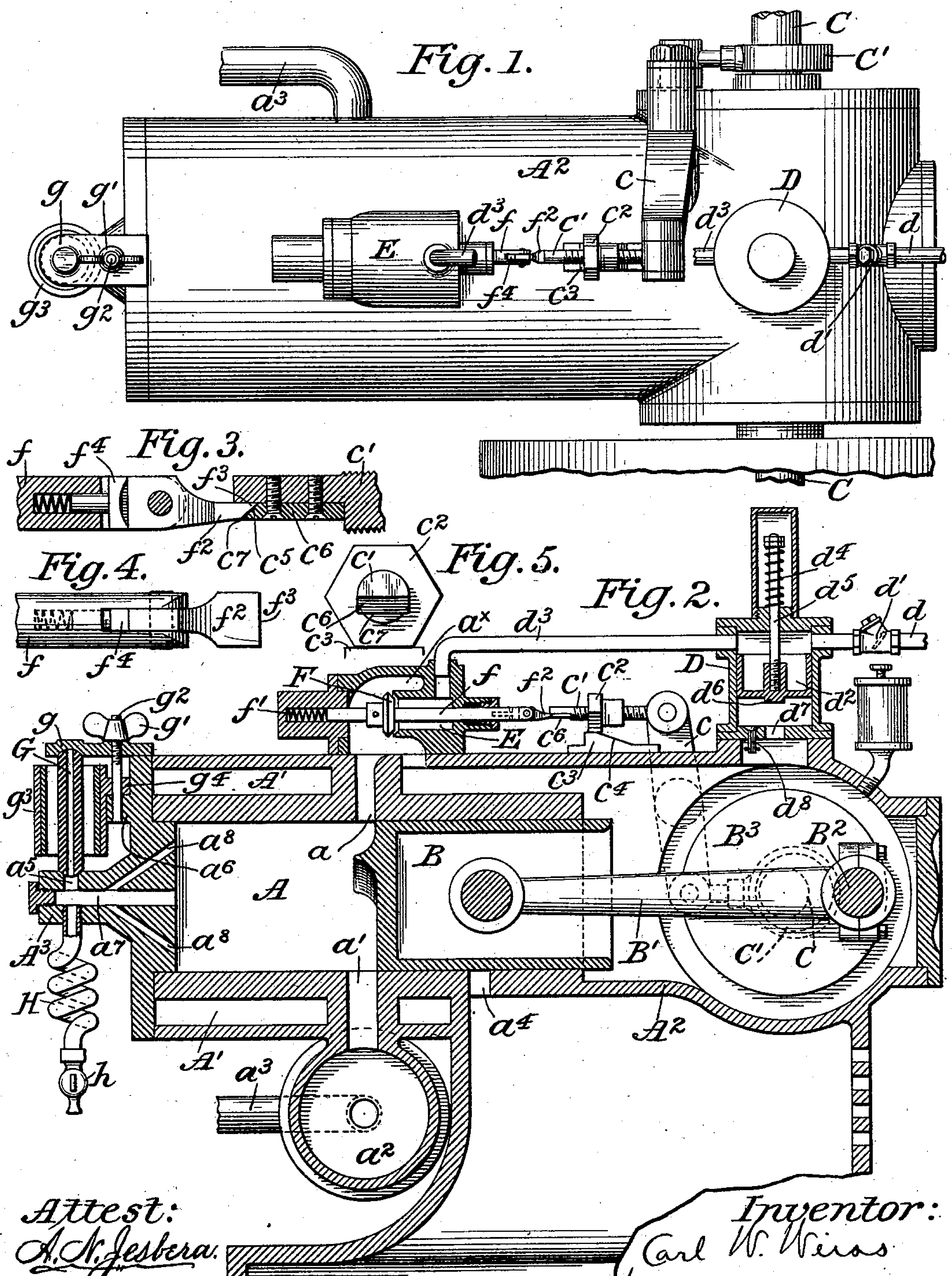
(No Model.) 2 Sheets—Sheet 1.

# C. W. WEISS.

## EXPLOSIVE ENGINE.

No. 592,033. Patented Oct. 19, 1897.




Attest:
A. N. Jesbera.
Chas. E. Ebworth

Inventor:
Carl W. Weiss
by Redding, Kiddle & Greeley Attys.

(No Model.)

2 Sheets—Sheet 2.

# C. W. WEISS.

## EXPLOSIVE ENGINE.

No. 592,033. Patented Oct. 19, 1897.

Fig. 6.

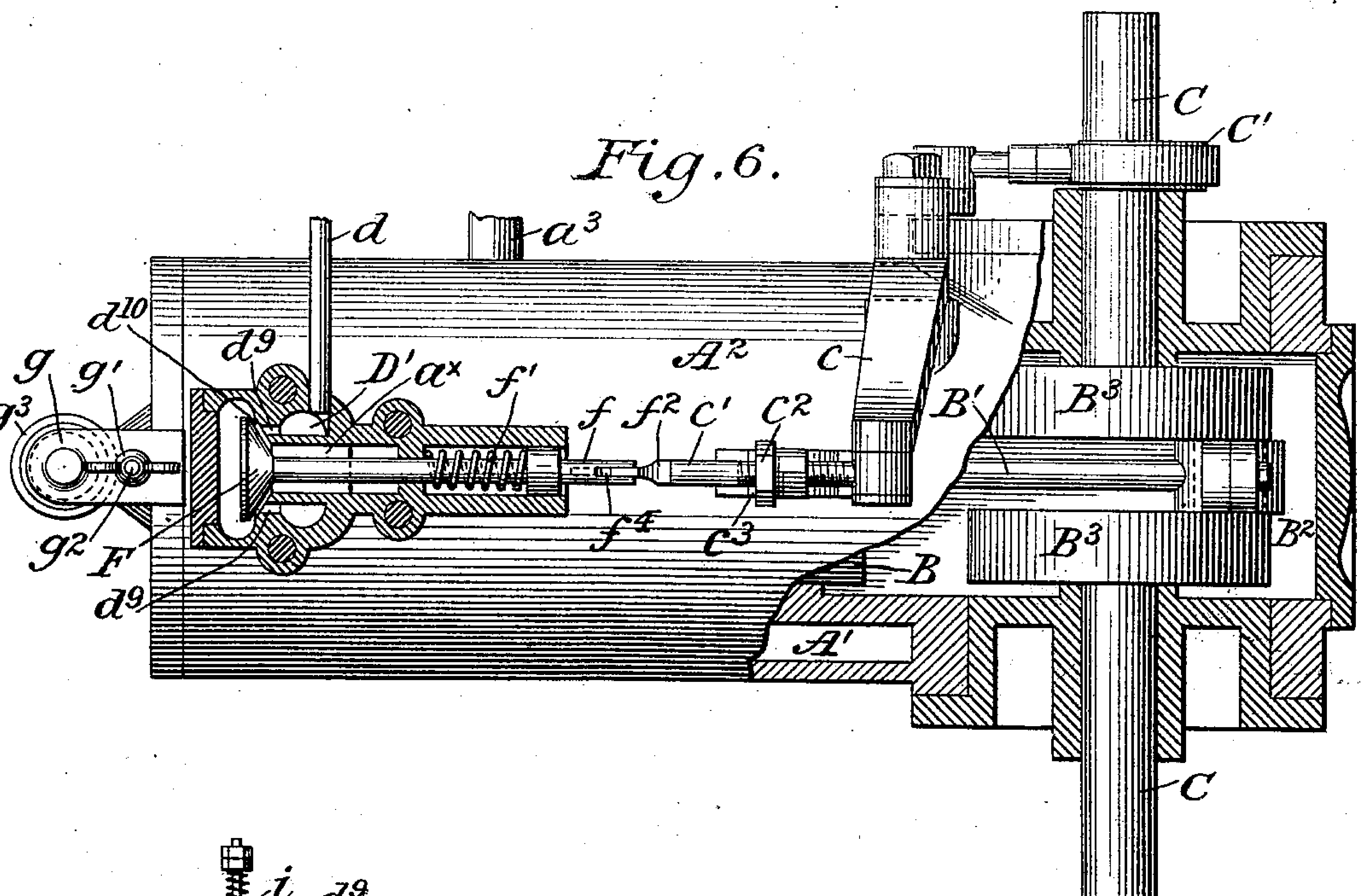
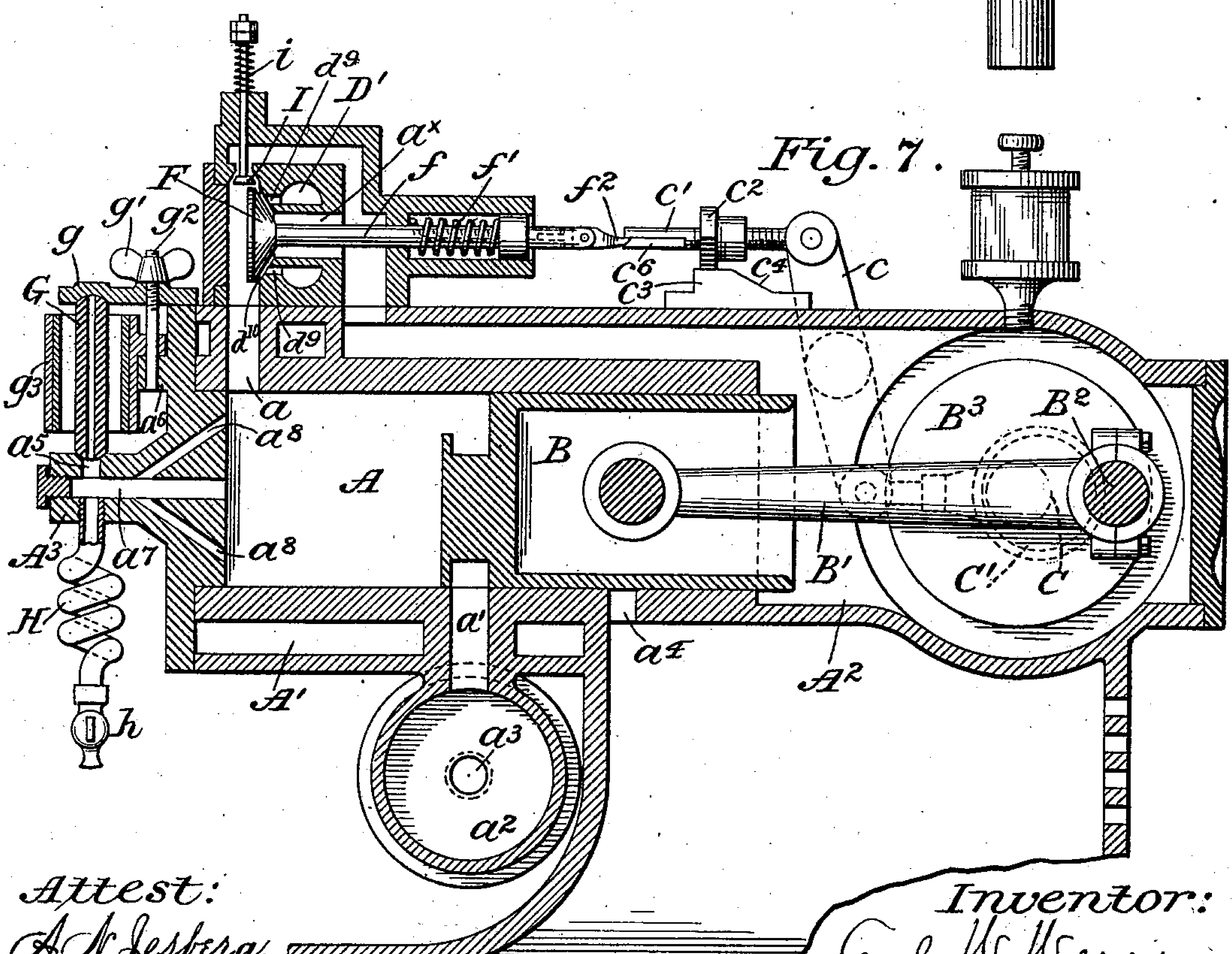


Fig. 7.



Attest:
A. N. Jesbera.
Chas. E. Epworth

Inventor:
Carl W. Weiss
by Redding, Kiddle & Greeley
Attys.

# UNITED STATES PATENT OFFICE.

CARL W. WEISS, OF NEW YORK, N. Y.

## EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 592,033, dated October 19, 1897.

Application filed June 12, 1896. Serial No. 595,252. (No model.)

*To all whom it may concern:*

Be it known that I, CARL W. WEISS, a citizen of the United States, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Explosive-Engines, of which the following is a specification, reference being had to the accompanying drawings, forming a part hereof.

This invention relates in general to engines of that class which depend for propulsive force upon the combustion or explosion of the gas or vapor or gaseous mixture or compound either in the cylinder or in a chamber connected directly to the cylinder, and more especially to engines in which that which forms the basis of the explosive mixture is introduced in the form of a gas or vapor and is mixed with the proper volume of air to form the explosive mixture.

One general object which I have had in view is to improve the construction and operation of engines of the class referred to, so that they shall respond more quickly to the action of the governor, and therefore be subject to less variation in speed while running, and incidentally thereto I have sought to improve the construction of the governor employed, so that it shall be and remain more sensitive in action than the ordinary governor and shall not be so quickly affected by wear. I have also sought to guard against firing back or ignition of the charge outside of the working cylinder or explosion-chamber and to improve the character and insure the uniformity of mixture of the explosive charge.

Furthermore, my invention relates in part to the ignition of the charge, with the view to preventing ignition until the working piston has commenced its forward movement, and with a view to causing the ignition of the explosive charge to be effected simultaneously at different points or over a wider area, so that the maximum of energy may be derived from the charge, and generally I have sought to improve the construction of engines of the class referred to in various details, as will more clearly appear hereinafter.

All of the various features of improvement will be fully explained hereinafter, but it may here be stated with reference to that feature of the operation of engines of this class, which is always of prime importance—namely, the introduction of the explosive mixture and its character—that I have provided means whereby pressure of the air which is introduced to form a part of the explosive mixture shall itself effect the introduction of the gas or vapor which forms the basis thereof, with the result that the amount of air introduced determines the amount of gas introduced for the same charge, thereby insuring uniformity in the relative proportions of air and gas of each charge, that the air and gas are brought together at substantially equal pressures and are mixed thoroughly as they pass on together into the working cylinder or explosion-chamber, thereby insuring a thorough and perfect mixture of the two, and that all gas is removed from those parts of the engine where its presence might occasion firing back. This and the other features of my invention I have illustrated, in order that they may be well understood, in convenient and practical embodiments thereof in the accompanying drawings, in which—

Figure 1 is a plan view of an engine to which my improvement is applied. Fig. 2 is a longitudinal central section thereof in a vertical plane. Figs. 3, 4, and 5 are detail views illustrating the improved construction of the governor. Fig. 6 is a plan view, partly in horizontal section, of an engine in which certain of the improvements are embodied in a slightly-different form from that shown in Figs. 1 and 2. Fig. 7 is a longitudinal central section thereof in a vertical plane.

The cylinder A of the engine may be of ordinary construction, except as hereinafter indicated, and may be provided with a water-jacket A′ as usual. The casing $A^2$ of the cylinder is preferably extended forward to inclose the crank or crank-disks and to receive the bearings of the crank-shaft. The trunk-piston B may be connected by a pitman B′ to the crank-pin $B^2$, which may be carried by crank-arms or crank-disks $B^3$, secured directly to the two parts of the crank-shaft C, which may have its bearings in the casing $A^2$. The chamber inclosed by the forward part of the casing $A^2$ constitutes an air-compression chamber, in which the air is compressed at each forward movement of the piston and which is connected through a suitable duct with the working cylinder A or the explosion-chamber through a port $a$, which is so arranged as to be closed against back pressure during the rearward movement of the piston. The cylinder A, having the inlet-port $a$, is also provided with an exhaust-port $a'$, which is covered by the piston except when the latter approaches the limit of its forward movement. In order that the pressure in the cylinder may be more quickly relieved and also that the exhaust may be muffled, the exhaust-port $a'$ opens directly into a chamber $a^2$, from which the exhaust-gases may be conducted eventually through a pipe $a^3$ to a point of discharge. The air-compression chamber $A^2$ is provided with a free port $a^4$ for the admission of air to said chamber, this port $a^4$ being unobstructed by any valve whatsoever and being normally covered by the trunk-piston B, but uncovered as the latter approaches the limit of its rearward movement. As a partial vacuum is formed in the chamber $A^2$ by the rearward movement of the piston, the air rushes in through the port $a^4$ when it is uncovered, and, as there is no valve to be lifted or to obstruct the port, the maximum volume of air will be admitted to the chamber to be compressed by the forward movement of the piston and to pass into the working cylinder at the proper time. The construction of the parts thus far referred to is substantially the same in Figs. 1, 2, 6, and 7, except that in Figs. 1 and 2 the inlet-port $a$ is uncovered by the piston as it reaches the forward limit of its movement, while in Figs. 6 and 7 the inlet-port $a$ is formed at the rear end of the cylinder and is closed during the rearward movement of the piston by other means.

I will now describe the means whereby the air compressed in the chamber $A^2$ is caused to effect the delivery of the gas or vapor which constitutes the basis of the explosive mixture, referring first to the particular construction shown in Figs. 1 and 2. As there represented the gas or vapor is delivered to the engine through a pipe $d$, which is provided with a check-valve $d'$, and communicates with a chamber or cylinder D, in which is placed the movable diaphragm or piston $d^2$, the latter being operated directly by the pressure of the air in the chamber $A^2$. From the chamber or cylinder D the gas is conducted through a pipe $d^3$ to a valve-chamber E, from which it is permitted to pass at the proper time into the duct by which the air is conducted from the compressor to the working cylinder A through the port $a$ and at a point intermediate the compressor and the cylinder. It is obvious that the diaphragm or piston $d^2$ is operated to effect the delivery of the gas when the pressure of air in the chamber $A^2$ rises above the normal and is operated to fill the chamber or cylinder D with gas when the pressure of air in the chamber $A^2$ falls below the normal, and it will also be obvious that, as the piston $d^2$ rises only until the pressure of the gas within the chamber or cylinder D becomes substantially equal to the pressure of the air in the chamber $A^2$, a measured quantity of gas will be delivered at each operation and will bear a certain proportion to the quantity of air delivered. A spring $d^4$ may be applied to the stem $d^5$ of the piston $d^2$ to counterbalance the weight of the latter, and, in order that when the piston $d^2$ falls it may not strike too heavily upon its seat, it is provided with a plug $d^6$ to enter the port $d^7$, through which the air enters the cylinder D below the piston, thereby forming an air-cushion to check the descent of the piston as it approaches the limit of its movement. In order that the piston may be exposed over its whole face to the pressure of the air in the chamber $A^2$, as soon as such pressure begins to rise above the normal, the port $d^7$ being then closed by the plug $d^6$, a loose valve $d^8$ is seated in the wall between the chamber $A^2$ and the chamber or cylinder D, at one side of the port $d^7$, which lifts when the pressure in the chamber $A^2$ rises above the normal and permits the pressure to be exerted upon the full face of the piston.

Referring now to the construction shown in Figs. 1, 2, 6, and 7, which is substantially the same although arranged somewhat differently in the two cases, it will be seen that the valve F, which controls the delivery of gas from the valve-chamber E, is represented as carried by a rod $f$ and held to its seat by a spring $f'$. When the engine is running at a normal speed, the rod is shifted to open the valve and admit a fresh charge of gas at every rotation of the crank-shaft, but when the engine runs too fast the rod is not shifted and the valve is not opened, wherefore one explosion is omitted and the gas is withheld until the shaft of the engine has completed a rotation. The means for shifting the valve do not differ in general from means which have been employed hitherto for controlling the speed of engines of this class, but I have provided certain improvements whereby the speed-controlling device or governor becomes more sensitive in operation and yet is better calculated to withstand the wear to which it is subjected. As represented in the drawings, the shaft C carries an eccentric $C'$, which operates a short lever $c$. To the upper end of the lever $c$ is pivoted a screw-threaded shaft $c'$, which carries a flat-faced nut $c^2$ to bear upon a block $c^3$, having an incline $c^4$. When the engine is running at a normal speed, the end of the rod $c'$ will strike the end of the rod $f$ and open the valve, but when the engine is running too fast the momentum of the rod and nut, as the latter travels up the incline $c^4$, will throw the end of the rod $c'$ above the end of the rod $f$, and the valve F will therefore remain upon its seat, preventing the delivery of the fresh charge. The end of the rod $f$ is usually brought down to a thin edge, so that the governor shall be reasonably sensitive in operation, but in the governors heretofore constructed this edge becomes quickly blunted and impairs the sensitiveness of the governor. I have therefore pivoted upon the end of the rod $f$ a tongue $f^2$, which has a very sharp edge $f^3$ disposed in a horizontal plane. The tongue $f^2$ is held in normal position by a spring-plunger $f^4$. The end of the rod $c'$ is formed with a notch $c^5$ to conform to the end of the tongue $f^2$, such notch being conveniently formed by cutting away the lower portion of the rod $c'$ and securing thereto a plate $c^6$, which has a beveled lip $c^7$. It will be obvious that, whenever the parts engage for effective operation, the tongue $f^2$ will enter the corresponding notch $c^5$ and its beveled face will take a full bearing against the bevel $c^7$ of the rod $c'$, thereby preventing the blunting of the edge $f^3$, which would be occasioned by the striking of a flat bearing-face against it. Should the rod $c'$ lift slightly, its bevel $c^7$ will engage the under side of the tongue $f^2$ and will lift the latter to a position where it will find a full bearing. Should the engine be running so rapidly as to necessitate a reduction in speed, the end of the rod will be lifted above the edge $f^3$ of the tongue $f^2$ and the opening of the valve will be omitted. It will be readily understood that by these means it is not only possible to have a very thin edge on the tongue $f^2$, whereby sensitiveness is secured, but the edge will be kept sharp at all times and will not be dulled or rounded by use, so as to impair the sensitiveness of the governor.

For the ignition of the charge in the working cylinder or explosion-chamber I prefer to employ a tube-igniter G of ordinary construction, which is seated upon the lateral port $a^5$, formed on the upper surface of a tubular projection $A^3$ from the cylinder-head, and is held to its seat by a clamping-plate $g$. The latter is held in position by a clamping-nut $g'$, which engages a threaded stud $g^2$, supported by a projection $a^6$ from the cylinder-head. A jacket $g^3$ to surround the tube G has a projection $g^4$ to rest upon the projection $a^6$ and to engage the stud $g^2$, and is thereby supported in position. The bore $a^7$ of the tubular projection $A^3$ communicates as usual with the explosion or combustion chamber, and I have also provided in the cylinder-head a plurality of diverging channels $a^8$, which shall distribute the flame of ignition to as many different points remote from the axis of the cylinder, thereby effecting a simultaneous ignition of the charge at different points or over an extended area and permitting the maximum efficiency of the charge to be obtained.

To the tubular projection $A^3$, directly opposite the igniting-tube G, I have connected a chamber or vessel H, which is preferably in the form of a spirally-coiled tube, as represented in Figs. 2 and 7, having at its lower end a waste-cock $h$, through which such liquid as accumulates in the chamber may be drawn off from time to time. The main function of this chamber is to delay the ignition of the charge in the cylinder until the piston shall have commenced its forward movement, thereby preventing the premature explosions which severely strain the working parts of the engine and occasion a loss of efficiency. That the chamber does operate with this result has been demonstrated. I will proceed to describe the nature of its operation so far as the same is understood by me. As the charge in the working cylinder is compressed some of it enters the tube G and is ignited, the tube being in a state of incandescence. The tendency of the flame is to work back through the channels $a^7$ $a^8$ into the working cylinder, and it would do so but for the fact that the explosive mixture is passing through said channels from the working cylinder, while the piston is moving to the rear, more rapidly than the flame can travel toward the working cylinder, this result being possible by reason of the existence of the chamber H, which permits some of the gas or mixture which passes through the channels $a^7$ and $a^8$ to be compressed into it. As soon, however, as the piston has reached the limit of its rearward movement and compression of the charge ceases the flame travels through the channels $a^7$ and $a^8$ into the cylinder and ignites the body of the charge therein.

As indicated above, other means than those shown in Fig. 2 may be employed through the medium of which the air compressed in the chamber $A^2$ is caused to effect the delivery of the gas or vapor which forms the basis of the explosive mixture, and I have illustrated another form of such means in Figs. 6 and 7. In the construction there represented the valve F, which permits the entrance of the gas or vapor, is operated, as before, by the governor or controlling mechanism already described, but, in place of a pump which is operated by the pressure of the air to effect the delivery of the gas, an aspirating device may be employed through which the air, under pressure from the chamber $A^2$, shall pass, and in its passage shall induce the flow of the gas, carrying it on and mixing it thoroughly with itself as it passes on to the working cylinder or explosion-chamber. It will be obvious that the aspirating device might be arranged in many different ways to accomplish the desired purpose. In Figs. 6 and 7 I have represented the gas-supply pipe $d$ as connected to a chamber D', from which ports $d^9$ open into the seat $d^{10}$ of the valve F, so that as the air rushes from the chamber $A^2$ through the channel $a^{\times}$ and between the valve F and its seat it draws the gas with it from the chamber D' and effects its delivery into the working cylinder or explosion-chamber. It is obvious that, inasmuch as the action of the aspirator depends upon the velocity and consequently upon the pressure of the impelling fluid, the quantity of gas delivered at each operation will depend upon the pressure of the air in the chamber $A^2$ and will bear a definite relation to the quantity of air delivered, thereby insuring, as before, an explosive mixture of uniform strength.

In the construction shown in Fig. 2 it will be observed that the inlet-port *a* and the outlet-port *a'* are so arranged relatively to each other that the outlet or exhaust port *a'* shall be opened first, thereby allowing the heated gases in the working cylinder to rush out and the pressure therein to fall. Then the inlet-port *a* opens and the fresh air enters, carrying before it the heated gases. Quickly after the opening of the port *a* the valve F is opened, and the air and gas flow on together and are thoroughly mixed as they enter the explosion-chamber. The valve F closes before the port *a* is closed, and, as the valve-seat projects into and is surrounded by the air-channel $a^{\times}$, every vestige of gas is carried out of the channel by the continued flow of the air. In this manner firing back is effectually prevented under all conditions. A similar result is produced by slightly different means in the construction shown in Fig. 7. In this case the air-channel is extended around the aspirating device and communicates with the inlet-port *a* through a port which is closed by a supplemental valve I, the latter being held to its seat normally by a spring *i*. When the pressure in the working cylinder falls, by reason of the opening of the exhaust-port *a'*, below the pressure in the compression-chamber $A^2$, and before the valve F is opened, the valve I opens automatically and permits the fresh air to enter, driving before it the heated gases. Likewise after the valve F is closed the valve I remains open or opens automatically for an instant and permits the pure air to flow past the valve F, carrying with it whatever gas may remain in the channel outside of the valve F.

The mode of operation of each of the several features of my invention has been fully explained in connection with the description of the construction of each, and, as the operation of the engine as a whole is substantially similar to that of ordinary engines of this type, no further explanation will be necessary except to call attention to the fact that, inasmuch as the fresh charge, both of air and of gas, is ready for delivery at the end of each forward stroke of the piston, the engine will respond quickly to the action of the governor, no more than a half-revolution being required to prepare for another explosion should the speed of the engine fall after the governor has acted to prevent the delivery of the gas or vapor. It is to be understood, moreover, that my invention might be embodied in other forms of mechanism than that which I have illustrated herein and therefore I do not desire to have my invention limited to the precise construction and arrangement of parts which I have shown herein.

I claim as my invention—

1. In an explosive-engine, the combination of a working cylinder and piston, an air-compressor, a duct through which the air is free to flow from the compressor to the cylinder when the pressure in the cylinder is less than that in the compressor, a conductor for gas or vapor connected to said duct at a point intermediate the compressor and the cylinder, a valve to close the extremity of said conductor, and means to open and close said valve while the piston is at the forward portion of its stroke, whereby the air from the compressor clears the gases from the duct before the valve is opened and after the valve is closed at each operation.

2. In an explosive-engine, the combination of a working cylinder and piston, an air-compressor, a duct through which the air is free to flow from the compressor to the cylinder when the pressure in the cylinder is less than that in the compressor, a conductor for gas or vapor connected to said duct at a point intermediate the compressor and the cylinder, a valve to close the extremity of said conductor, means operated by the pressure of the air to effect the movement of the gas or vapor through said conductor when the valve is open, and means to open and close said valve while the piston is at the forward portion of its stroke, whereby the air from the compressor clears the gases from the duct before the valve is opened and after the valve is closed at each operation.

3. In an explosive-engine the combination of a gas or vapor supply, an air-compressor connected to the working cylinder to deliver air thereto, a second cylinder communicating with said air-compressor through a port and having the gas or vapor supply connected thereto, a check-valve for said gas or vapor supply and a piston movable in said second cylinder to deliver gas or vapor to the working cylinder and operated directly by the pressure of air in said compressor, said piston having a plug to enter said port to form an air-cushion as the piston returns to normal position.

4. In a governor, the combination with a rod reciprocated longitudinally and movable laterally with variations in the speed, of a valve-stem and a tongue pivoted upon said valve-stem and adapted to be engaged by said rod to shift the valve.

5. In a governor, the combination with a rod reciprocated longitudinally and movable laterally with variations in speed, of a longitudinally-movable valve-stem in line with said rod and a tongue pivoted upon said valve-stem and adapted to be engaged by said rod to shift the valve.

6. In a governor, the combination with a rod reciprocating longitudinally and movable laterally with variations in speed, of a longitudinally-movable valve-stem in line with said rod, a tongue pivoted upon said valve-stem and adapted to be engaged by said rod to shift the valve, and a spring-plunger carried by said valve-stem to maintain said tongue in normal position.

7. In a governor, the combination with a

rod reciprocating longitudinally and movable laterally with variations in speed, of a valve-stem movable longitudinally in line with said rod and a tongue pivoted upon said valve-stem and having a sharp edge, said rod having a beveled notch to engage and conform to the sharpened edge of said tongue.

8. In an explosive-engine, the combination with the working cylinder of an igniter, the head of said cylinder having diverging channels connecting said igniter with different points in the cylinder.

This specification signed and witnessed this 8th day of June, A. D. 1896.

CARL W. WEISS.

In presence of—
W. B. GREELEY,
ALFRED W. KIDDLE.