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F. C. OLIN.

GAS ENGINE.

No. 569,564. Patented Oct. 13, 1896.

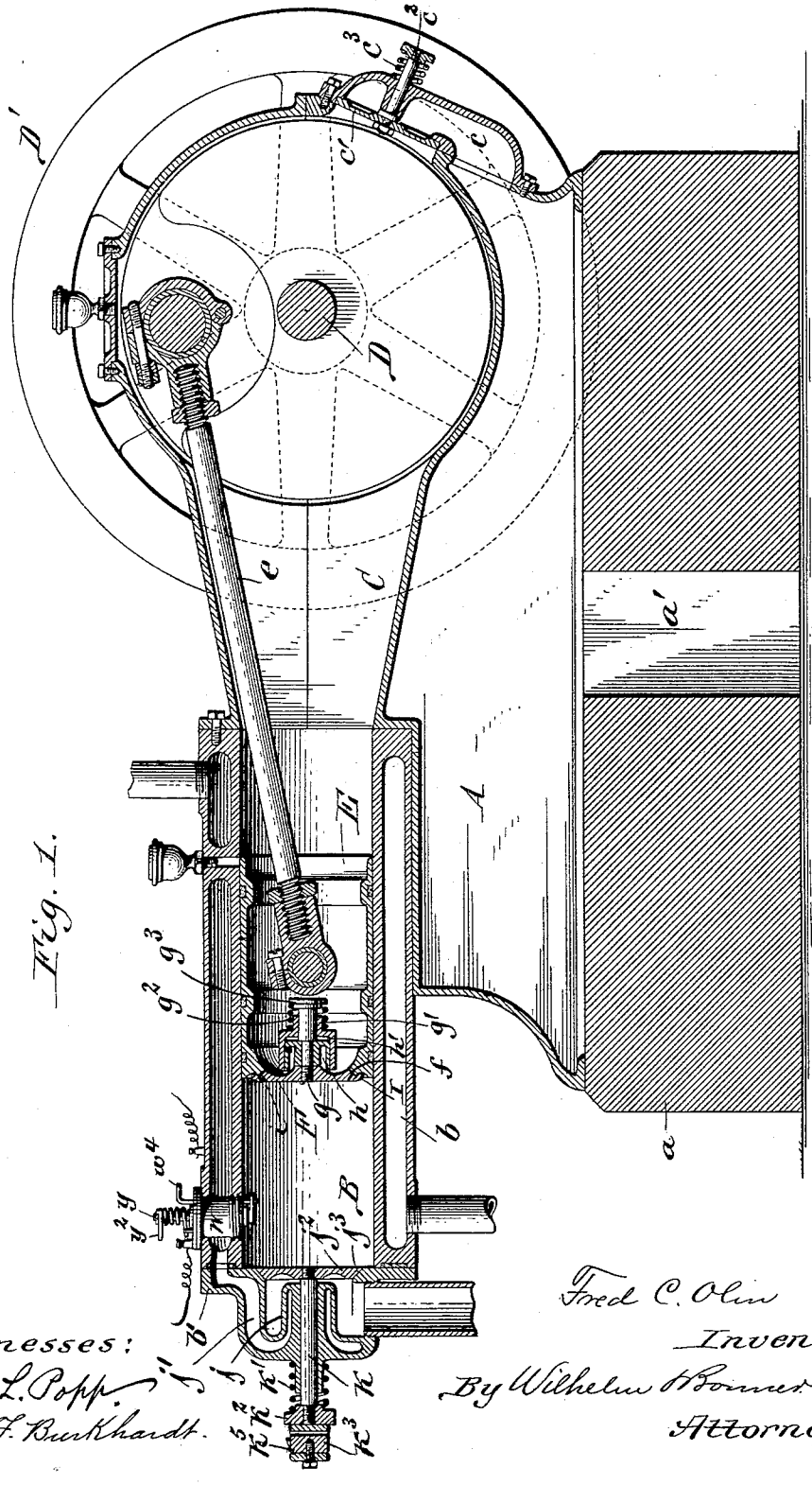

Fig. 1.

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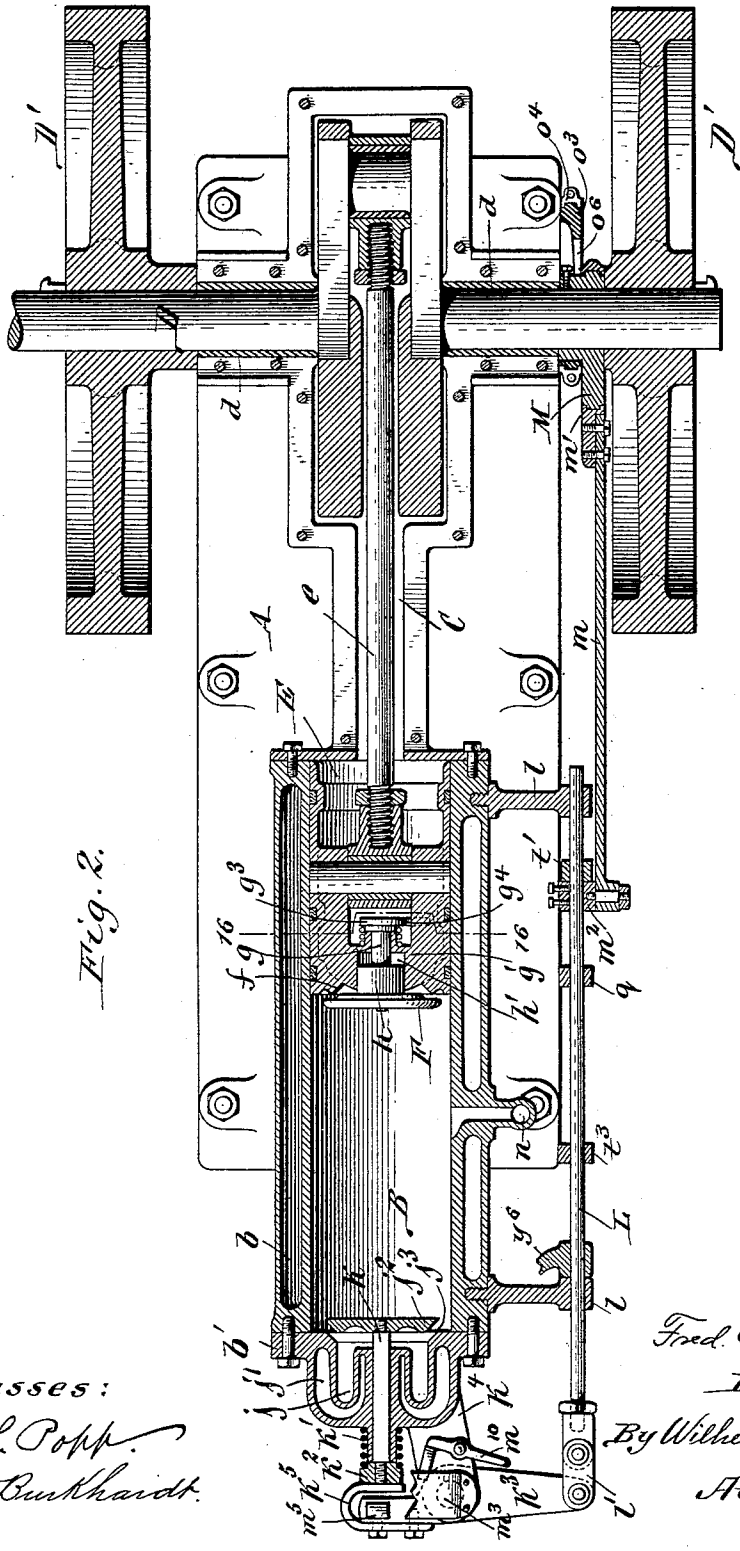

Fig. 2.

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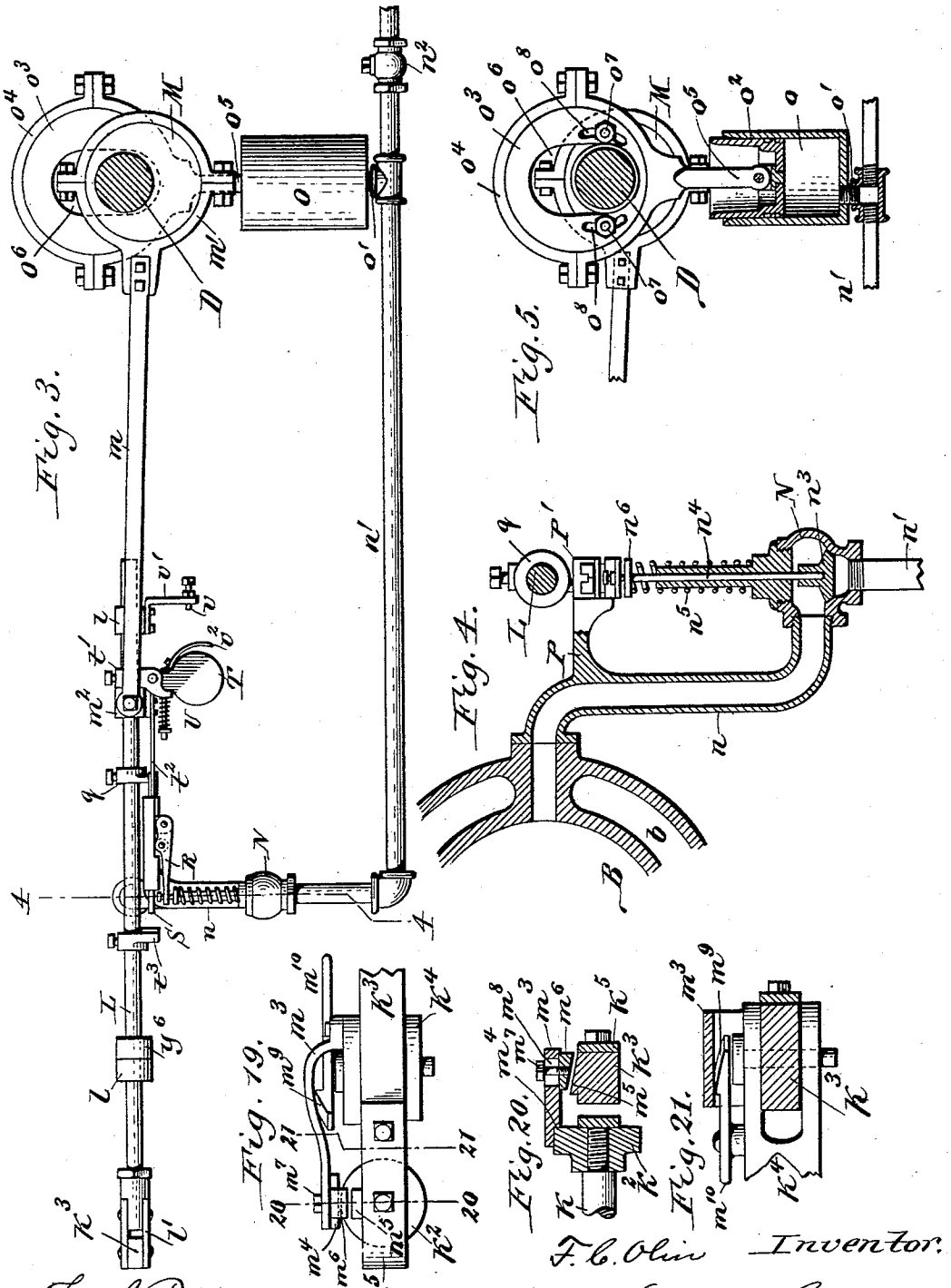

Fig. 3.

Fig. 5.

Fig. 4.

Fig. 19.

Fig. 20.

Fig. 21.

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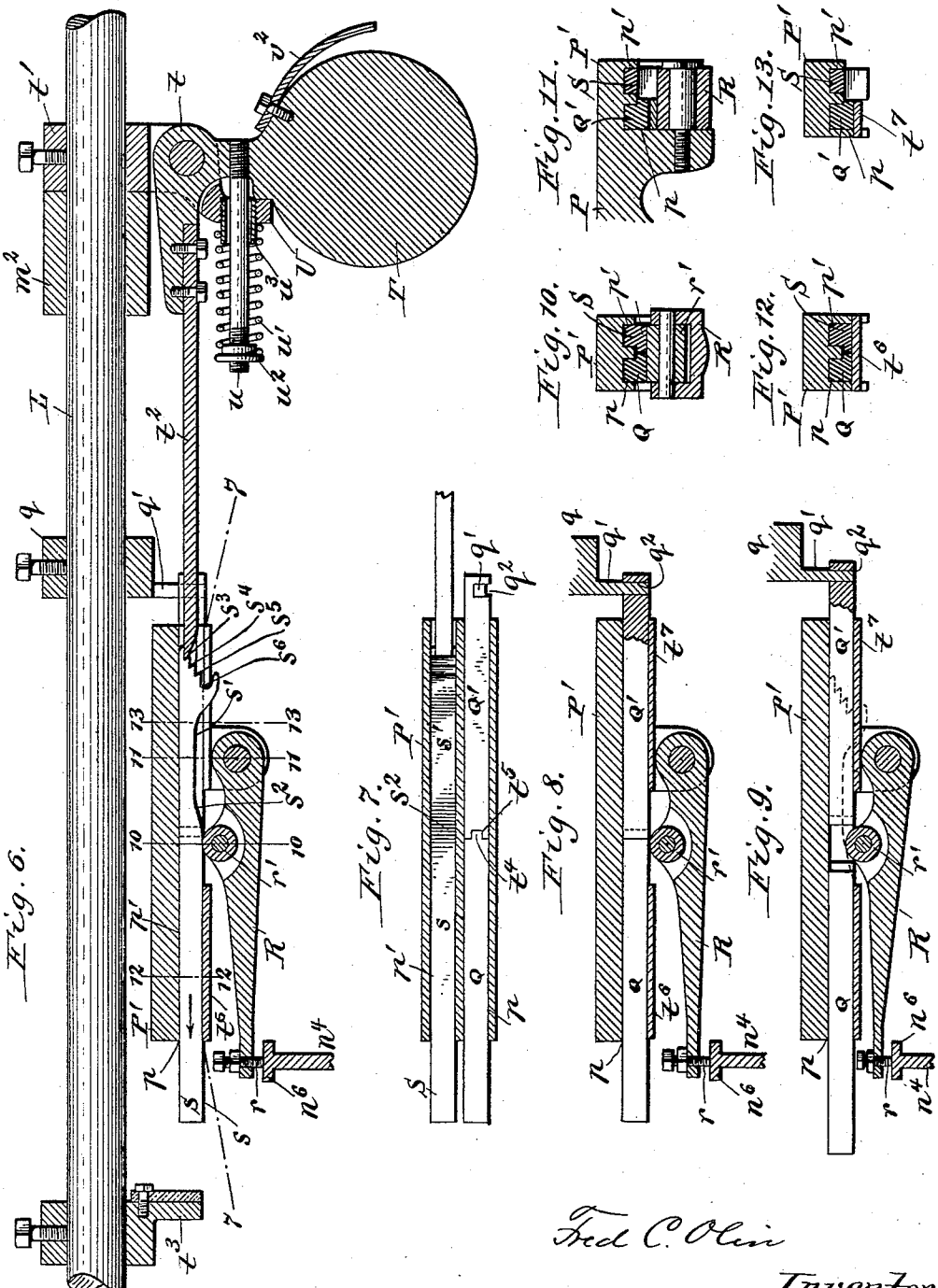

Fig. 6.

Fig. 11.

Fig. 13.

Fig. 10.

Fig. 12.

Fig. 7.

Fig. 8.

Fig. 9.

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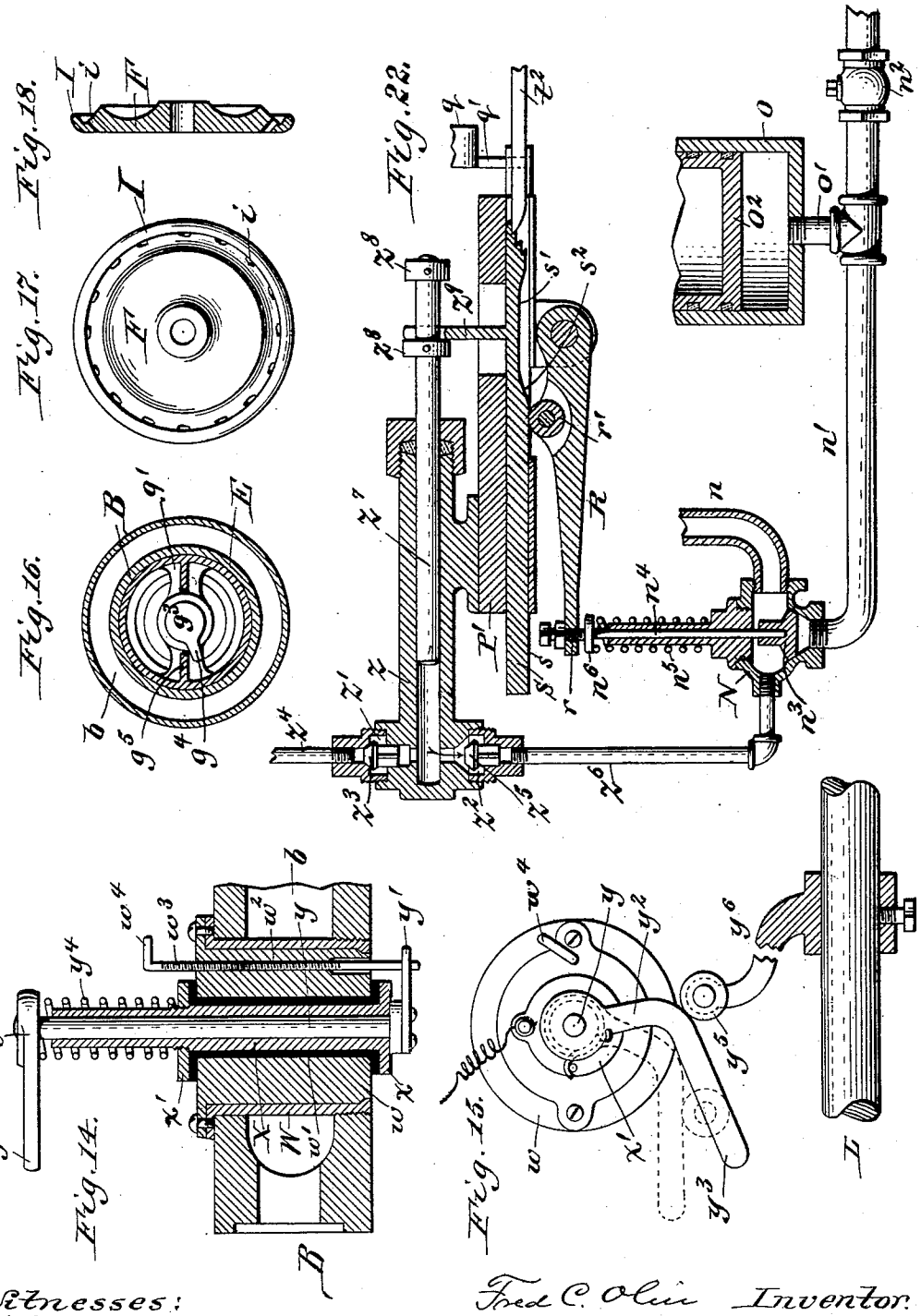

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UNITED STATES PATENT OFFICE.

FRED C. OLIN, OF BUFFALO, NEW YORK.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 569,564, dated October 13, 1896.

Application filed August 7, 1894. Serial No. 519,628. (No model.)

To all whom it may concern:

Be it known that I, FRED C. OLIN, a citizen of the United States, residing at the city of Buffalo, in the county of Erie and State of New York, have invented new and useful Improvements in Gas-Engines, of which the following is a specification.

This invention relates to that class of engines in which the power is derived by the rapid combustion of fuel in a cylinder containing a piston.

One of the objects of my invention is to provide an engine of this character in which the different parts forming the explosive mixture are not commingled until they reach the firing-space, in which the expansion of the fuel charge when exploded is about twice that of its compression, and in which a working impulse may be obtained during each revolution of the crank-shaft.

My invention has the further object to improve the construction of the piston-valve, to improve the means for operating the exhaust-valve, to provide a reliable mechanism for regulating the supply of fuel, to produce an economical and positive electric igniter, and to simplify and improve the machine in other respects.

In the accompanying drawings, consisting of five sheets, Figure 1 is a longitudinal sectional elevation of my improved engine. Fig. 2 is a horizontal section thereof. Fig. 3 is a side elevation of the mechanism for feeding gaseous fuel into the cylinder and the means for regulating the fuel supply. Fig. 4 is a vertical cross-section, on an enlarged scale, in line 4 4, Fig. 3. Fig. 5 is a fragmentary sectional elevation of the fuel-pump and its driving mechanism. Fig. 6 is a longitudinal sectional elevation, on an enlarged scale, of the governor, the section being taken on one side of the regulating-slide. Fig. 7 is a fragmentary horizontal section in line 7 7, Fig. 6, looking upward. Figs. 8 and 9 are fragmentary longitudinal sections of the governor, taken on one side of the sectional releasing-slide and showing the latter in different positions. Figs. 10, 11, 12, and 13 are vertical transverse sections in lines 10 10, 11 11, 12 12, and 13 13, Fig. 6, respectively. Fig. 14 is a vertical section, on an enlarged scale, of the igniter. Fig. 15 is a top plan view of the same. Fig. 16 is a cross-section in line 16 16, Fig. 2. Fig. 17 is a rear view, on an enlarged scale, of the air-inlet valve in the working piston. Fig. 18 is a cross-section of the same. Fig. 19 is a fragmentary end elevation, on an enlarged scale, of the mechanism for operating the exhaust-valve. Figs. 20 and 21 are fragmentary longitudinal sections, on an enlarged scale, in lines 20 20 and 21 21, Fig. 19, respectively. Fig. 22 is a longitudinal sectional elevation of the governor, showing the same adapted for feeding fluid fuel to the working cylinder.

Like letters of reference refer to like parts in the several figures.

A represents a hollow base resting upon a pedestal *a*, which latter has an opening *a'* for the admission of air into the hollow base.

B represents the working cylinder, arranged horizontally upon the front portion of the base and preferably provided with a water-jacket *b*. The rear end of the cylinder is open and its front end is provided with a head *b'*.

C represents an air-compressing chamber arranged above the hollow base and communicating with the open rear end of the working cylinder.

c represents a passage connecting the hollow base with the compressing-chamber and provided with a check-valve *c'*, which opens inwardly to permit the air to pass from the hollow base into the compressing-chamber, but prevents the air from moving in the reverse direction. The check-valve *c'* is arranged to bear against a seat formed around the outlet of the passage *c*, and is provided with a stem c^2, which is guided in the wall of the passage *c*. The check-valve is yieldingly held against its seat by a spring c^3, bearing with its ends against the wall of the passage and a collar secured to the valve-stem.

D represents the crank-shaft, journaled in bearings *d* on the base and having its crank arranged to rotate within the compressing-chamber. The crank-shaft is provided on opposite sides of the base with balance-wheels D'.

E represents the working piston, arranged in the working cylinder and connected with the crank-shaft by a pitman *e*, extending through the open end of the cylinder. The

front portion of the cylinder between its head and the working piston forms a firing-space, into which pure air and fuel are introduced separately to form an explosive mixture, and in which the latter is ignited for driving the piston forwardly. During the backward stroke of the piston pure air is drawn into the compressing-chamber past the check-valve, and during the subsequent forward movement of the piston under the pressure of the explosive the air in the compressing-chamber is compressed. This compressed air may be delivered at the proper time into the firing-space in any suitable way, but is preferably carried through the piston. For this purpose the working piston is made hollow and is provided with an automatic disk valve F, which opens toward the firing-space for allowing the air to pass from the compressing-chamber into the firing-space and closes for compressing the air in the compressing-chamber. In this manner the piston E serves the double function of a working piston, which is acted upon by the explosive, and a plunger for compressing pure air and pumping the same into the firing-space. The disk valve F is arranged to bear against an annular seat f, formed on the front end of the working piston, and is screwed upon the front end of a valve-stem g. The latter is guided in a cross piece or bridge g', formed on the inside of the piston, and the valve is normally held against its seat by a spring g^2, surrounding the valve-stem and bearing with its ends against the rear side of the bridge and a head g^3, formed on the rear end of the valve-stem. The head of the valve-stem is provided with a radial arm g^4, which is adapted to strike against a projection or stop g^5 on the inner side of the cylinder for the purpose of holding the valve-stem against rotation when it is desired to screw the piston-valve upon or unscrew the same from the valve-stem.

In order to cause the valve in the piston to work without jarring, a dash-pot is interposed between said valve and the piston, consisting of a dash or plunger h, mounted on the valve-stem and arranged to enter a cylinder or pot h' in the front side of the bridge g'. The plunger bears with its front end against the piston-valve and with its rear end against a shoulder formed on the valve-stem.

I represents an annular flange formed on the margin of the piston-valve and projecting rearwardly, and i is an annular row of air-openings formed in the piston-valve inside of the flange and extending from the face on the rear side of the valve obliquely inward to the front side thereof. As the air passes through the piston and around the valve a portion of it is deflected outwardly against the wall of the cylinder by the flange, while the remaining portion passes through the openings in the valve and is delivered into the central part of the cylinder, thereby delivering the air into the rear portion of the firing-chamber in a more solid state and preventing the same from mixing with the burned gases of the previous charge of fuel. The head closing the front end of the working cylinder is provided with an exhaust-chamber j, opening into the firing-space and surrounded by a water-jacket j', communicating with the water-jacket of the working cylinder.

j^2 represents an inwardly-opening exhaust-valve, whereby the firing-space is placed in communication or shut off from the exhaust-chamber. This valve is adapted to bear against a seat j^3, formed on the inner side of the cylinder-head, and is secured to the inner end of the valve-stem k, which latter is arranged to slide through the cylinder-head. The exhaust-valve is normally held against its seat for closing the same by a spring k', surrounding the valve-stem and bearing with its ends against the outer side of the cylinder-head and a head or screw nut k^2, secured to the outer end of the valve-stem.

k^3 represents a rock-lever whereby the exhaust-valve is opened and which is pivoted between its arms upon a bifurcated bracket k^4, arranged on the cylinder-head. The inner arm of the rock-lever is provided with a spring k^5, which bears against the outer end of the exhaust-valve stem in the act of opening the latter.

L represents an actuating-rod arranged to reciprocate lengthwise on one side of the working cylinder and supported in guide-arms l, secured to said cylinder. The front end of the actuating-rod is connected by a link l' with the outer arm of the exhaust rock-lever.

M is an eccentric-disk whereby the exhaust-valve is actuated and which is secured to the crank-shaft.

m is a connecting rod or bar provided at one end with an eccentric-strap m', surrounding the eccentric-disk and pivotally connected at its opposite end to a collar m^2, secured to the actuating-rod.

The exhaust-valve must remain closed during a portion of each cycle of the engine, and in order to enable this valve to be operated by the eccentric-disk, which moves constantly, the latter is so constructed that it produces an outward movement of the inner arm of the exhaust-lever in excess of what is necessary to close the exhaust-valve. The exhaust-valve is held open by the inner arm of the exhaust-lever during the last portion of its inward movement and the first portion of its outward movement. After the exhaust-valve is closed said arm continues to move idle during the remainder of its outward movement and the first portion of its subsequent inward movement until it again comes in contact with the exhaust-valve stem. By interposing a cushioning spring between the exhaust rock-lever and the exhaust-valve stem it prevents noise and jarring when these parts come in contact with each other. The exhaust-valve is opened upon approaching the end of the forward stroke of the working

piston and remains open until the piston has completed about one-half of its backward stroke. During the remainder of the backward stroke of the piston the previously-introduced charge of fuel confined between the piston and the cylinder-head is compressed preparatory to ignition.

For the purpose of starting the engine the piston is moved forward and backward to the beginning of its forward stroke by turning the crank-shaft by hand, and in order to enable this to be done easily without compressing the full charge of fuel the exhaust-valve is held open for a greater length of time during the backward stroke of the piston by the following mechanism:

m^3 represents a spring-arm secured at one end to the bifurcated bracket and provided at its opposite end with a movable stop or shoulder m^4, which is adapted to engage against the outer end of the head of the exhaust-valve stem. When the inner arm of the exhaust-lever moves inwardly and opens the exhaust-valve to its fullest extent the spring-arm, unless restrained, carries the stop downwardly in front of the head on the valve-stem and prevents the exhaust-valve from closing during the subsequent outward movement of the inner arm.

m^5 is a lug arranged on the upper side of the inner arm and provided with an inclined face which is adapted to engage with a similar inclined face formed on a block m^6, which latter is adjustably secured to the under side of the spring-arm by a bolt m^7, passing through a slot m^8 in the spring-arm. During the last portion of the outward movement of the exhaust-valve and the inner arm h^3 the inclined lug of the latter engages with the inclined block of the spring-arm and lifts the latter sufficiently to disengage its shoulder from the head of the valve-stem, thereby permitting the spring k' to close the exhaust-valve. By shifting the inclined block on the spring-arm the time of releasing the spring-arm and closing the exhaust-valve may be varied. After the first working impulse of the piston the spring-arm is elevated into an inoperative position, so that its shoulder cannot engage with the head of the exhaust-valve stem. This is accomplished by means of a wedge m^9, engaging against the under side of the spring-arm and arranged upon one end of a lever m^{10}, which is pivoted on the bifurcated bracket.

Fuel is supplied to the working cylinder by a supply-pipe composed of two sections $n\,n'$. The section n has its outlet connected with the central portion of the working cylinder, while its inlet is connected with the outlet of the casing N of a regulating-valve. The section n' of the supply-pipe has its outlet connected with the inlet of the valve-casing N and its inlet with an inwardly-opening check-valve n^2 of any suitable construction.

n^3 is a regulating-valve arranged in the valve-casing B and adapted to bear against a seat for closing the inlet of said valve-casing.

n^4 represents a vertical valve-stem which rests loosely with its lower end upon the regulating-valve and passes upwardly through the bonnet of the valve-casing. When the valve-stem is free, it is lifted by a spring n^5, bearing with its ends against the valve-bonnet, and a head n^6, formed on the upper end of the valve-stem, thereby permitting the regulating-valve to be lifted from its seat by the pressure of the fuel below the valve and allowing the fuel to pass into the working cylinder.

Q represents the barrel of a fuel-supply pump, which is connected with the supply-pipe between the regulating and check valves by a branch pipe o', and o^2 is the plunger of the fuel-pump. During the upward movement of the plunger the fuel is drawn through the check-valve into the pump-barrel, and during its downward movement the contents of the barrel is forced toward the regulating-valve.

o^3 is an eccentric-disk mounted on one side of the eccentric-disk M, which operates the exhaust-valve, and provided with an eccentric-strap o^4, which is connected with the plunger of the fuel-pump by a pitman o^5. The pump eccentric-disk is provided with an elongated opening o^6, through which the crank-shaft passes and is adjustably secured to the inner side of the exhaust eccentric-disk by bolts o^7, passing through slots o^8, formed in the pump eccentric-disk on opposite sides of the opening o^6. By adjusting the pump eccentric-disk radially with reference to the crank-shaft the stroke of the plunger can be varied for feeding different quantities of fuel. By adjusting the pump eccentric-disk circumferentially the pump can be properly timed.

The regulating-valve and the fuel-pump are so timed with reference to each other that the valve remains closed during the first portion of the compression stroke of the pump, so that the fuel is partly compressed and forced into the working cylinder under high pressure the instant the regulating-valve is opened, thereby causing the same to commingle more readily with the air in the cylinder.

The feeding of the fuel into the working cylinder is controlled for regulating the speed of the engine by a governor, which is constructed as follows:

P represents a bracket formed on the section n of the fuel-supply pipe and provided with a horizontal guide-bar P', having two parallel longitudinal guide-grooves $p\,p'$ on its under side.

Q Q' are the two sections of a releasing-slide, whereby the opening of the regulating-valve is controlled. These slide-sections are

arranged in line in the groove p of the guide-bar and have their under sides provided with horizontal or flat bearing-faces.

q represents a collar secured to the actuating rod and provided with a depending finger q', which engages with a notch q^2, formed in the rear end of the rear slide-section Q', thereby causing the latter to take part in the reciprocating movement of the actuating-rod. The front section Q of the releasing-slide is loosely supported in the groove p.

R represents a trip-arm arranged lengthwise underneath the releasing-slide and pivoted at one end to the bracket P and provided at its opposite end with a screw r, bearing against the upper end of the stem of the regulating-valve. The trip-arm is provided on its upper side with a trip-collar r', which bears with one portion against the under side of the releasing-slide sections. The spring of the regulating-valve exerts a constant tendency to raise the trip-collar through the medium of the valve-stem and trip-arm. During the backward movement of the actuating-rod the rear section of the releasing-slide is moved backward with it and the latter in turn moves the front section of the releasing-slide backwardly. While the slides are moving backwardly their opposing ends abut against each other and form a continuous bearing-surface which forms an abutment for the trip-roller and holds the latter in a depressed position and the regulating-valve connected therewith in a closed position. At the end of the backward movement of the actuating-rod the releasing-slide sections have been moved backwardly, so that the joint between the same stands at a small distance in front of the roller of the trip-arm. During the first portion of the subsequent forward movement of the actuating-rod the rear releasing-slide section moves with said rod, but the front section remains stationary, thereby forming a gap or recess between the two sections, which permits the spring n^5 to raise the trip-roller into the recess between the slide-sections through the medium of the regulating-valve stem and trip-arm, thereby releasing the regulating-valve and permitting the fuel which is under pressure to lift the same from its seat and pass into the firing-space of the working cylinder.

S represents a regulating-slide whereby the extent of the opening movement of the regulating-valve is controlled when released by the releasing-slide. This slide is arranged in the groove p' of the guide-bar over the opposite end of the trip-roller and provided with a horizontal face s on the under side of its front portion, a recess s' on the under side of its rear portion, and an inclined face s^2, extending from the bottom of the recess to the horizontal face. When the trip-roller bears against the horizontal face of the regulating-slide, the arm and regulating-valve connected therewith are held in a depressed position. Upon shifting the regulating-slide backwardly in the direction of the arrow, Fig. 6, so that its inclined face or its recess stands over said trip-roller, the trip-arm, unless otherwise prevented, is lifted by the spring n^5, thereby permitting the regulating-valve to be opened by the pressure of the fuel in the supply-pipe. The rear end of the regulating-slide is provided with a series of notches or ledges s^3 s^4 s^5 s^6, which are arranged in the form of steps and recede progressively downward and forward from the rear end of the regulating-slide.

T represents a depending governor-weight provided at its upper end with an eye t, which is pivoted horizontal to a collar t', secured to the actuating-rod, so as to partake in the reciprocating movement of the rod.

t^2 is a horizontal shifting arm whereby the regulating-slide is moved backwardly in the guide-bar. This arm is arranged at right angles to the governor-weight and secured with one end to an extension formed on the eye of said weight, while its opposite end is provided with a knife-edge, which is adapted to engage with one of the series of notches in the rear end of the regulating-slide. When the actuating-rod moves backwardly at a comparatively slow speed, the governor-weight remains in its normal position, thereby holding the shifting arm in a horizontal position and causing its knife-edge to engage with the uppermost notch of the regulating-slide. When this takes place, the regulating-slide is moved backwardly its fullest extent by the actuating-rod, thereby bringing the recess or the upper end of the inclined face over the trip-roller at the end of the backward movement of the actuating-rod and permitting the regulating-valve to be opened its fullest extent. As the speed of the actuating-rod increases during its backward movement the inertia of the governor-weight depresses the free end of the shifting arm and causes the same to engage with one of the lower notches of the regulating-slide, thereby proportionately reducing the extent of the backward movement of the regulating-slide and bringing a lower part of the inclined regulator-face over the roller of the trip-arm. This reduces the extent of the opening of the regulating-valve, thereby reducing the supply of fuel to the working cylinder and the speed of the engine proportionately. Although the recess or the incline of the regulating-slide stands over the trip-roller at the end of the backward movement of the actuating-rod, the trip-roller is still held down, and the valve is held shut by the releasing-slide; but when the sections of the latter separate and form a gap during the first portion of the subsequent forward movement of the actuating-rod the regulating-valve is permitted to open in accordance with the position of the inclined face of the regulating-slide. By this means the opening of the valve is controlled by the releasing-slide sections, while the extent which said valve is opened is governed by the

regulating-slide. During the last portion of the forward movement of the actuating-rod the regulating-slide and the front section of the releasing-slide are returned to their normal position by a tappet t^3, secured to the actuating-rod and engaging against the front ends of said slides. In order to prevent the trip-roller from accidentally separating and forming a gap between the sections of the releasing-slide before the proper time, the end of one section of the releasing-slide is provided with a tenon t^4, which engages with a recess t^5, formed in the opposing end of the other section, as represented in Fig. 7, thereby forming a bridge across the joint. The front section of the releasing-slide and the regulating-slide are confined in their respective guide-grooves by a plate t^6, secured to the under side of the front portion of the guide-bar, and the rear section of the releasing-slide is secured in its guide-groove by a plate t^7, secured to the under side of the rear portion of the guide-bar.

In order to enable the inertia of the governor-weight to be varied to suit different requirements, an adjusting device is provided, which is constructed as follows:

U represents a yoke formed on the lower portion of the supporting-collar t' and arranged in front of the governor-weight so as to act as a stop to limit the backwardly-swinging movement of the governor-weight.

u is a tension-rod passing through an opening in the yoke and secured with its rear end to the governor-weight.

u' is a tension-spring surrounding the tension-rod and bearing with its ends against the front side of the yoke and a screw-nut u^2, applied to the screw-threaded front end of the tension-rod. Upon turning the screw-nut the tension of the spring can be varied for adjusting the inertia of the governor-weight. The rear portion of the tension-spring is preferably held in its proper position by a screw-sleeve u^3, surrounding the tension-rod and screwed with its rear end into the yoke, while its front end enters the coils of the tension-spring.

v represents a stop-screw arranged upon a hanger v', which depends from the rear guide-arm of the actuating-rod. At the end of the forward stroke of the actuating-rod the stop-screw v engages against a spring v^2, secured to the rear side of the governor-weight, thereby yieldingly pressing the latter against the yoke and bringing it to a standstill without jarring the machine. By quieting the governor-weight at the end of each forward stroke the subsequent backward stroke is always begun under the same conditions and insures proper working of the regulating mechanism.

After the charge of fuel and air has been properly mixed and compressed in the working-cylinder the same is ignited automatically by the following mechanism:

W represents a cylindrical socket arranged near the front end of the working cylinder and extending from the inner side of the latter to the outer side of the water-jacket.

w is a plug which is removably secured in said socket by screws and provided with a central opening w' and a screw-threaded opening w^2, arranged on one side of the central opening, both openings extending from end to end of the plug.

w^3 is a screw-threaded contact-rod arranged in the threaded opening of the plug and having its inner end extending beyond the inner side of the cylinder, while its outer end is provided outside of the water-jacket with a crank-arm w^4. One pole of an electric generator is connected with the cylinder or other suitable part of the engine and terminates at the inner end of the contact-rod.

X represents a bearing-sleeve arranged in the central opening of the plug and provided at its inner end with a flange x, which overlaps the inner end of the plug. The upper portion of the bearing-sleeve is provided with an external screw-thread which receives a screw-nut x', bearing against the outer end of the plug. The bearing-sleeve and its flange and screw-nut are insulated from the plug by any suitable material.

y represents a rock-spindle journaled in the bearing-sleeve and provided at its inner end within the working cylinder with a radial contact-finger y', which is adapted to bear against the contact-rod. The upper end of the rock-spindle, which is arranged outside of the cylinder, is provided with a radial trip-arm y^2, having an extension y^3 at its free end, which is arranged at an angle to the radial portion of the trip-arm. The opposite pole of the electric generator is connected with the screw-nut or bearing-sleeve and terminates at the contact-finger of the spindle. The contact-finger is normally held against the inner end of the contact-rod for closing the electric circuit by a spring y^4, which surrounds the upper portion of the bearing-sleeve and is secured with its ends to the screw-nut x' and the trip-arm.

y^5 represents a tappet-roller whereby the contact-finger is separated from the contact-rod to form a spark for the purpose of igniting the charge of fuel. This roller is pivoted on the end of an arm y^6, secured to the actuating-rod, and is adapted to engage against the trip-arm at the end of the backward movement of the working piston, thereby separating the contact-finger and arm and igniting the charge when at the point of greatest compression. The eccentric which operates the actuating-rod is so arranged on the crank-shaft that it always moves the latter approximately in a direction opposite to that of the working piston. The tappet-roller deflects the trip-arm for igniting the charge during the first portion of the backward movement of the actuating-rod, and during the balance of the backward and the first portion of the subsequent forward movement thereof the tappet-roller continues to bear against the

trip-arm, thereby holding the contact-finger out of engagement with the contact-rod and preventing waste of the electric current. During the last portion of the forward movement of the actuating-rod the tappet-roller leaves the trip-arm, which allows the contact-finger to make connection with the contact-rod and close the circuit momentarily.

The angle of the extension y^3 on the trip-arm is such that the tappet-roller upon engaging with the same during the idle portion of its movement will not continue to turn the spindle after the contact-finger has been separated from the contact-rod the proper distance, thereby avoiding undue tensioning of the spring y^4.

When the lower end of the contact-rod becomes worn by the contact-finger, the point of contact between these parts can be shifted by turning the rod, thereby moving the same lengthwise.

After the engine has been started the operation during one cycle is as follows: Assuming that the explosive mixture which has previously been compressed by the backward stroke of the piston is fired by the igniter, the expansion of the combustible charge will impel the piston forwardly. While combustion takes place in the cylinder the exhaust-valve is held closed mechanically and the piston-valve is held closed by the pressure of the exploding charge. During the greater portion of the forward stroke of the piston the latter compresses the air which is confined in the rear portion of the cylinder and in the air-compressing chamber. Just before completing the forward stroke of the piston the exhaust-valve opens, thereby permitting the products of combustion to escape and removing the pressure against the front side of the piston-valve. The instant this takes place the compressed air in rear of the piston opens the piston-valve and rushes into the cylinder in front of the piston, thereby driving the bulk of the products of combustion out of the firing-space and through the exhaust-passages. The exhaust-valve is still held open during the first half of the backward stroke of the piston, which causes all trace of gaseous products still remaining in the firing-space to be expelled with the excess of air. A fresh supply of air is drawn into the compressing-chamber by the piston during its backward stroke. When the piston has completed about one-half of its backward stroke, at which time it has not yet reached the fuel-inlet passage and at which time the exhaust-valve is still open, the fuel-inlet valve opens and permits a charge of fuel to be delivered into the cylinder in front of the piston. As soon as the feed of the fuel into the cylinder has been completed, which takes place about the middle of the return stroke of the piston, the latter covers the fuel-inlet passage and the exhaust-valve closes, which causes the air and fuel in front of the piston to be mixed and compressed during the remaining portion of the backward stroke of the piston. The instant the latter reaches the end of its backward stroke the igniter produces a spark which fires the charge for propelling the piston through the next following cycle. By this timing and construction of the parts the expansion of the charge of explosive mixture is about twice that of the compression of the charge.

The construction of parts illustrated in Figs. 3, 4, and 6 are adapted for an engine which is operated by gaseous fuel. If it is desired to operate the engine by means of gasolene or other suitable liquid fuel the construction of the engine may be modified, as illustrated in Fig. 22. In this figure z represents a pump cylinder or barrel mounted on the top of the guide-bar and provided with inlet and outlet chambers z' z^2. The inlet-chamber is provided with an inwardly-opening check-valve z^3 and connected with a liquid-fuel supply by a pipe z^4. The outlet-chamber is provided with an outwardly-opening check-valve z^5 and is connected with the receiving end of a delivery-pipe z^6. The outlet of the latter opens into the casing of the regulating-valve on the back or upper side of the valve.

z^7 is a plunger arranged in the pump-barrel and provided on its outer end with two collars z^8. The upper side of the regulating-slide is provided with an arm z^9, which projects through a slot in the top of the guide-bar and is provided with a fork which straddles the pump-plunger between its collars. During the reciprocating movement of the regulating-slide the plunger is carried with it and delivers a charge of fluid fuel into the casing of the regulator-valve. When fluid fuel is used for running the engine, the supply-pipe n' is connected with an air-supply instead of gas, which causes the fuel-pump to deliver a jet of air into the casing of the regulating-valve, thereby carrying the liquid fuel from the latter into the cylinder in the form of spray, which enables it to mix more readily with the air in the cylinder.

I claim as my invention—

1. The combination with the cylinder provided with an exhaust-valve in its front end, of a piston arranged in the cylinder and provided with an air-inlet valve, a fuel-port opening into the cylinder about midway of its length, a fuel-valve controlling the passage of fuel through said port and capable of being opened when the piston reaches about the middle of its backward stroke just before the piston covers the fuel-port and mechanism whereby the exhaust-valve is closed during the forward stroke of the piston, opened during about one-half of the backward stroke thereof and until after the fuel-valve has been opened and then closed during the remainder of the backward stroke of the piston, substantially as set forth.

2. The combination with the engine-cylinder and the hollow piston provided with a valve-seat, of a valve adapted to bear against said seat and provided with a marginal flange

which projects rearwardly, substantially as set forth.

3. The combination with the engine-cylinder and the hollow piston provided with a valve-seat, of a valve adapted to bear against said seat and provided near its margin with a row of openings, substantially as set forth.

4. The combination with the engine-cylinder and the hollow piston provided with a valve-seat, of a valve adapted to bear against said seat, said valve being provided with a marginal rearwardly-projecting flange and an annular row of openings on the inner side of said flange, substantially as set forth.

5. The combination with the engine-cylinder and the hollow piston provided with a bridge or stop, of a valve adapted to bear against a seat on the piston, and provided with an internally-screw-threaded opening, a valve-stem guided in said bridge and having an external screw-thread at one end which engages with the threaded opening of the valve and a radial arm arranged on the valve-stem and adapted to strike said stop for holding the stem against turning, substantially as set forth.

6. The combination with the engine-cylinder and the hollow piston, of a bridge extending across the piston and provided with a pot or barrel, a valve adapted to bear against a seat formed on the piston, a stem supporting said valve and guided in said bridge and a plunger or dash secured to the stem and fitting into the pot or barrel, substantially as set forth.

7. The combination with the engine-cylinder and the exhaust-valve provided with a stem, of a rock-lever adapted to bear loosely against said stem for opening the valve, and a spring-arm provided at one end with a shoulder which is adapted to engage with the stem and hold the valve open, substantially as set forth.

8. The combination with the engine-cylinder and the exhaust-valve provided with a stem, of a rock-lever adapted to bear loosely against said stem for opening the valve, a spring-arm provided with a shoulder adapted to engage with said stem for holding the valve open, and an inclined lug formed on the rock-lever and adapted to engage with said spring-arm for throwing its shoulder out of engagement with the stem and permitting the valve to close, substantially as set forth.

9. The combination with the engine-cylinder and the exhaust-valve provided with a stem, of a rock-lever adapted to bear loosely against said stem for opening the valve, a spring-arm provided with a shoulder adapted to engage with said stem for holding the valve open, a block provided with an inclined face and adjustably secured to the under side of said spring-arm by a bolt passing through a slot in the spring-arm a lug arranged on the rock-lever and provided with an inclined face which is adapted to engage with the inclined block and throw the shoulder of the spring-arm out of engagement with the stem, and a wedge for holding the shoulder of the spring-arm out of the path of the valve-stem, substantially as set forth.

10. The combination with the engine-cylinder and the shaft, of a pump-barrel having a delivery-pipe connected with the cylinder and a plunger, a support arranged on the shaft an eccentric-disk provided with an elongated opening which receives the shaft and with a slot on one side of the opening, a bolt arranged in said slot and adjustably securing the eccentric-disk to said support, and an eccentric-strap surrounding the eccentric-disk and connected with said plunger, substantially as set forth.

11. The combination with the engine-cylinder and the valve which controls the admission of fuel into the cylinder, of two movable slide-sections arranged end to end, and a trip device bearing against the slide-sections, the latter being adapted to abut against each other when moved in one direction and form a continuous bearing-surface for the trip device whereby the valve is held closed and to be separated when moved in the opposite direction thereby forming a gap or recess which releases the trip device and opens the valve, substantially as set forth.

12. The combination with the engine-cylinder and the valve which controls the admission of fuel into the cylinder, of a reciprocating actuating-rod, two slide-sections adapted to abut against each other to form a continuous bearing-surface or to separate to form a gap between the sections, one of the sections being rigidly connected with the actuating-rod, and the other section being loosely connected with the actuating-rod, and a trip device bearing against the slide-sections and connected with the valve, substantially as set forth.

13. The combination with the engine-cylinder and the fuel-controlling valve, of two slide-sections, one of which is provided with a tenon which is adapted to engage with a recess, in the other section and a trip device bearing against said slide-sections and connected with the valve, substantially as set forth.

14. The combination with the engine-cylinder, the fuel-controlling valve and the actuating-rod, of a fixed slide-section connected at one end with the actuating-rod, a loose slide-section adapted to bear with one end against the opposite end of the fixed section, a tappet secured to the actuating-rod and adapted to bear against the opposite end of the loose slide-section and a trip device bearing against said sections and connected with said valve, substantially as set forth.

15. The combination with the engine-cylinder and the fuel-controlling valve, of two slide-sections adapted to abut against each other while moving in one direction and to separate while moving in the opposite direction and a trip-arm connected with said valve

and provided with a trip-roller bearing against said slide-sections, substantially as set forth.

16. The combination with the engine-cylinder and the fuel-controlling valve, of a slide provided on one side with a flat bearing-face and a recess, and a trip device connected with said valve and adapted to engage with said face and recess, substantially as set forth.

17. The combination with the engine-cylinder and the fuel-controlling valve, of a slide provided on one side with a flat bearing-face and an inclined face at the end of the flat face, and a trip device connected with said valve and adapted to engage with the flat and inclined faces, substantially as set forth.

18. The combination with the engine-cylinder and the fuel-controlling valve, of a releasing-slide composed of two sections, a regulating-slide provided with a flat face and an inclined face, and a trip-arm connected with said valve and bearing against said releasing and regulating slides, substantially as set forth.

19. The combination with the engine-cylinder, of a valve-casing having its outlet connected with said cylinder, a valve controlling the inlet of said casing, a valve-stem loosely connected with said valve and mechanism for shifting the valve-stem, substantially as set forth.

20. The combination with the engine-cylinder and the actuating-rod, of a valve-casing having its outlet connected with said cylinder, a valve controlling the inlet of the valve-casing, a valve-stem loosely connected with the valve, a slide having a movement with said rod, a trip-arm loosely connected with said stem and bearing against said slide, and a spring which tends to lift the valve-stem and release the valve, substantially as set forth.

21. The combination with the engine-cylinder, the fuel-controlling valve and the actuating-rod, of a slide controlling said valve, a collar secured to the actuating-rod and provided with a depending yoke, a governor-weight pivoted on said collar and provided with a shifting arm adapted to engage with said slide, a tension-rod secured at one end to said weight and provided at its opposite end with a screw-nut and a spring interposed between said screw-nut and said yoke, substantially as set forth.

22. The combination with the engine-cylinder, the fuel-controlling valve and the actuating-rod, of a slide controlling said valve, a governor-weight pivoted on said rod and provided with a shifting arm which engages with said slide, a stop adapted to limit the swinging movement of the weight in one direction, a spring secured to said weight and a stop adapted to bear against said spring and hold the weight against swinging in the opposite direction, substantially as set forth.

23. The combination with the engine-cylinder, of a contact-rod projecting into the cylinder and forming one terminal of an electric current, a rock-spindle provided within the cylinder with a contact-finger forming the other terminal of the electric current and adapted to engage with said rod, a spring whereby said spindle is turned for holding the finger against said rod, and a trip-arm secured to the outer end of said spindle and adapted to turn the spindle for moving the contact-finger away from the contact-rod, substantially as set forth.

24. The combination with the engine-cylinder, of a plug arranged in said cylinder and provided with a central opening and a screw-threaded opening, a screw-threaded contact-rod engaging with the threaded opening and forming one terminal of an electric current, a bearing-sleeve arranged in said central opening and provided with a flange inside of the cylinder and a screw-threaded portion outside of the cylinder, a screw-nut applied to the screw-threaded portion of the bearing-sleeve, said bearing-sleeve, flange, and screw-nut being insulated from the plug, a rock-spindle journaled in said bearing-sleeve and provided with a contact-finger forming the other terminal of said electric current, and adapted to bear against said contact-rod, a spring whereby the contact-finger is held against said rod and a trip-arm secured to the outer end of the spindle and adapted to move the contact-finger away from the contact-rod, substantially as set forth.

25. The combination with the engine-cylinder and the actuating-rod, of a contact-rod projecting into the cylinder and forming one terminal of an electric current, a rock-spindle provided with a contact-finger forming the other terminal of the electric current, a spring whereby said finger is yieldingly held against said contact-rod, a trip-arm secured to the rock-spindle and composed of an inner radial portion and an outer portion arranged at an angle to the radial portion and a tappet secured to the actuating-rod and adapted to engage with the trip-arm for moving the contact-finger away from the contact-rod, substantially as set forth.

Witness my hand this 12th day of July, 1894.

FRED C. OLIN.

Witnesses:
JNO. J. BONNER,
ELLA R. DEAN.