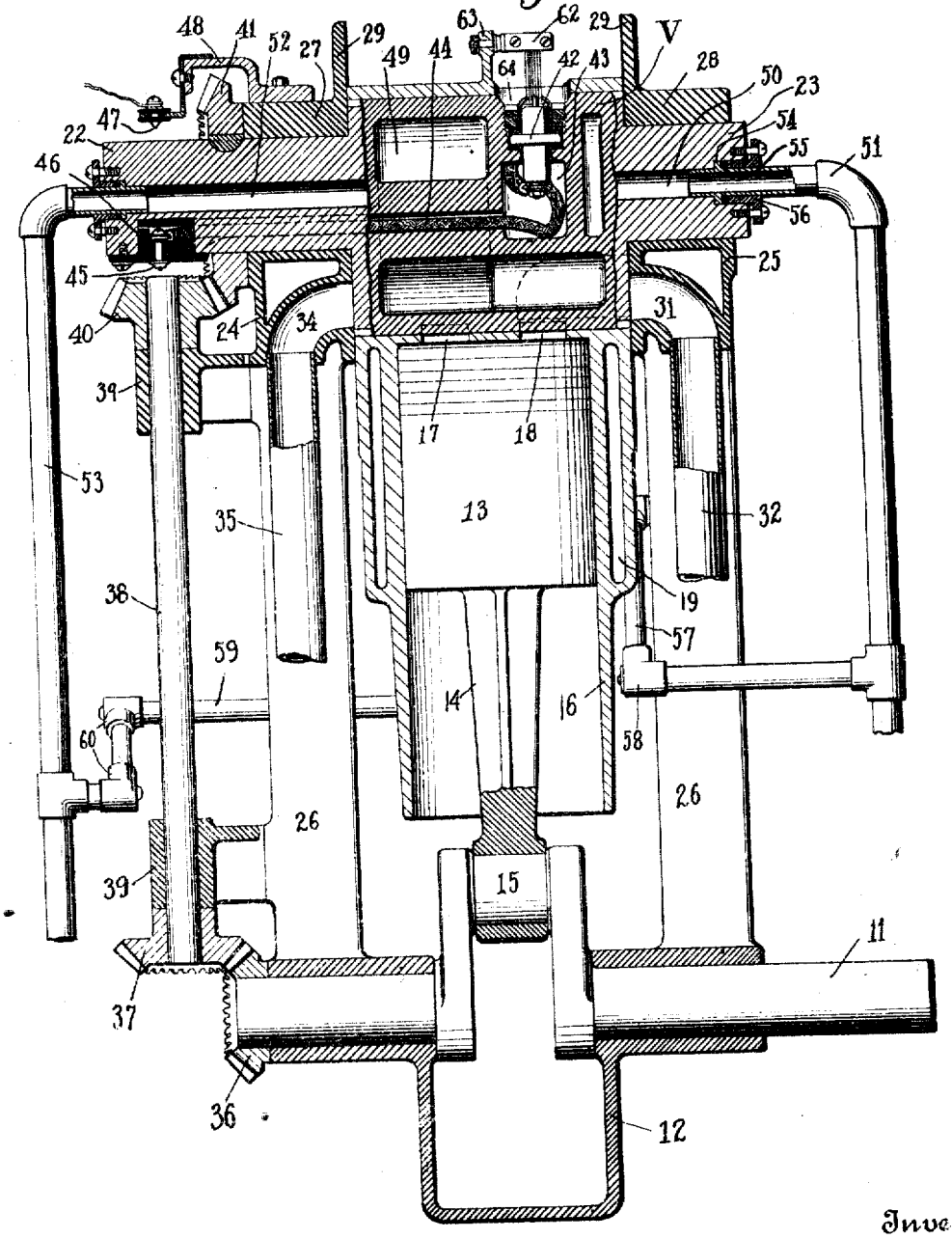
APPLICATION FILED JULY 6, 1916.

1,383,075.

Patented June 28, 1921.

4 SHEETS—SHEET 1.

Fig. 1



Inventor

R. G. CLARK

By his Attorney John O. Seifert

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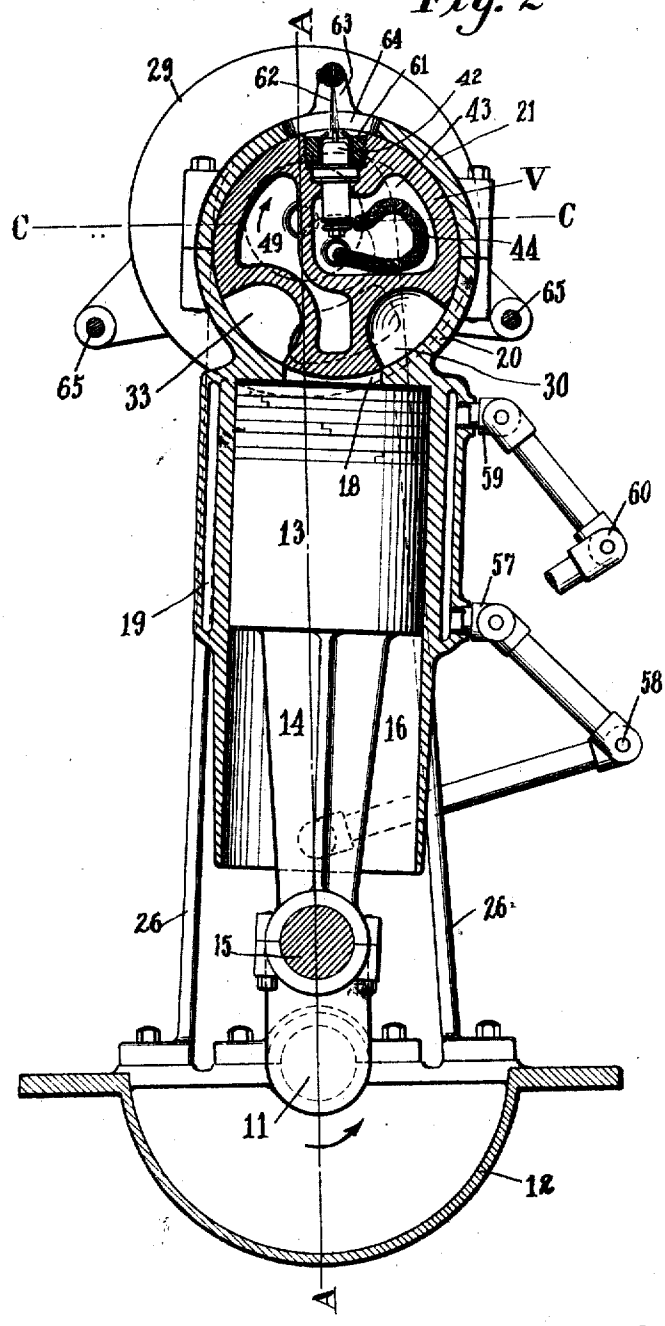
4 SHEETS—SHEET 2.

Fig. 2



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4 SHEETS—SHEET 3.

Fig. 3

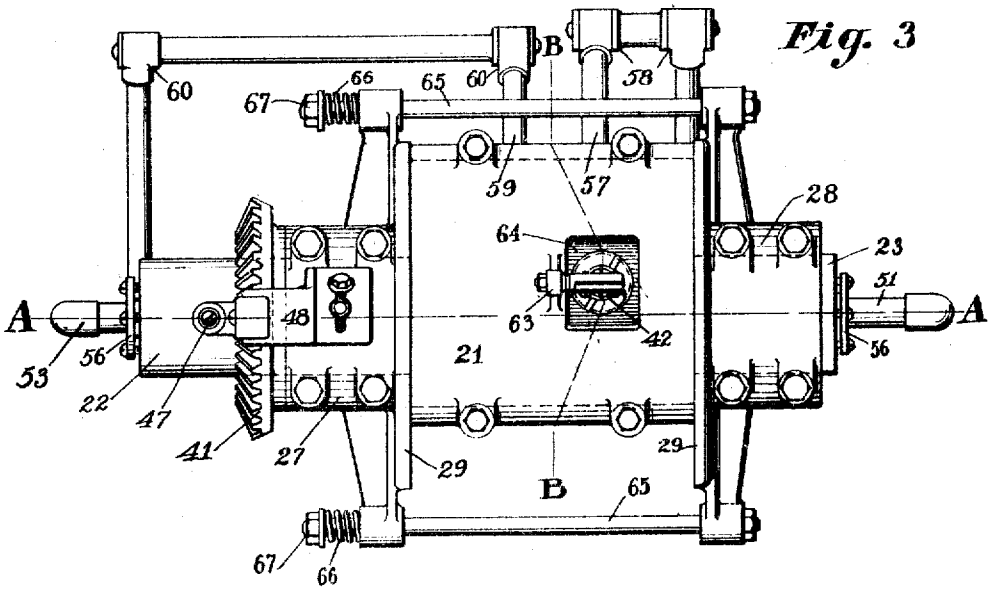


Fig. 4

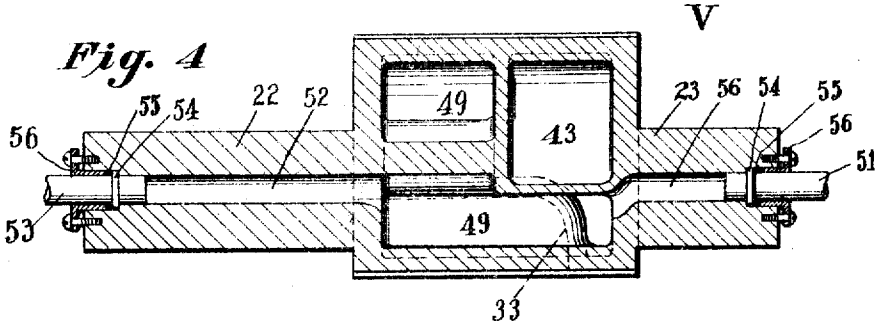


Fig. 5

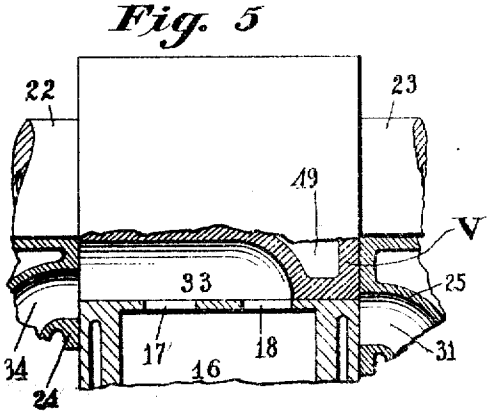
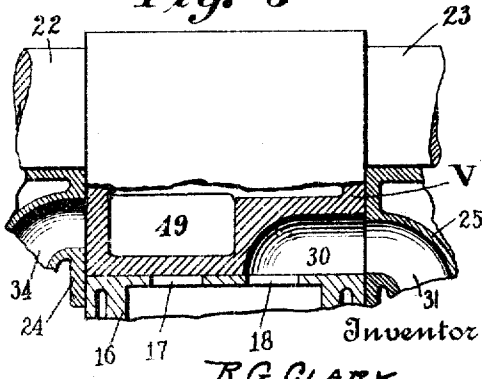


Fig. 6



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4 SHEETS—SHEET 4

Fig. 7

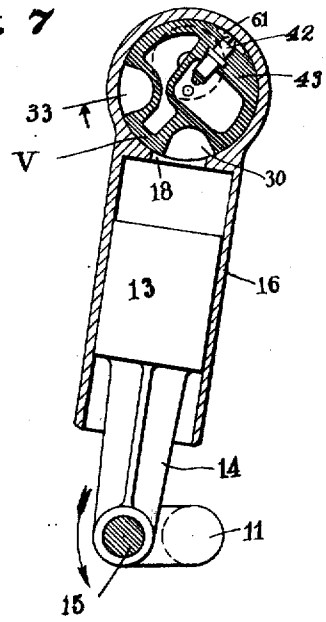


Fig. 8

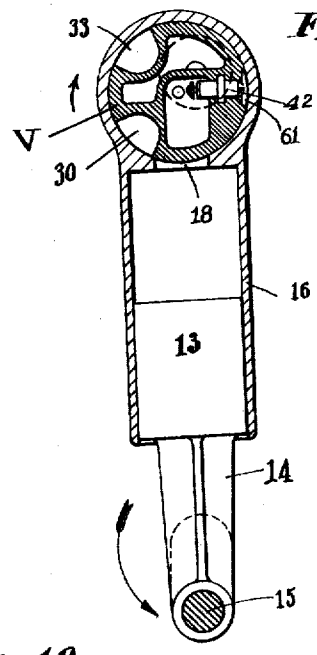


Fig. 9

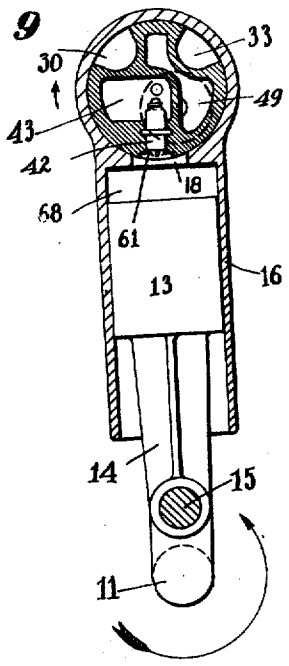
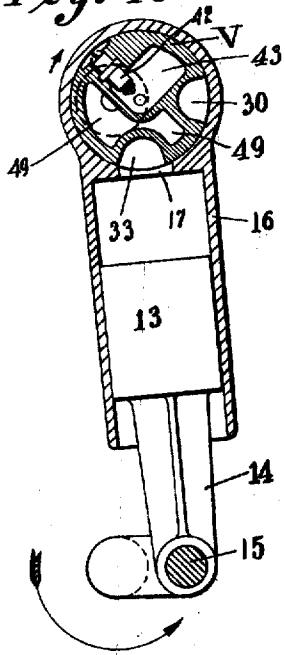


Fig. 10



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UNITED STATES PATENT OFFICE.

ROBERT G. CLARK, OF BROOKLYN, NEW YORK.

INTERNAL-COMBUSTION ENGINE.

1,383,075. Specification of Letters Patent. Patented June 28, 1921.

Application filed July 6, 1916. Serial No. 107,756.

To all whom it may concern:

Be it known that I, ROBERT G. CLARK, a citizen of the United States, residing in the borough of Brooklyn, in the county of Kings, city 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 type in which a piston connected to a power or crank shaft reciprocates in a cylinder, and it is the primary object of the invention to improve the general construction of engines of this type to cheapen the cost of construction and increase the efficiency thereof.

One of the disadvantages of an engine having a reciprocable piston connected to a power or crank shaft is that the piston and cylinder become quickly worn due to the lateral force or pressure of the piston thereby affecting the economical operation of the engine and shortening the life of the same, and it is an object of the invention to overcome this disadvantage by supporting the cylinder so that it will at all times assume a position in axial alinement with the piston in all positions of the piston during the reciprocation thereof and whereby the expansive force or thrust of the power medium during combustion is always directed in a straight line to the center of the crank pin of the power shaft.

In engines of this character the cylinder having a combustion chamber is secured in a fixed position and as the reciprocable movement of the piston is at all times the same the cylinder is so proportioned relative to the movement of the piston as to leave a space or clearance between the end of the cylinder and the piston when the latter is in its innermost position for the compression of the fuel charge, this space or clearance usually being one-quarter of the area or volume of the combustion chamber or one-third of the movement of the piston. While this space is essential for the compression of the fuel charge, it is detrimental to the proper scavenging or exhausting of the products of combustion from the combustion chamber, since as the movement of the piston is at all times the same it does not move into the cylinder during the exhaust stroke thereof with the least possible clearance between the head of the cylinder and piston with the result that a portion of the burnt gases remains in the cylinder. It is a further object of the invention to provide an engine in which there is a clearance space between the head of the cylinder and piston during the compression stroke sufficient for the compression of the fuel charge, and which clearance space during the exhaust stroke is reduced to a minimum.

A further object of the invention is to provide improved rotary valve mechanism to permit of the use of large fuel intake and exhaust ports for the free flow of the gases thereby avoiding back pressure and loss of power, and permitting of much higher speed, and to means to mount the valve mechanism to rotate on an axis eccentric to the axis of the valve and mount the piston cylinder upon the valve to permit of oscillatory movement of the cylinder and imparting reciprocatory movement to the cylinder relative to the movement of the piston.

A further object of the invention is to provide improved igniting means including an electric spark plug whereby the spark plug is caused to be placed in communication with the fuel charge in the cylinder and maintained out of communication with the cylinder during the combustion of the fuel and the exhausting of the burnt gases from the cylinder, and to provide means to wipe the sparking points of the plug to clean off soot or carbon which may have accumulated thereon.

A further object of the invention relates to means to water-cool the valve mechanism and cylinder.

In the drawings accompanying and forming a part of this specification Figure 1 is a sectional side elevation of an engine illustrating an embodiment of my invention, the section being taken substantially on the line A—A of Figs. 2 and 3.

Fig. 2 is a sectional end elevation taken on the line B—B of Fig. 3.

Fig. 3 is a plan view.

Fig. 4 is a longitudinal sectional view of the valve taken on the line C—C of Fig. 2.

Fig. 5 is a sectional view of a portion of the valve mechanism and cylinder to show the manner of connecting the cylinder through the valve with the exhaust outlet.

Fig. 6 is a sectional view of a portion of the valve and cylinder to show the manner of connecting the cylinder through the valve with the source of fuel supply; and

Figs. 7 to 10 inclusive are diagrammatic

views to show the different positions of the valve, cylinder and piston during a cycle of operations of the engine.

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

The embodiment of my invention shown in the drawings consists of a crank shaft 11 journaled in a crank case 12 and to which shaft a piston 13 is connected by a rod 14, the rod having a pivotal connection with a crank pin 15 and a fixed or rigid connection with the piston. The piston is reciprocable in a cylinder 16 having ports 17, 18 in the head for the entrance of the fuel charge and the exhaust of the products of combustion, and has a water jacket 19. The head of the cylinder has an extending portion 20 which is in the nature of a continuation of the cylinder, to which is removably connected a similar shaped portion 21 to provide a cylindrical valve chamber open at opposite ends or the sides of the cylinder and with which the ports 17 and 18 communicate.

A valve (designated in a general way by V) to control the charge of fuel to and the exhaust from the cylinder through the ports 17 and 18 rotatably engages in the valve chamber, the said valve having trunnions 22, 23, the axis of which trunnions is eccentric to the axis of the valve, whereby the valve is journaled in bearings or pillow blocks 24, 25 at the upper ends of standards 26 extending upward from the crank case and retained in said bearings by caps 27, 28. The bearings and caps have annular flanges, as at 29, to engage with the ends of the valve or shoulder formed by the trunnions and the ends of the valve chamber to constitute a guide for the valve chamber and valve during the rotation of the latter. The valve also serves as a pivotal support for the cylinder to permit oscillatory movement of the cylinder and impart reciprocatory movement to the cylinder relative to the movement of the piston for a purpose to be hereinafter described.

The charge of fuel to the cylinder is controlled by a by-pass port 30 in the valve adapted to connect the fuel intake port 18 of the cylinder with a port 31 in the bearing 25 and through a pipe 32 connect said latter port with the source of fuel supply. The exhaust from the cylinder is controlled through the ports 17 and 18 in the cylinder by a by-pass port 33 in the valve adapted to connect said cylinder ports with a port 34 in the bearing 24 to which is connected an exhaust outlet pipe 35. The valve is rotated from the piston through the crank shaft at one-half the velocity of the crank shaft through a miter gear 36 fixed to the crank shaft meshing with a miter gear 37 fixed to a shaft 38 journaled to rotate on a vertical axis in bearings 39 extending laterally from one of the standards 26, and a beveled pinion 40 fixed to said shaft meshing with a beveled gear 41 keyed to the trunnion 22 of the valve.

To ignite the fuel charge in the combustion chamber of the cylinder an electric ignition or spark plug 42 is secured in a recessed portion 43 of the valve by a nut 61 with the sparking points of the plug within the periphery of the valve. The plug is connected by a current conductor 44 with a terminal contact 45 carried by and insulated from the valve, as at 46. The contact 45 is adapted to intermittently place the plug in circuit with the source of electricity during the rotation of the valve by contacting with a terminal contact 47 connected in circuit with the source of electricity. The contact 47 is carried by an arm or bracket 48 secured to the bearing cap 27 to have adjustment in the arc of a circle to advance or retard the contact and thereby the spark of the plug. The sparking points of the plug ignite the fuel charge through an opening 64 to the recess 43 with which the gases have communication when the plug is in igniting position. To clean the sparking points of the plug after the ignition of a charge of fuel in the cylinder I provide a suitable brush 62 carried by a bracket 63 on the portion 21 of the valve chamber, the bristles of the brush being of such length to extend through an opening 64 in the valve chamber in line with the movement of the plug as it is rotated by the valve, and as the sparking points of the plug move over said bristles they will wipe off any soot, carbon or other foreign substance which might be on said sparking points and thereby insuring clean sparking points at all times. By the provision of the opening 64 in the valve chamber the spark plug and especially the sparking points of the plug may be examined at will without removal of the plug.

To cool the valve and valve chamber the valve has a water chamber or jacket (shown in a general way by 49) to extend around the ports 30, 33 and the recess for the spark plug, said chamber having an inlet 50 axially in the trunnion 23 to which one end of an inlet pipe 51 is connected, and an outlet 52 axially in the trunnion 22 to which is connected an outlet pipe 53. It will be obvious that the water inlet and outlet pipes 51, 53 are stationary and to make a water-tight joint connection between said pipes and the outlet and inlet in the trunnions the ends of said inlet and outlet are counter-bored, said pipes engaging in said inlet and outlet and having a flange portion 54 to engage with the bottom of the counter-bore and packing 55 placed in the counter-bore in back of the flange and retained therein by a flanged sleeve 56, the packing and sleeve being in the nature of a

stuffing box. The water jacket 19 for the cylinder has an inlet connected to the inlet pipe 51 by a pipe 57 having a flexible joint connection, as at 58, with the pipe 51, and also has an outlet connected by a pipe 59 through a flexible joint connection 60 with the outlet pipe 53 for the water jacket of the valve. By the flexible joint connections 58, 60 to the outlet pipes 51, 53 the inlet and outlet pipes 57, 59 will not interfere with the reciprocable movements of the cylinder.

The heads 24, 27 and 25, 28 are connected by tie rods 65 and maintained in yielding engagement with the ends of the valve and valve chamber by springs 66 interposed between one of said heads and a nut 67 on the adjacent end of said rods.

The operation is substantially as follows. Assuming the parts to be in the position shown in Fig. 2 with the piston in the cylinder at the end of its exhaust or scavenging stroke. Upon the next outward or suction stroke of the piston the valve will move to place the port 30 in connection with the cylinder port 18 connecting said latter port with the source of fuel supply through the port 31 and pipe 32, as shown in Fig. 7, the port 30 being open substantially to its full extent upon 90 degrees of revolution of the crank shaft. The valve will keep moving and as the piston reaches the end of its suction stroke, or the crank shaft is revolved 180 degrees, the cylinder port 18 will be entirely shut off by the valve and the ports will assume the position substantially as shown in Fig. 8. During the next stroke of the piston, or 180 degrees of revolution of the crank shaft, the charge of fuel will be compressed in the cylinder and simultaneously with the compression stroke of the piston the cylinder will be moved by its valve support in the same direction as the movement of the piston, but to a less extent, and when the piston has reached the end of its compression stroke, a clearance space, as shown at 68 in Fig. 9, will be provided, this clearance space, as is customary, being one-quarter of the volume of the combustion chamber, or one-third of the piston stroke. During this movement of the piston and cylinder the valve has brought the spark plug and the opening for said spark plug in the valve chamber in line with the cylinder port 18 and through said port in communication with the compressed fuel charge, the contact terminal 45 of the spark plug at this time having been brought into engagement with or passed over the contact terminal 47 and a spark created at the sparking points of the plug and the fuel charge ignited. At this time combustion of the fuel takes place and the piston is forced from the cylinder, the further movement of the valve moving the spark plug out of range of combustion of the fuel charge thus preventing soot and carbon forming or collecting on the sparking points. At the next inward movement of the piston the exhaust port 33 of the valve will connect the ports 17 and 18 of the cylinder with the port 34 and exhaust pipe 35, the exhaust ports being entirely open after the crank shaft has revolved substantially 90 degrees, as shown in Fig. 10.

Simultaneously with the exhaust stroke of the piston the cylinder is moved by its eccentric valve support in a direction opposite to the movement of the piston, but to a less extent, and when the piston has reached the end of its exhaust stroke the cylinder will have terminated said movement with the space between the cylinder head and piston reduced to a minimum when the ports will again be in the position shown in Fig. 2 with practically all of the burnt gases ejected from the cylinder, thus insuring a fresh and rich fuel charge in the cylinder which will ignite more readily and perfect combustion will take place increasing the power and speed for a given charge. During the next suction stroke of the piston the sparking points of the spark plug will be moved across the brush 62 thereby cleaning any soot, carbon or other foreign substance from said points.

By making the piston rod rigid with the connecting rod 14 the lateral movement imparted to the piston as the crank shaft is revolved will also be imparted to the cylinder which is permissible due to its pivotal support upon the valve, with the result that the piston and cylinder are relieved of the lateral thrust and the consequent wear on the piston and cylinder. Furthermore the expansion thrust of the fuel during combustion on the piston is at all times direct in a straight line with the center of the crank pin of the shaft.

The valve will wear tight automatically due to the upward thrust of the swinging cylinder as it opposes the action of the piston and as combustion takes place in the cylinder. The eccentricity of the valve with relation to its supporting trunnions is such that the valve will have a throw of one-third of the stroke of the piston, and it will be understood that when the valve is substantially at right angles to the force coming upon it, such as the cylinder being forced upward by the piston during the compression stroke and while combustion is taking place in the cylinder, the valve will act as a crank and first turn itself and after overcoming resistance and friction will transmit added power to the power or crank shaft. However, it is not intended to take power from this source other than that which is necessary to assist in revolving the valve. It will be noted that this friction only takes

place during the compression and power strokes of the piston and while the valve is in the most favorable position to overcome such friction, and the eccentric throw of the valve returns during the intake and exhaust strokes of the piston and while there is practically no force to overcome and swings around in time to receive the expansive forces of the gases in the cylinder during the next power stroke.

Having thus described my invention I claim:—

1. In an internal combustion engine, the combination of a crank shaft, a reciprocable piston connected thereto, a piston cylinder, and means to support said cylinder to permit said cylinder to oscillate to assume a position in axial alinement with the piston in all positions of the latter during the reciprocation thereof, to move the cylinder in a direction longitudinally of the piston during the movement of the piston to vary the space between the heads of the piston and cylinder for the purpose specified.

2. In an internal combustion engine, the combination of a crank shaft, a reciprocable piston connected thereto, a piston cylinder supported to permit said cylinder to be oscillated through the lateral thrust of the piston to assume a position in axial alinement with the piston in all positions of the latter during the reciprocation thereof, and to reciprocate said cylinder in a direction longitudinal of the piston and relative to the movement of the piston to vary the space between the heads of the piston and cylinder during the power and exhaust strokes of the piston.

3. In an internal combustion engine, the combination of a reciprocable piston; a piston cylinder having a head with a bore extending transversely to the bore of the cylinder; and an eccentrically mounted and rotatable support for the cylinder engaging in said head and operable from a moving part of the engine to move said cylinder longitudinally relative to the piston to vary the space between the piston and cylinder for the purpose specified.

4. In an internal combustion engine, the combination of a reciprocable piston; a piston cylinder having a head with a bore extending transverse to the bore of the cylinder; and a rotatable eccentrically mounted and rotatable support for the cylinder engaging in said head operable from the piston to impart longitudinal movement to the cylinder relative to the reciprocable movement of the piston to vary the space between the piston and cylinder during the cycle of operations of the piston and cause said cylinder to at all times assume a position in axial alinement with the piston in all positions of the latter during the reciprocation thereof.

5. In an internal combustion engine, the combination of a reciprocable piston; a piston cylinder having fuel intake and exhaust ports and a head the bore of which is transverse to the bore of the cylinder with which the cylinder ports communicate; and an eccentrically supported rotary valve engaging in said head to control the opening and closing of the cylinder ports and to support said cylinder to have longitudinal reciprocable movement in the same direction as the movement of the piston during the compression stroke of the piston and in a direction opposite to the movement of the piston during the exhaust stroke of the piston to vary the space between the piston and cylinder for the purpose specified.

6. In an internal combustion engine, the combination of a reciprocable piston; a piston cylinder having ports; rotary valve mechanism to control the charge of fuel to the cylinder through one of said ports and the exhaust from the cylinder through all of said ports; and means to support the cylinder from said valve mechanism to cause said cylinder at all times to assume a position in axial alinement with the piston and to have longitudinal movement imparted thereto, substantially as and for the purpose specified.

7. In an internal combustion engine, the combination of a reciprocable piston; a piston cylinder having fuel intake and exhaust ports and a valve chamber with which said ports communicate; and an eccentrically supported rotary valve to operate in the valve chamber, substantially as and for the purpose specified.

8. In an internal combustion engine, the combination of a reciprocable piston; a piston cylinder having fuel intake and exhaust ports and a valve chamber with which said ports communicate; a rotary valve to operate in said valve chamber to control the charge of fuel to and exhaust from the cylinder through the cylinder ports; and means to eccentrically support said valve and impart movement to the cylinder relative to the movement of the piston, substantially as and for the purpose specified.

9. In an internal combustion engine, the combination of a crank shaft and a reciprocable piston; a piston cylinder having fuel intake and exhaust ports in the head thereof, and a valve chamber at the head; a valve rotatable in said valve chamber operable from the piston to control the charge of fuel to and the exhaust from the cylinder, said valve having trunnions the axis of which trunnions is eccentric to the axis of the valve; and heads at opposite ends of the valve chamber and valve in which the valve trunnions are journaled, substantially as and for the purpose specified.

10. In an internal combustion engine, the combination of a crank shaft; a reciprocable piston connected thereto; a piston cylinder having fuel intake and exhaust ports in the head; a valve chamber integral with the cylinder; a valve rotatable in said valve chamber having trunnions the axis of which trunnions is eccentric to the axis of the valve; heads at opposite ends of the valve chamber and valve in which the valve trunnions are journaled, one of said heads having a port connected to the fuel supply and the other head having a port connected to the exhaust outlet, and said ports adapted to be placed in communication with the fuel intake and exhaust ports of the cylinder through the valve; and means to operate the valve from the piston, substantially as and for the purpose specified.

11. In an internal combustion engine, the combination of a crank shaft; a piston pivotally connected to the crank shaft; a piston cylinder having fuel intake and exhaust ports in the head; a valve chamber constituting a continuation of the cylinder head; a valve rotatable in said chamber having supporting trunnions, the axis of said trunnions being eccentric to the axis of the valve; heads supported in a fixed position at opposite ends of the valve chamber and valve in which the valve trunnions are journaled, one of said heads having a port connected to the fuel supply and the other head having a port connected to the exhaust outlet and said ports adapted to be placed in communication with the fuel intake and exhaust ports of the cylinder through the valve; and means to connect and rotate the valve from the crank shaft, substantially as and for the purpose specified.

12. In an internal combustion engine, the combination with a cylinder having a water jacket and fuel inlet and exhaust ports, and a piston to operate therein, of a rotary valve having trunnions whereby it is rotatably supported; by-pass ports in said valve to connect the cylinder ports with the source of fuel supply and the exhaust; a water jacket in the valve around said ports having an inlet in one of the trunnions and an outlet in the other trunnion; water inlet and outlet pipes connected to said trunnions; and inlet and outlet pipes connected to the water jacket of the cylinder and having a flexible joint connection with the outlet and inlet pipes of the water jacket in the valve.

ROBERT G. CLARK.