(No Model.) 2 Sheets—Sheet 1.

F. BURGER & H. M. WILLIAMS.

GAS ENGINE.

No. 584,282. Patented June 8, 1897.

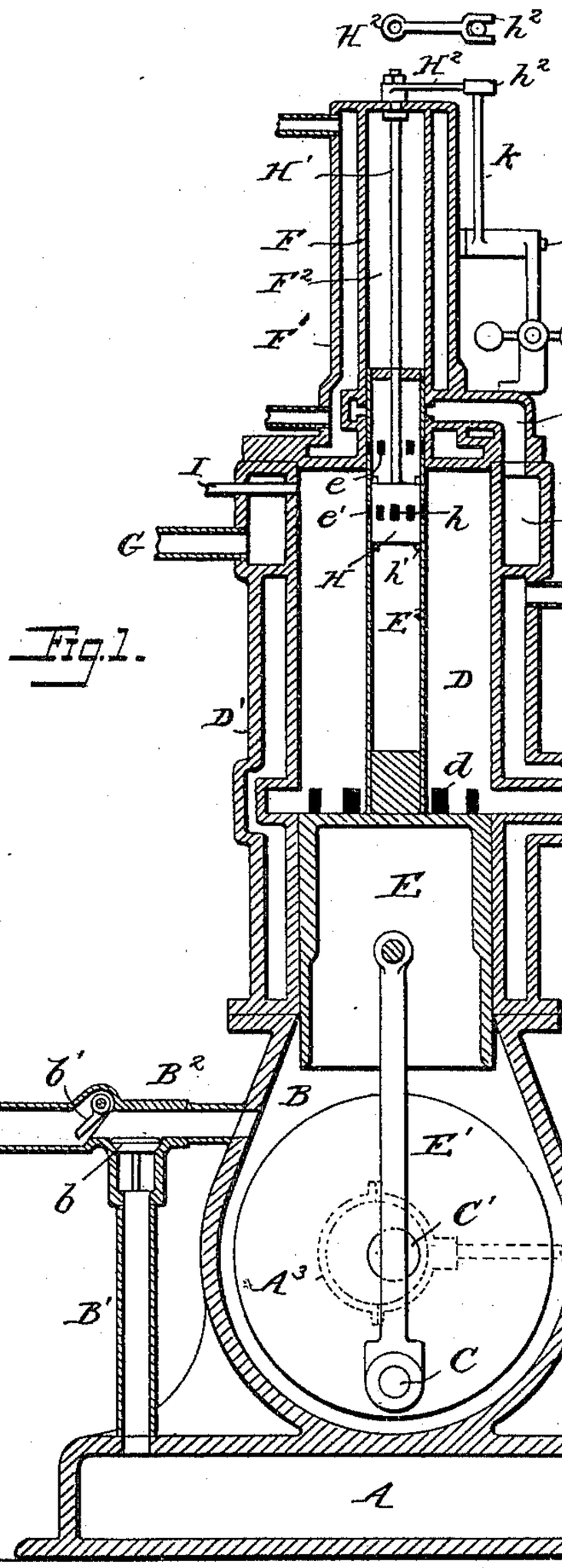

Fig. 1.

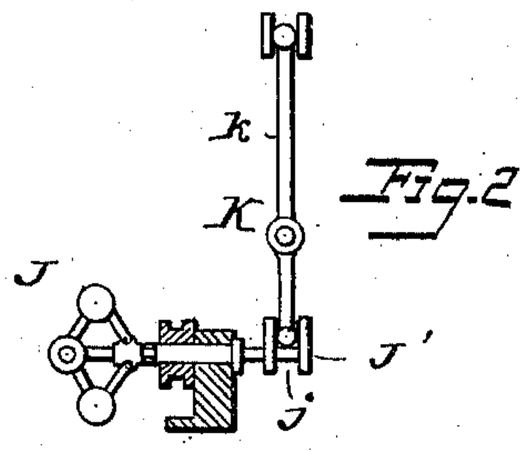

Fig. 2.

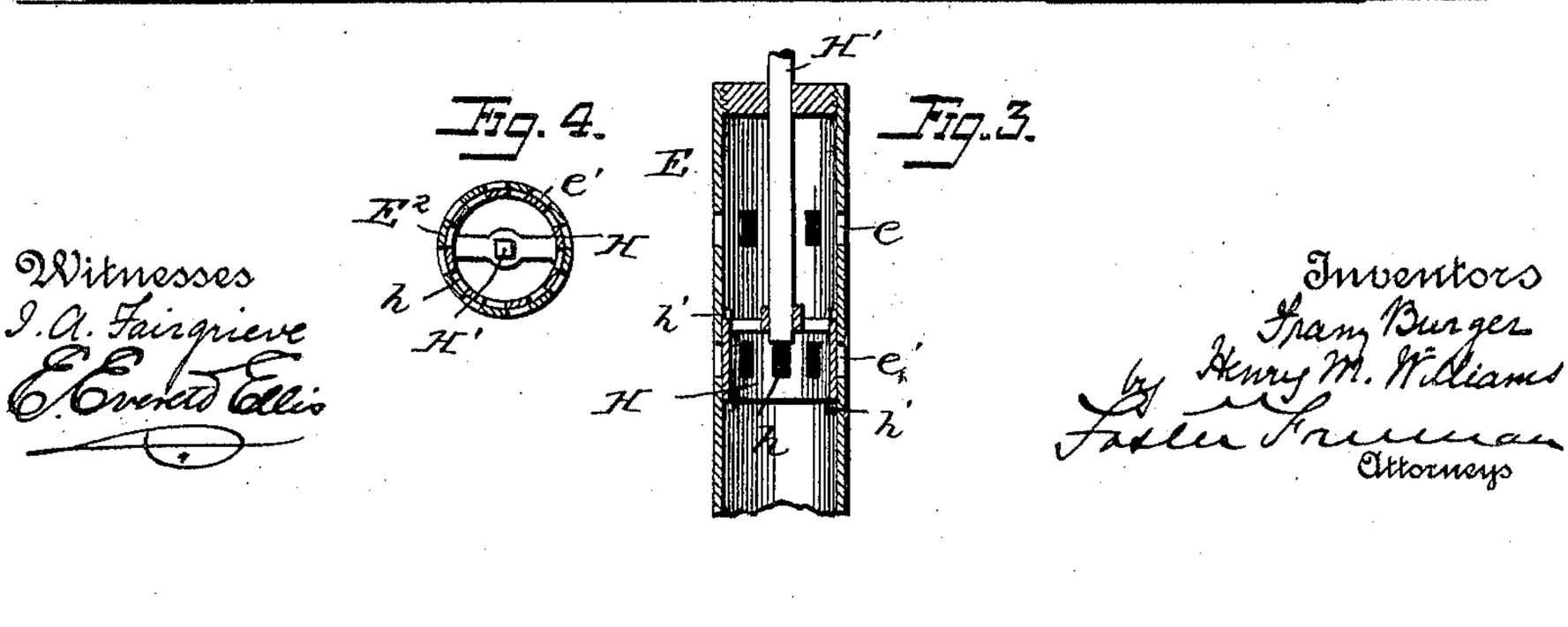

Fig. 4.

Fig. 3.

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Fig. 5

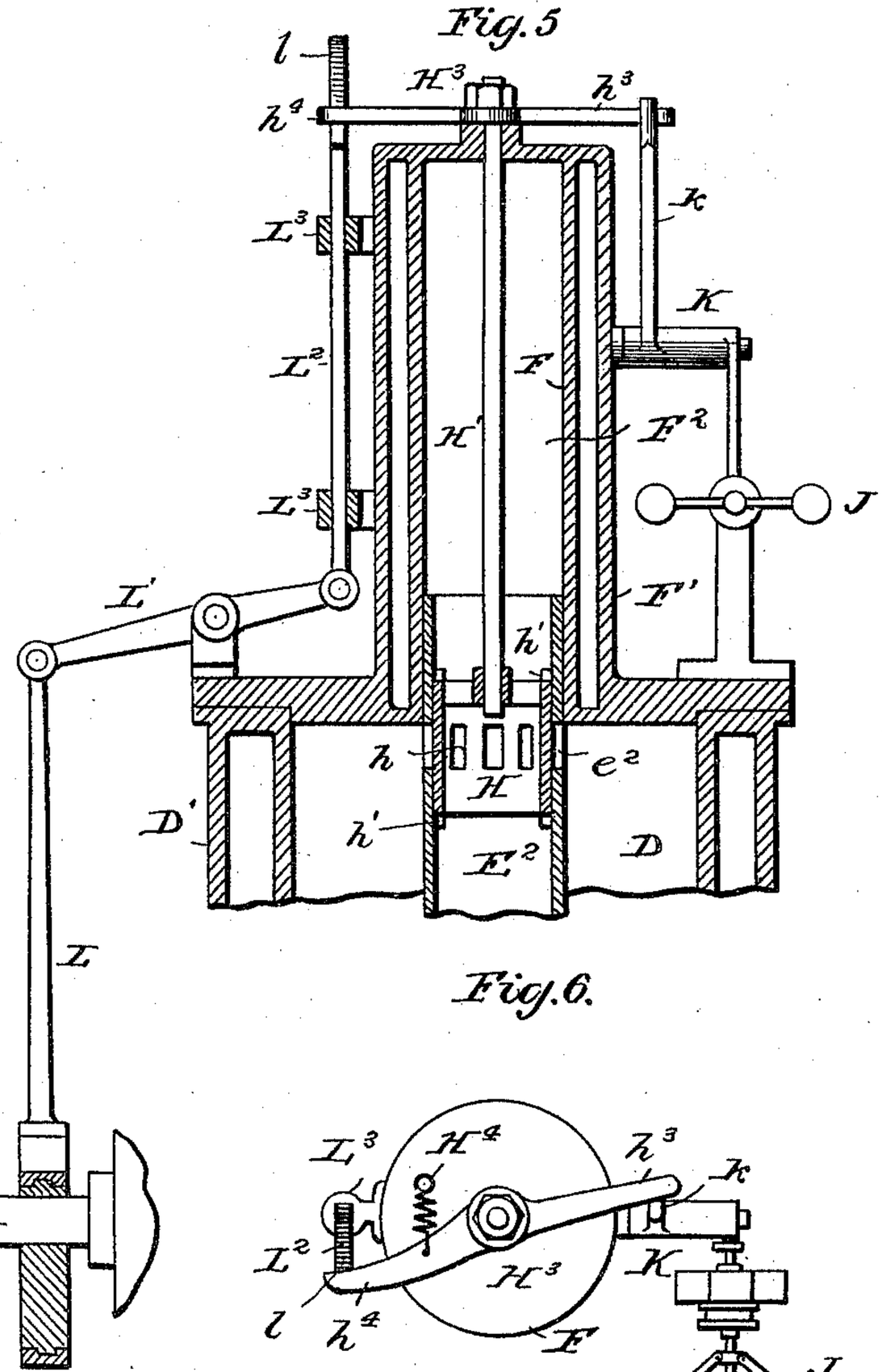
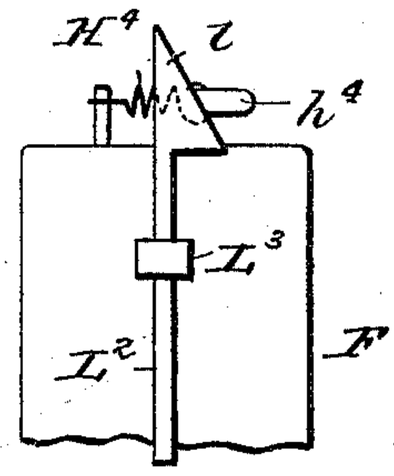


Fig. 6.

Fig. 7.



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UNITED STATES PATENT OFFICE.

FRANZ BURGER AND HENRY M. WILLIAMS, OF FORT WAYNE, INDIANA.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 584,282, dated June 8, 1897.

Application filed August 1, 1894. Serial No. 519,205. (No model.)

To all whom it may concern:

Be it known that we, FRANZ BURGER and HENRY M. WILLIAMS, citizens of the United States, residing at Fort Wayne, Allen county, State of Indiana, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

Our invention relates to air and gas engines, and has for its object to improve the construction and arrangement of such machines, to simplify their parts and mode of operation generally, and more especially to provide an engine in which the burned products of combustion will be thoroughly and completely exhausted from the combustion or explosion chamber before a new charge of explosive gases is admitted, this exhaustion being accomplished through the aid of a vacuum in connection with other means, as hereinafter more particularly set forth, and it is a further object of our invention to provide a simple and effective regulator or governor which shall control the admission of the explosive gases in accordance with the work to be done; and to these ends our invention consists in the various features of construction and arrangement having the mode of operation substantially as hereinafter more particularly pointed out.

Referring to the accompanying drawings, Figure 1 is a longitudinal vertical section of an engine embodying our invention. Fig. 2 is a detail side view, partly in section, of a portion of the governing device. Fig. 3 is an enlarged vertical section showing the valve-regulator. Fig. 4 is a transverse section of the same. Fig. 5 is a longitudinal vertical section of a portion of the engine, showing a slightly-modified arrangement. Fig. 6 is a plan view of a portion of the same, showing the regulating device; and Fig. 7 is an enlarged detail of the regulator or governing device.

One of the principal objects of our invention is to provide an engine in which the burned products of combustion of a previous charge shall be completely exhausted before a new charge of explosive gases enters the explosion-chamber, and a part of our invention is directed to means whereby this will be automatically accomplished in the most economical way and by the aid of a vacuum produced by the operation of the engine, aided by the condensation of the burned gases, in the manner hereinafter described, and we will first describe the construction of the engine shown, pointing out the principles of our invention in this regard, and at the same time we will consider the construction and arrangement of the governor or regulating device for controlling the charge of explosive gases, showing its applicability to the construction of engine illustrated as well as to others, and while the construction and arrangement of parts herein set forth are preferred it is evident that the details may be arranged or varied and parts used in combination with themselves or with other equivalent parts without departing from the spirit of our invention.

The base of the engine is made hollow, forming a vacuum-chamber A, and supported thereon and preferably formed as a part thereof is a case containing a chamber B, which we will designate the "crank-chamber," for the reason that the crank C of the shaft C′ is mounted therein, the shaft extending through the sides of the chamber, which form bearings therefor, and being arranged so as to form an air and gas tight crank-chamber. Supported upon said crank-chamber and secured thereto is a cylinder D, which is provided with a water-jacket D′ and in which moves the piston E, which is connected to the crank C by the connecting rod or pitman E′.

Mounted on the cylinder D is a tubular cap F, which is also preferably provided with a water-jacket and which serves to support the governor or regulator controlling the admission of the air and gas, which in the present instance is received through a pipe or connection G, connected to a suitable reservoir or source of supply, and passes into the chamber G′, around the upper portion of the cylinder, and thence by a passage G^2, which is controlled by a valve E^2, in the form of a tube connected to the piston E and extending into the chamber F^2 of the cap F and provided in the present instance with two sets of inlet-ports *e e′*, which control the admission of the explosive gases from the passage G^2 into the cylinder in the manner hereinafter described.

The cylinder is provided with outlet-ports *d*, which communicate with a passage *d′*,

which in turn communicates with a passage d^2, connected with a chamber D^2, and these passages and chamber are provided with a water-jacket D^3, preferably surrounding the chamber and the passages, as indicated. In the passage d' is arranged a valve v, and another valve v' is arranged in connection with the chamber D^2 and its outlet D^4, and these valves are shown as check-valves of a conventional form.

Connecting the passage d' and the vacuum-chamber A is a passage A', which is provided with a valve a, which is mechanically controlled by some operating part of the engine, and in the present instance we have shown a rod a' connected to a bell-crank a^2, which in turn is connected by a rod a^3 to an eccentric or cam A^3 on the shaft C', so that the valve a is mechanically operated by said eccentric or cam for the purposes and in the manner hereinafter stated.

The vacuum-chamber A is connected to the crank-chamber B by passages B' B^2, and in the passage B' is a valve b, in the form of a check-valve, opening outward from the vacuum-chamber, and an extension of the passage B^2 forms a discharge for the air and is controlled by a valve b'.

As the parts so far described are operative with greater or less efficiency without the use of the regulator or governor, we will now describe their mode of operation and afterward set forth the construction and arrangement of the governor, which is preferably used with the engine for the sake of economy, regularity, and efficiency of operation, although, as before stated, the engine will operate without such a regulator.

Assuming the parts to be in the position shown in the drawings, with the burned gases of the previous explosion exhausted, the upward movement of the piston E will close the exhaust-ports d and the valve a will be closed by the cam or eccentric and connection, and as the piston rises, carrying the valve or extension E^2, the ports e will come in communication with the passage G^2, permitting the explosive gases to enter the cylinder through said ports e and the ports e', which are at this time just below the upper end of the cylinder, it being understood, of course, that the explosive gases are under pressure and are forced in that way or are drawn in by the vacuum previously produced in the cylinder or by both forces combined. We would remark, however, that the vacuum is the preferred means for charging the chamber and is sufficient in itself to accomplish the result satisfactorily.

As the piston advances in its upward movement it compresses the explosive mixture in the upper portion of the cylinder until the piston reaches its extreme upward movement, when the gases are exploded by some suitable means, as by an igniter I, which may be of any well-known character, and the piston is forcibly returned to the position indicated in the drawings. Meanwhile, as the piston E has been rising a partial vacuum has been formed in the chambers A and B, the air from the chamber A being drawn through the passages B' B^2 into the vacuum crank-chamber B, the check-valve b rising and the check-valve b' of course being closed. As soon as the piston reaches its upper limit of motion the check-valve b is seated, and as the piston returns to its lower position any air above atmospheric pressure in the crank-chamber is expelled through the passage B^2 and check-valve b'. As the piston approaches its lower position the exhaust-ports d are opened and the burned gases rush out through the passages d' d^2 by their own elasticity, and as they come in contact with the cool pipes and walls of the chamber D^2 they are condensed, and this tends, further, to aid in exhausting the burned gases from the cylinder. In order, however, to insure the most practically complete exhaustion of the gases, the valve a is opened at the proper time by the eccentric or cam, so that the partial vacuum in the vacuum-chamber A operates directly upon the remaining gases in the cylinder D to exhaust them, the valve b of course being closed by the vacuum, so that by the time that the piston E commences to rise again to close the exhaust-port the burned gases are substantially exhausted from the explosion-chamber, and there is a greater or less vacuum therein, which, as before stated, will operate to draw into the cylinder the explosive mixture as soon as the ports controlling the admission of this mixture are in proper position. The gases which have been drawn into the passage d^2 and chamber D^2 are further condensed by the water-jacket and may run out of the chamber through the valve v' into the passage D^4 and be discharged therefrom ready for the next operation.

From this explanation it will be seen that we are enabled to exhaust the cylinder of the burned products of combustion, and that this is accomplished by the vacuum produced in the operation of the engine, and that it may be further aided by utilizing the pressure of the burned gases themselves and the condensation of a portion of them, so that the greatest economy is effected in the operation of the machine. It will further be seen that the valve is so arranged that a fresh charge of explosive gases will not be admitted until the cylinder is exhausted and the exhaust-ports closed, and there is no danger of mixing the explosive gases with the burned products of combustion of a previous charge.

It will be further seen that the vacuum produced by the operation of the engine exhausts the burned gases from the cylinder and also draws in the fresh gases to form the explosive charge, and that this is accomplished solely by the vacuum or by the aid of the burned gases themselves, which are condensed in the manner set forth. While the construction set forth is well adapted to carry

out this mode of operation, it is evident that it can be carried out in other constructions and arrangements of parts, and our invention is not limited in this respect to the construction set forth.

It is well known that it is desirable to control the amount of charge of the explosive mixture admitted to an engine in accordance with the work done, the speed of rotation, or otherwise, and in order to produce the most efficient results some form of governor or regulator must be used, and while many have been suggested we have made a simple, cheap, and efficient one, which is positive in its operation and is accurately controlled in accordance with the requirements of the engine, and the parts are so arranged that they are not subject to derangement by the effects of the explosion, the regulating devices being so arranged that the products of combustion do not come in contact therewith. Thus, as before stated, the tube E^2, which is attached to the piston in the construction shown in Fig. 1, is provided with two sets of ports $e\,e'$, arranged so as to permit the charge to be delivered to the cylinder at the proper time, and in order to regulate this charge in accordance with the requirements we provide a regulator-valve H, which is shown as being provided with ports h, corresponding to the ports e' in the present instance, or, in fact, they may correspond with the ports e, or with both, they being so arranged that when the valve H is in its open position the inlet ports or passages of the engine will be completely open, but when the relative position of the valve H and the valve or tube E^2 is changed the passage will be more or less closed or throttled, in accordance with the requirements. It will be evident that the valve H will accomplish this result whether it slides with relation to the valve E^2 or rotates, and as these valves are shown as provided with a number of ports it is evident that a very accurate and delicate adjustment can be accomplished by moving one with relation to the other, and we will now proceed to describe the means shown to accomplish this result.

In the construction shown in Fig. 1 the valve H is in the form of a cylinder, fitting the inside of the tube or valve E^2, and has ports h, which normally coincide with the ports e', and the valve or cylinder H is arranged to move with the valve or tube E^2, ribs or stops h' being shown to maintain the parts in relative position. Mounted in the cap is a rod H′, which is squared or otherwise arranged, as shown in Fig. 4, so that it will rotate the cylinder or valve H to open or close the ports h with relation to the ports e'. This rod H′ is provided with an arm H^3, having a bifurcated end h^2, and this extends out laterally from the rod, as shown.

A governor J, which may be of any well-known form, (being typically shown,) is mounted on the side of the engine and connected with some moving part thereof, and the sliding rod J′ thereof is provided with lips or stops j, which engage a lever K, pivotally mounted at K′, one arm of which, k, engages the bifurcated end h^2 of the arm H^2. It will thus be seen that in accordance with the position of the balls of the governor J, the shaft or rod H′ will be turned more or less through the medium of the lever K and the arm H^2, and this will rotate the valve H in accordance therewith, opening or closing the inlet-ports of the engine. The valve H slides on the rod H′, and of course moves with it in accordance with all its variations, but the effective movement, which really controls the inlet-charge, takes place at the moment the ports e correspond with the passage G^2, and this, it will be seen, is practically at the medium time between two successive explosions, and thus, although the valve H may move more or less and vary its position at different points of the movement of the piston, its effective and controlling point is practically the mean between the successive explosions, and this we have found is a desirable relation in accomplishing the even and uniform operation of the engine.

In Figs. 5, 6, and 7 we have illustrated a modified arrangement for operating the same governor or regulator, and in this it will be seen that the main principles are the same, although the details vary. In this instance the tube E^2 has but one set of ports e^2 and the charge is admitted through the body of the tube, and the valve H has its ports h corresponding therewith, and it slides on the rod H′, as before, and is practically identical with the construction shown in connection with Fig. 1. Instead, however, of having a single arm attached to the end of the rod H′ we attach a double arm H^3, and the governor J is arranged substantially as before and is connected with the lever K, the arm k of which impinges against the end h^3 of the lever H^3.

Connected to some moving part of the engine—as, for instance, the shaft C′—by means of an eccentric and a rod L is a lever L′, which in turn is connected to a rod L^2, sliding in brackets L^3 on the cap F, and this rod is provided with a tip l, having an inclined side or edge, as clearly shown in Fig. 7. It will thus be seen that at each rotation of the shaft the inclined plane l is reciprocated, and being arranged in relation to the end h^4 of the lever H^3 it will forcibly move the lever, causing the shaft H′ to rotate to open or close the ports h of the valve H with relation to the ports e^2 of the valve E^2.

The lever H^3 is under stress of a spring H^4, which tends to maintain the end h^3 of the lever in contact with the end k of the lever K, the position of which, as before stated, is controlled by the governor J.

It will thus be seen that at each rotation of the shaft or reciprocation of the arm L^2 the inclined surface thereof as it rises forces the lever H^3 to move to a certain definite point in one direction, but its movement in the oppo-

site direction is controlled by the governor J, through the medium of the lever K, acting on the other end h^3 of the lever H^3, and of course it will be seen that the ports are opened to a greater or less extent, controlled by the position of the governor J. In other words, the governor J controls the movement of the valve in one direction only, it being positively moved to a certain position by the inclined or wedge-shaped rod L^2 at each rotation. It will thus be seen that in both constructions the regulating-valve H is moved with relation to the controlling-valve E^2 to open and close its ports in substantially the same manner, the extent of its movement being controlled by the governor, but in one instance its movements are positively controlled by the governor in both directions, while in the other it is positively controlled by the governor in one direction only, and from this it will be seen that the invention is not limited to the precise construction and arrangement of parts in carrying out the principle of operation.

What we claim is—

1. In a gas-engine, the combination of the cylinder wherein the charge is induced by means of a vacuum created therein, the piston, and inlet and outlet ports, a vacuum-chamber, connections between the vacuum-chamber and the outlet-ports of the cylinder, a vacuum crank-chamber, and connections between the vacuum-chamber and the crank-chamber, valves in the latter connections, a valve in the connections between the vacuum-chamber and outlet-ports, and means for closing this valve on the upward stroke of the piston and opening the same as the piston approaches its lower position, substantially as described.

2. In a gas-engine, the combination with the cylinder, the piston and the inlet and outlet ports controlled by the piston, of a vacuum crank-chamber into which the piston moves, a vacuum-chamber connected to the vacuum crank-chamber, connections between the vacuum-chamber and the outlet-ports of the cylinder, and valves controlling the connections of the vacuum-chamber, substantially as described.

3. In a gas-engine the combination with the tube E^2, forming the inlet-port, of the valve H, controlling said port and arranged to move with the tube without independent longitudinal movement, a rod for turning the valve and means for moving the rod in accordance with the speed of the engine, substantially as described.

4. In a gas-engine, a regulating device comprising a hollow valve having ports, a valve H moving with said hollow valve without independent longitudinal movement and also having corresponding ports, a rod for turning the said latter valve, an arm for operating the rod, and means connected to the arm and controlled by the governor, substantially as described.

5. In a gas-engine, a regulator comprising two concentric valves having corresponding supports and reciprocating together without independent longitudinal movement, a rod for turning one of the valves relative to the other, and means controlling the movement of the rod in accordance with the speed of the engine.

6. In a gas-engine, a regulator comprising two concentric valves having corresponding ports, a rod for moving one of the valves, an arm connected to the rod, means for moving the arm positively in one direction at each rotation of the shaft, and means controlled by the speed of the rotation controlling the movement of the arm in the opposite direction, substantially as described.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

FRANZ BURGER.
HENRY M. WILLIAMS.

Witnesses:
WM. P. COOPER,
GEORGE K. TORRENCE.