(No Model.) 4 Sheets—Sheet 1.

J. S. KLEIN.

GAS ENGINE.

No. 568,115. Patented Sept. 22, 1896.

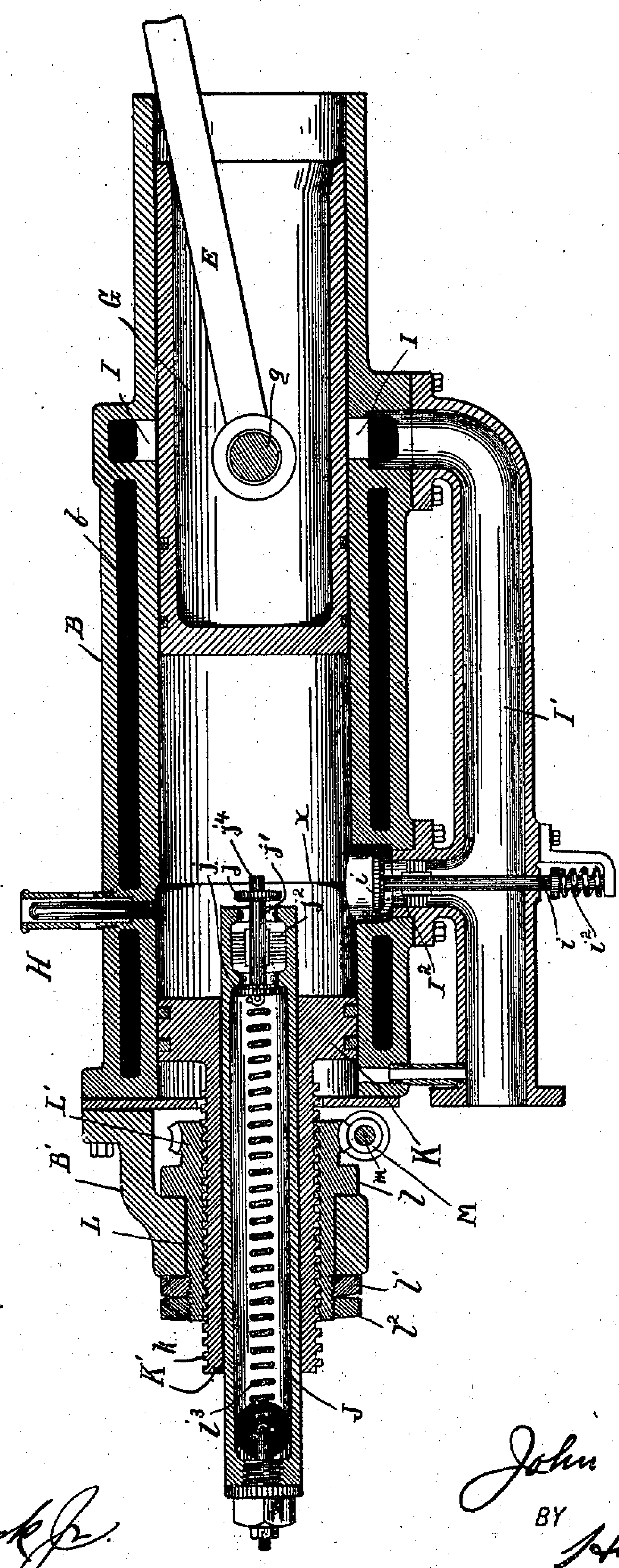

Fig. 1.

WITNESSES:

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(No Model.)

4 Sheets—Sheet 2.

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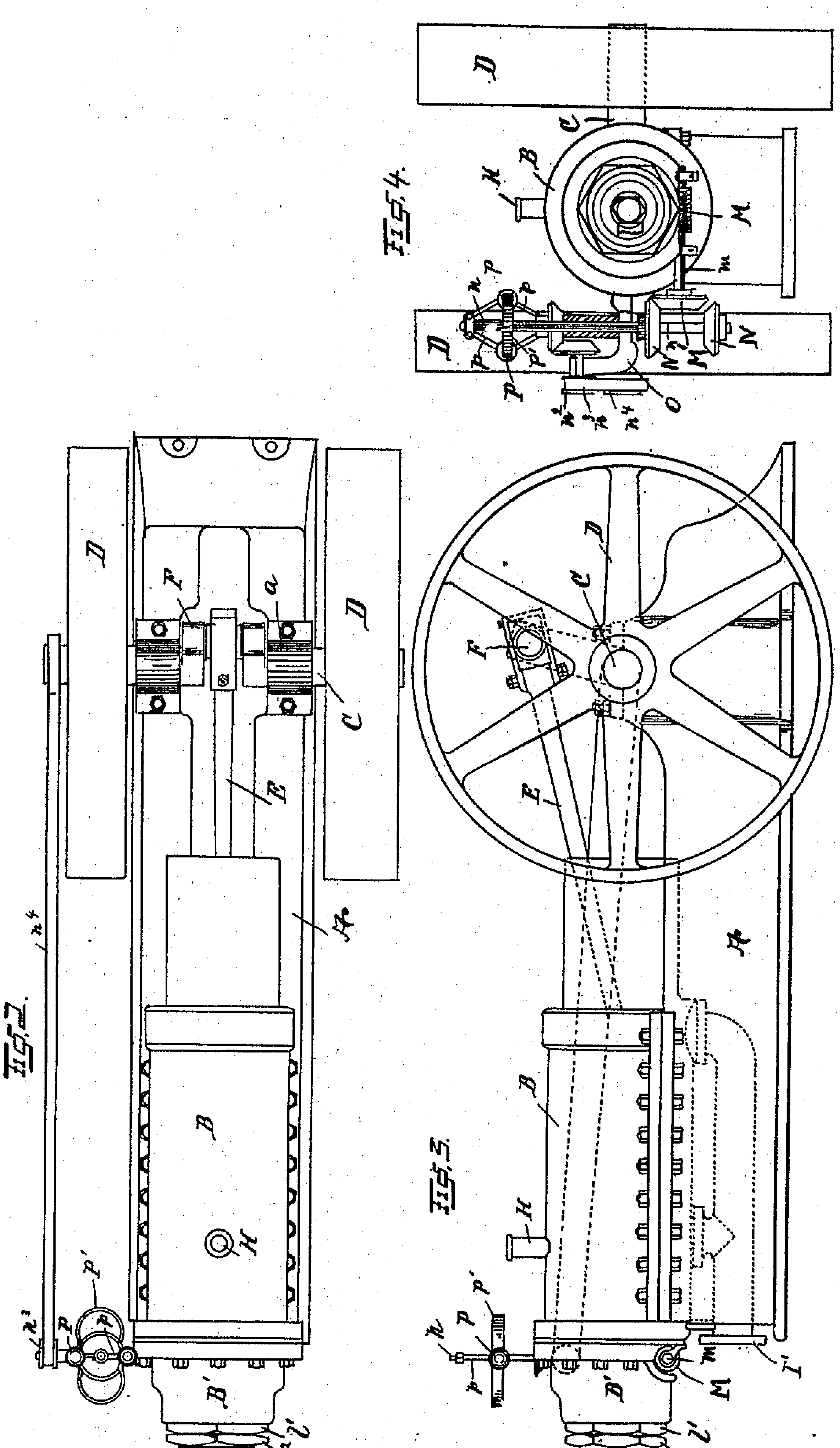

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4 Sheets—Sheet 3.

J. S. KLEIN

GAS ENGINE.

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Patented Sept. 22, 1896.

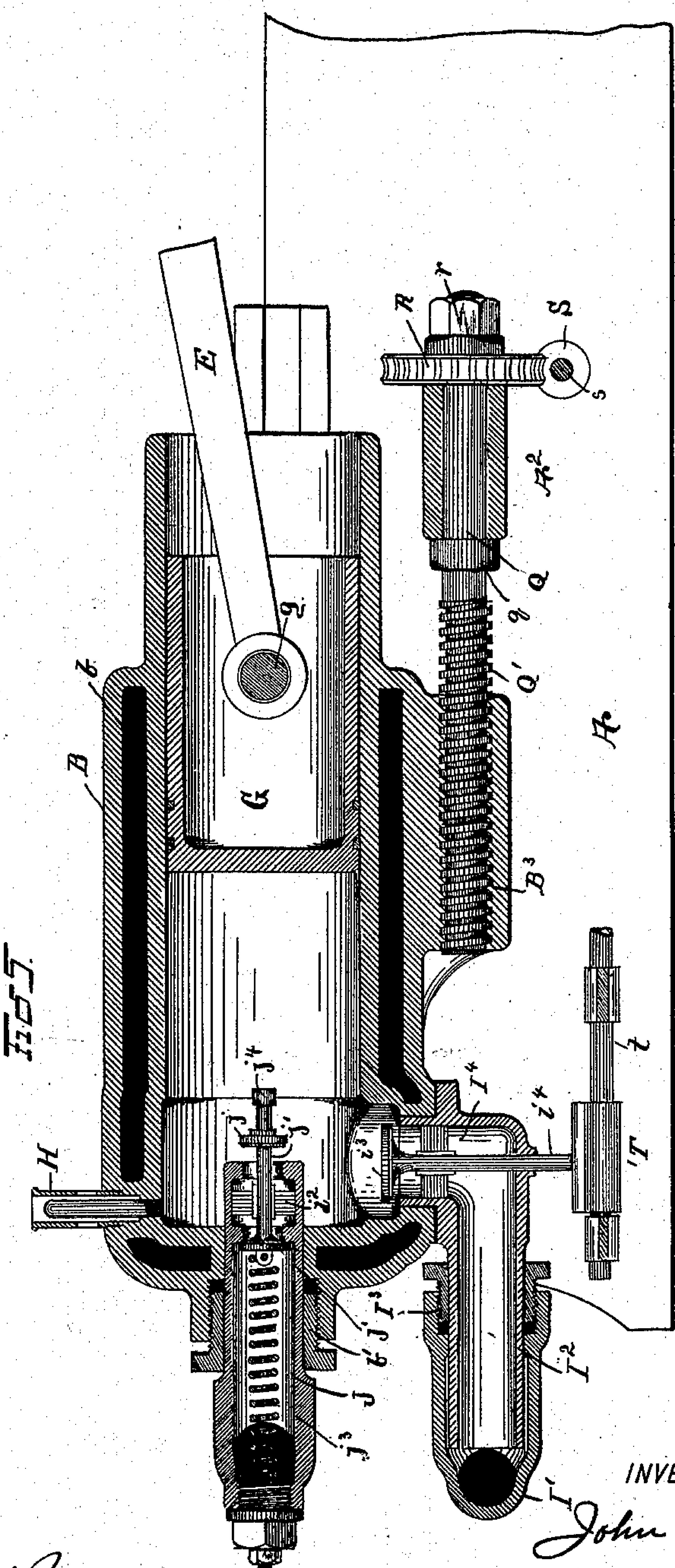

Fig. 3

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4 Sheets—Sheet 4.

J. S. KLEIN.

GAS ENGINE.

No. 568,115. Patented Sept. 22, 1896.

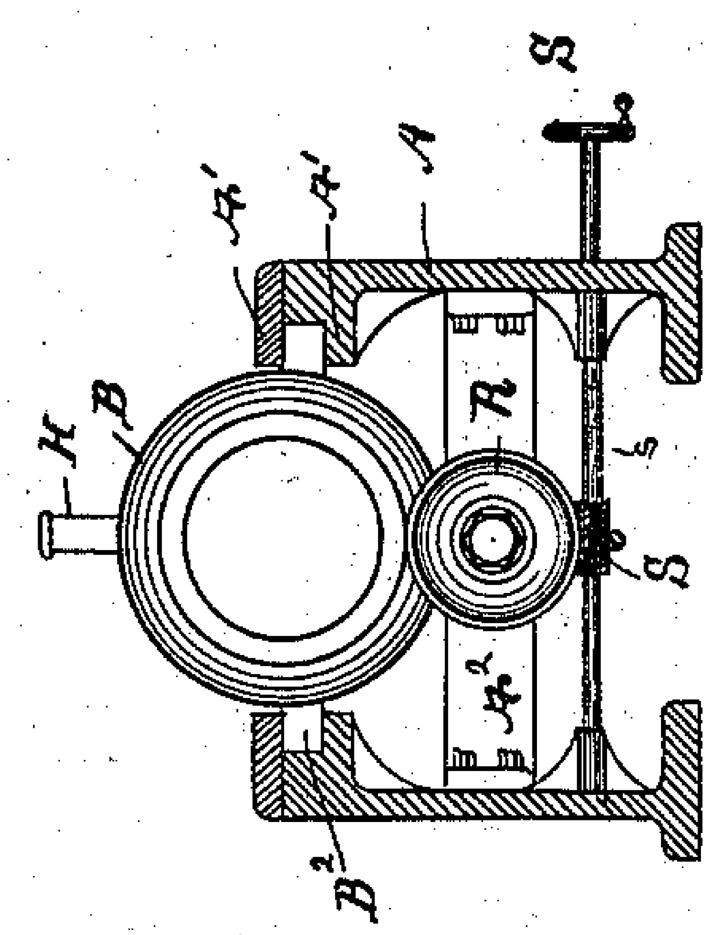

Fig. 7.

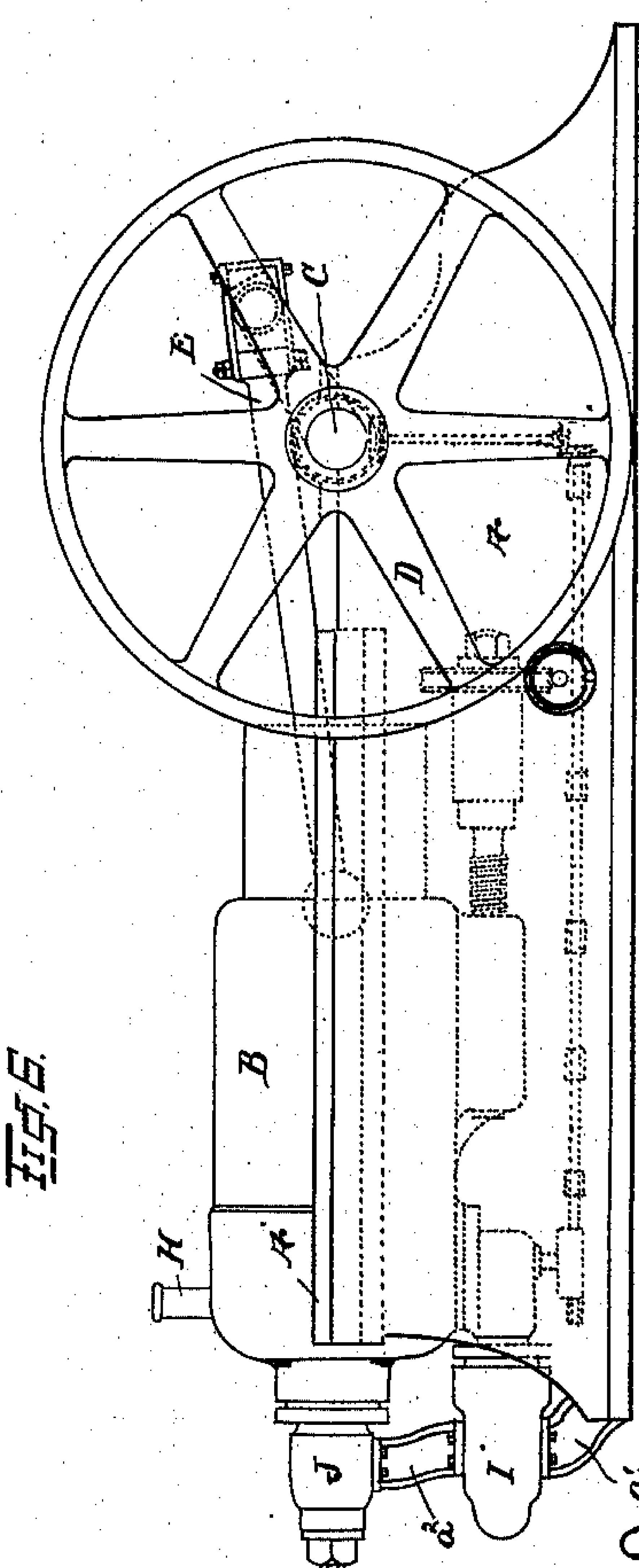

Fig. 6.

WITNESSES:

W. Marks Jr.

INVENTOR

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ATTORNEYS

UNITED STATES PATENT OFFICE.

JOHN S. KLEIN, OF OIL CITY, PENNSYLVANIA.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 568,115, dated September 22, 1896.

Application filed January 4, 1896. Serial No. 574,360. (No model.)

To all whom it may concern:

Be it known that I, JOHN S. KLEIN, a citizen of the United States, residing at Oil City, in the county of Venango and State of Pennsylvania, have invented certain new and useful Improvements in Gas-Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to gas-engines; and it consists in certain improvements in the construction thereof, as will be hereinafter fully described, and pointed out in the claims.

More particularly the invention relates to means of governing the speed and regulating the power of this class of engines.

The invention is illustrated in the accompanying drawings as follows:

Figure 1 shows a vertical section through the center of the cylinder and auxiliary parts. Figs. 2, 3, and 4 show, respectively, the plan, side elevation, and end elevation of the engine. Fig. 5 shows a vertical section of an alternative construction. Fig. 6 shows a side elevation of said alternative construction. Fig. 7 shows a cross-section of the same construction.

A marks the frame or engine-bed; B, the cylinder; *b*, the usual water-jacket; C, the crank-shaft journaled in the box *a*; D, the fly-wheels on said crank-shaft; E, the pitman; F, the crank to which the pitman is connected; G, the piston, with which the pitman is connected by means of the pin *g*, and H the igniter. All these parts are or may be of any common or desired construction.

In the construction shown in Figs. 1, 2, 3, and 4 the exhaust is effected through a main exhaust-port I at forward end of the cylinder and an auxiliary exhaust I^2 at the working end of the cylinder. Both these ports enter the exhaust-pipe I'. The auxiliary port is provided with a valve *i*, which is carried by a stem *i'*. A spring i^2 raises the valve *i* when the pressure above is relieved.

The operation of the exhaust mechanism is as follows: When the piston passes the port I, the main exhaust takes place. This relieves the pressure from the valve *i*. The spring i^2 then raises the valve *i*, and the exhaust continues during the back stroke of the piston through the auxiliary port. As the gas mixture is admitted under pressure its pressure closes the valve *i*, thus closing the exhaust.

The gas-port J is formed of a pipe connected with the supply-pipe J'. The port-pipe is finished on its outer surface and extends into the rear end of the cylinder. At the inner end of the port is a double valve *j*, the disks of which, working on oppositely-faced seats, are connected by the pin *j'*, which plays through a spider j^2. A spring j^3, secured to the port-pipe, is attached to the rear end of the valve and tends to draw the front disk to its seat, but is not sufficiently strong to overcome the gas-pressure in the port-pipe when the cylinder-pressure is relieved. A projection j^4 extends from the front of the valve and is of such length that the piston will contact it on its back stroke and carry the valve to position with both disks off their seats. The operation of the device is as follows: Starting with the position shown in the drawings with the cylinder exhausting, the piston moves back into contact with the projection j^4 and opens the valve. The pressure closes the exhaust-valve *i*. As soon as the cylinder-pressure approximates the port-pressure the spring j^3 closes the valve by drawing the forward disk to its seat. The ignition then takes place and the operation is continued as before described.

In engines of this class as heretofore made various means have been employed to vary the speed or power of the engine. One way of accomplishing this result has been to vary the explosive power of the mixture either by cutting off a part of the supply, (the consequent expansion of which changes its explosive quality.) Another method has been to vary the quality of the mixture admitted. It has also been accomplished by varying the capacity of the explosion-chamber with a fixed supply. By this means as the capacity of the chamber is increased the fixed quantity of the gas has less initial compression, and the exploded gas operating in a greater chamber exerts less pressure on the piston, so that the power is correspondingly decreased, but without any saving or diminution of the gas used. It has also been accomplished by cutting off the entire supply for one or more revolutions or, in other words, by "missing an impulse." These methods have proved unsatisfactory principally because they are not economical where a variable speed or load is required, as the greatest economy is accomplished by the use of a predetermined mixture under uniform compression and with regular impulses.

My invention overcomes these defects in this class of engines by supplying means of changing the capacity of the explosive-chamber at the moment of ignition and varying the quantity of gas admitted as the capacity of the chamber is varied. With this construction the mixture at the moment of explosion is of a uniform quality or strength, having a predetermined compression, under all conditions of speed or load. This may be accomplished in various ways, but I prefer the constructions shown in Figs. 1, 2, 3, and 4, in which it is effected as follows: A movable cylinder-head K is placed in the rear end of the cylinder. This movable head fits movably but tightly on the port-pipe J and is extended by a sleeve K, which protrudes from the rear of the cylinder and is provided with screw-threads k. A screw-threaded nut is run onto the sleeve K′. This nut is journaled in the bracket B′, extending from the rear of the cylinder. An annular shoulder l holds the nut against longitudinal movement in one direction, and the nut l' and jam-nut l^2 complete the locking of the nut L against longitudinal movement.

The operation of the device will be readily understood. As the nut L is revolved the movable head K is moved by the screw in or out. Assuming the extreme inward stroke of the piston (the inner dead-point) to be approximately the line X, it will be readily seen that as the movable head K is moved toward this line the initial explosion-chamber is decreased, and as it is moved from this line it is increased. The mixture, of such quality and compression as has been ascertained to be most economical and effective, is admitted uniformly in this condition to the explosion-chamber. The initial force exerted by the explosion is of course about the same with all positions of the movable head, the variation of power being accomplished by the variation of the expansive force. Thus when the movable head is at a position the most remote from the line X and the explosion-chamber of maximum capacity the fall of the expansion-line will not be rapid and the mean effective pressure maximum, but if the movable head is at a position nearest the line X, so that the explosion-chamber is of minimum capacity, the fall of the expansion-line will be most rapid and the mean effective pressure minimum, and by moving the head to different positions any intermediate power may be obtained. It will readily be understood, however, that if the supply of mixture is not increased as the capacity of the explosion-chamber is increased the power of the engine will be diminished as the capacity of the chamber is increased. It will also be understood that if the supply is varied as the capacity of the explosion-chamber—*i. e.*, increased or diminished and in the same proportion, so that the uniform compression is maintained at the moment of ignition—the power of the engine will increase as the capacity of the explosion-chamber and supply of mixture are increased, and vice versa. It will also appear from this that the supply can be so regulated with relation to the various capacities of the explosion-chamber as to maintain a fixed power-exerting force, that is, the supply may be sufficiently increased, as the capacity of the explosion-chamber is increased, to prevent a diminution of power and still be insufficient to effect an increase in power. To obtain, therefore, the economic results flowing from my invention, the supply should be so increased as the capacity of the explosion-chamber is increased as to effect an increase in the power of the engine, and vice versa. I prefer, however, the construction shown, wherein the supply is so varied as the capacity of the explosion-chamber is varied that the compression of the explosive mixture at the moment of ignition is kept constant, and in which the compression of the explosive mixture at the moment of ignition approximates the compression at which it is admitted.

The regulation of the power of the engine may be accomplished automatically or arbitrarily by hand. In my preferred construction I have shown an automatic governor for automatically regulating the speed, as follows: On the nut L is a worm-gear L′, which is actuated by a worm M, keyed to the shaft m. The shaft m is journaled in the frame and has at its outer end a beveled friction-wheel M′. The governor-spindle n, journaled in a frame O, carries two cone friction-wheels N N, which as the spindle is raised or lowered come into contact with bottom or top of the wheel M′, so that one wheel N drives the worm M in one direction and the other in the opposite direction. The governor-weights P are carried by the levers p, and the springs P′ counteract the centrifugal force of the weights. The levers p are arranged to raise or lower the spindle n with each changed position of the weights. When the speed is normal, the spindle is held so that both wheels N are out of contact. The spindle n is driven through gears n' and n^2 by the pulley n^3, which is driven from the crank-shaft by a belt n^4. The arrangement of the weights, springs, pulleys N and M′, and the worm M is such that if the speed exceeds the normal the worm actuates the nut L to move the head K toward the line X, and vice versa, with the result heretofore described.

In the alternative construction shown in Figs. 5, 6, and 7 the general result attained in the preferred construction is accomplished in a different way. In this construction the cylinder is provided with lugs B^2, which are carried by the guides A' A' on the frame, so as to slide freely therein. The change in the position of the head is accomplished by moving the entire cylinder. To facilitate this movement, the screw Q' is provided, which runs in a screw-threaded lug B^3 on the bottom of the cylinder. The screw-shank Q is journaled in a cross-plate A^2 of the frame and is locked against longitudinal movement by the collar q and the worm-gear R, which is secured with a nut r. A worm S, carried by the shaft s, actuates the worm-gear and consequently the cylinder. A hand-wheel S' is provided for operating the worm in this instance, but it is plain a governor may be attached, if desired. The exhaust-port I' terminates in a sleeve I, which runs through a stuffing-box I^3 into the exhaust-pipe. The exhaust-valve i^3 is actuated by a cam T, which is carried by the shaft t and operated from the crank-shaft by a system of gears, as shown by dotted line in Fig. 6. The supply-port passes through a gland b' into the cylinder, thus allowing the movement of the cylinder. The other parts of the mechanism operate as in the preferred construction and the movement of the cylinder effects the same result on the regulation as the movement of the movable head in that construction.

I do not wish to be limited to the constructions herein shown, the essential feature of my invention being the means for providing a variable capacity of explosion-chamber at the moment of ignition with a variable supply. By the term "gas-engine" I wish to include all those engines which use the explosive principle in their operation.

I do not herein claim the method of utilizing the increased expansive force of increased quantities of explosive mixture to increase the power of the engine, and vice versa, as this is the substance of a separate application, filed April 28, 1896, Serial No. 589,432.

What I claim as new is—

1. In a gas-engine, the combination with the cylinder; a means of exhaust; the piston; and the igniter; of means of varying the capacity of the explosion-chamber at the moment of ignition; and means of admitting explosive mixture to the explosion-chamber in quantities so varied as the capacity of the explosion-chamber varies as to increase the power of the engine as the capacity of the explosion-chamber is increased.

2. In a gas-engine, the combination with the cylinder; a means of exhaust; the piston; and the igniter; of means of varying the capacity of the explosion-chamber at the moment of ignition; and means of admitting explosive mixture to the explosion-chamber in quantities so varied as the capacity of the explosion-chamber varies as to maintain a substantially uniform compression at the moment of ignition.

3. In a gas-engine, the combination with the cylinder; a means of exhaust; the piston; and the igniter; of means of varying the capacity of the explosion-chamber at the moment of ignition; and means of admitting explosive mixture to the explosion-chamber under a compression approximating the compression at the moment of ignition and in quantities so varied as the capacity of the explosion-chamber varies as to increase the power of the engine as the capacity of the explosion-chamber is increased.

4. In a gas-engine, the combination with the cylinder; a means of exhaust; the piston; and the igniter; of means of varying the capacity of the explosion-chamber at the moment of ignition; and means of admitting explosive mixture to the explosion-chamber under a compression approximating the compression at the moment of ignition and in quantities so varied as the capacity of the explosion-chamber varies as to maintain a substantially uniform compression at the moment of ignition.

5. In a gas-engine, the combination with the cylinder; a means of exhaust; the piston; and the igniter; of means of changing the relative parts to vary the capacity of the explosion-chamber at the moment of ignition; and means of admitting explosive mixture to the explosion-chamber in quantities so varied as the capacity of the explosion-chamber varies as to increase the power of the engine as the capacity of the explosion-chamber is increased.

6. In a gas-engine, the combination with the cylinder; a means of exhaust; the igniter; and a reciprocating piston; of means of varying the capacity of the explosion-chamber with the piston at the inner dead-point; and means of admitting explosive mixture to the explosion-chamber in quantities so varied as the capacity of the explosion-chamber varies as to increase the power of the engine as the capacity of the explosion-chamber is increased.

7. In a gas-engine, the combination with the cylinder; a means of exhaust; the igniter and a reciprocating piston; of means of varying the capacity of the explosion-chamber with the piston at the inner dead-point; and means of admitting explosive mixture to the explosion-chamber in quantities so varied as the capacity of the explosion-chamber varies as to maintain a substantially uniform compression at the moment of ignition.

8. In a gas-engine, the combination with the cylinder; a means of exhaust; the igniter and a reciprocating piston; of means of varying the capacity of the explosion-chamber with the piston at the inner dead-point; and means of admitting explosive mixture to the explosion-chamber under a compression approximating the compression at the moment of ignition, and in quantities so varied as the ca-

pacity of the explosion-chamber varies as to increase the power of the engine as the capacity of the explosion-chamber is increased.

9. In a gas-engine, the combination with the cylinder; a means of exhaust; the igniter and a reciprocating piston; of means of varying the capacity of the explosion-chamber with the piston at the inner dead-point; and means of admitting explosive mixture to the explosion-chamber under a compression approximating the compression at the moment of ignition and in quantities so varied as the capacity of the explosion-chamber varies as to maintain a substantially uniform compression at the moment of ignition.

10. In a gas-engine, the combination of the cylinder; means of supplying gas thereto; a means of exhaust; the igniter; and a piston; of a cylinder-head movable relatively to the piston and through which is carried the gas supply.

11. In a gas-engine, the combination of the cylinder; means of supplying gas thereto; means of exhaust; the igniter; and a piston; of a cylinder-head movable relatively to the cylinder and the piston and through which is carried the gas supply.

12. In a gas-engine, the combination of the cylinder; the supply-port pipe J; the movable head K having the screw-threaded sleeve K′ thereon surrounding said port-pipe; the nut L on said sleeve and locked against longitudinal movement; a means of exhaust; the igniter; and the piston.

13. In a gas-engine, the combination with the cylinder; means of supplying gas thereto; a means of exhaust; the igniter; and the piston; of means actuated by an automatic governor for varying the capacity of the explosion-chamber at the moment of ignition.

14. In a gas-engine, the combination of the cylinder; means of supplying gas thereto; a means of exhaust; the igniter; and a reciprocating piston; of means actuated by an automatic governor for varying the capacity of the explosion-chamber with the piston at the dead-point.

15. In a gas-engine, the combination of the cylinder; means of supplying gas thereto; a means of exhaust; the igniter; and a piston; a cylinder-head movable relatively to the piston; a worm-gear for effecting said movement; a worm for actuating said gear; and a centrifugally-acting governor driven from the engine for operating said worm.

In testimony whereof I affix my signature in presence of two witnesses.

JOHN S. KLEIN.

Witnesses:
F. W. HAYS,
A. B. STEEN.