(No Model.) 3 Sheets—Sheet 1.

L. H. NASH.

METHOD OF OPERATING GAS ENGINES.

No. 418,418. Patented Dec. 31, 1889.

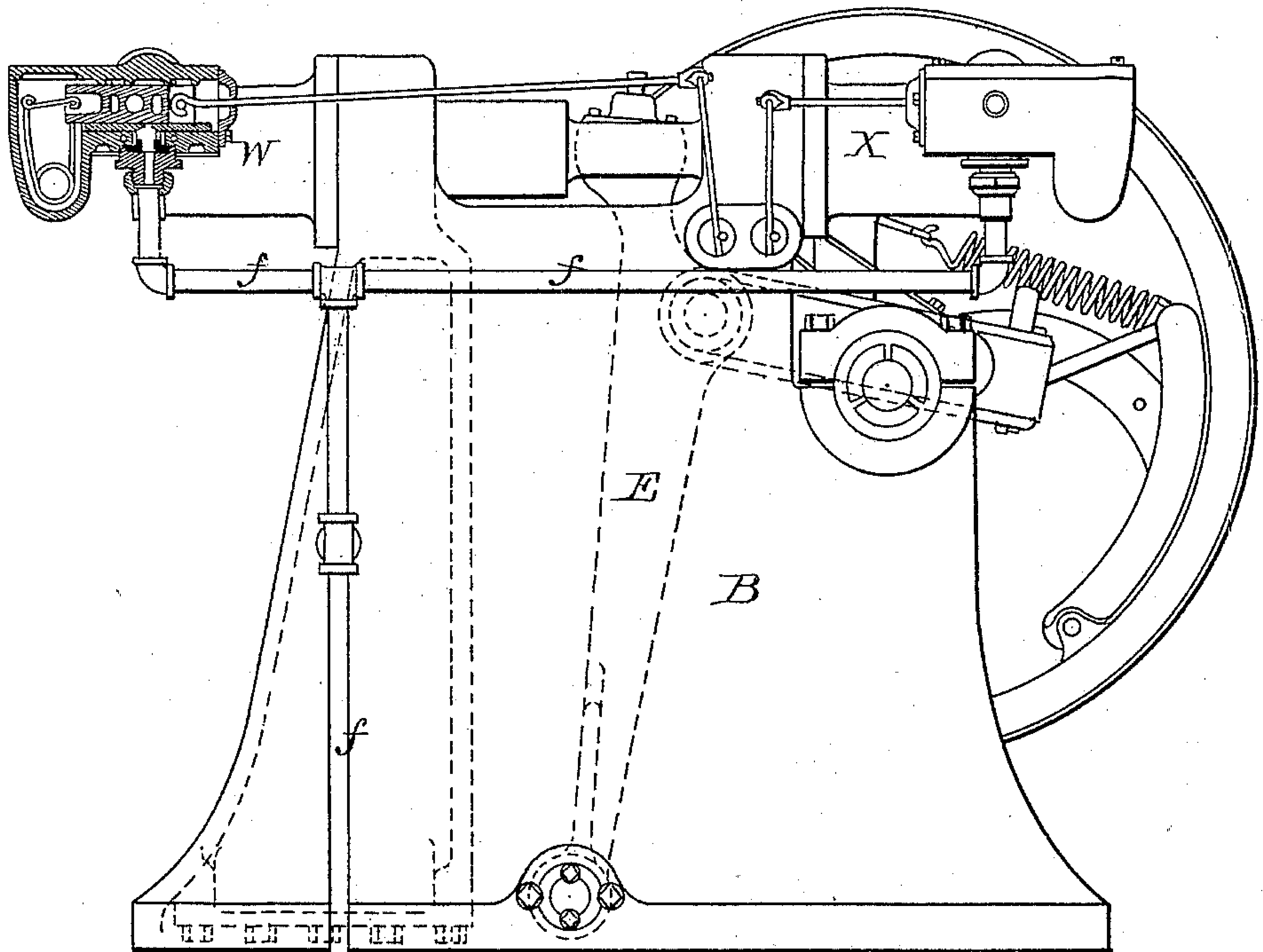
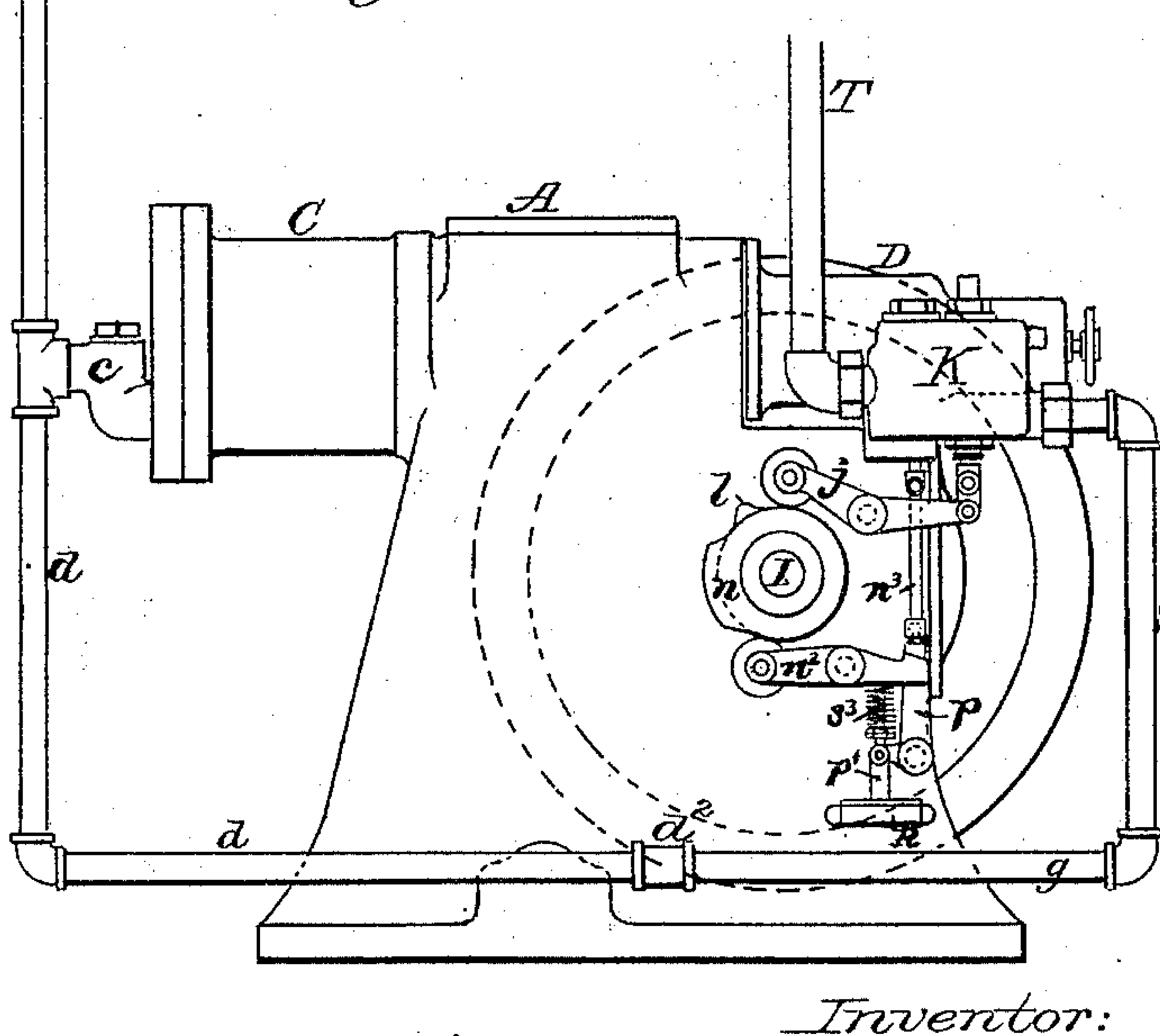


Fig. 1.



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3 Sheets—Sheet 2.

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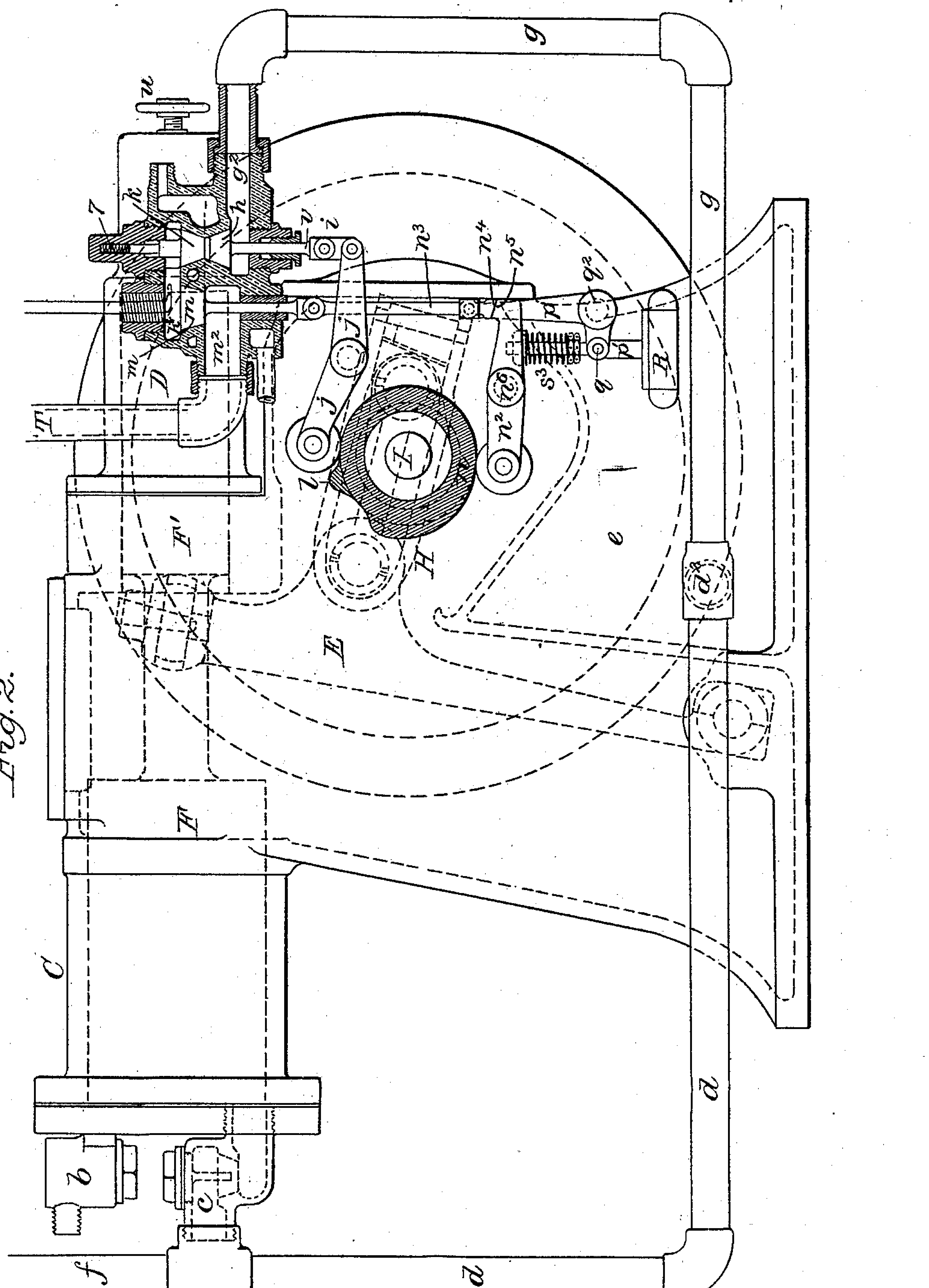

Fig. 2.

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(No Model.) 3 Sheets—Sheet 3.

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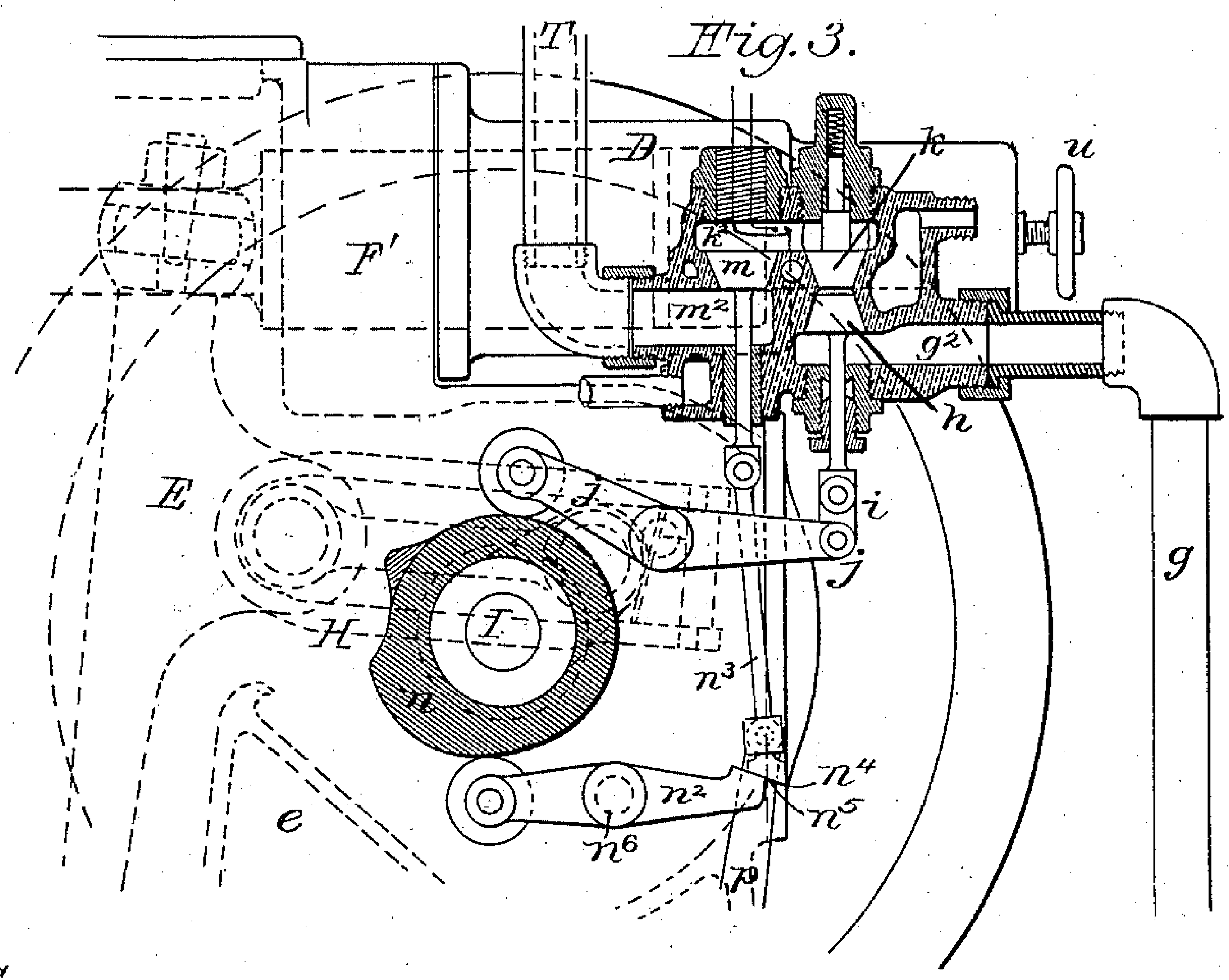
Fig. 3.



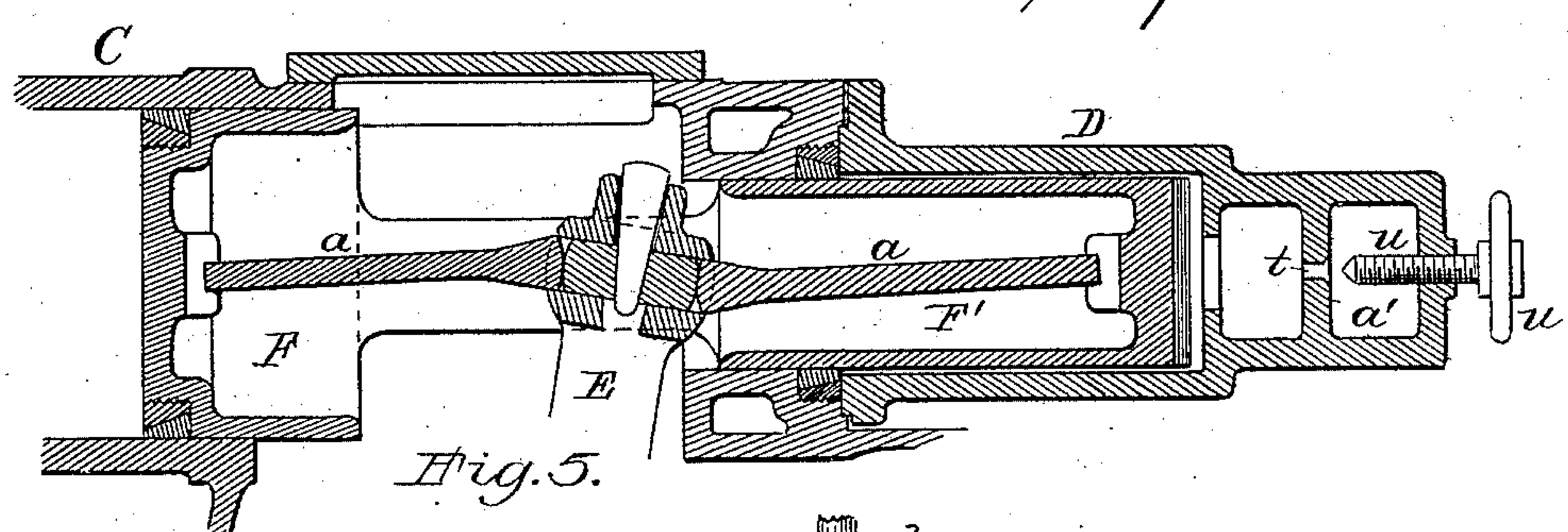


Fig. 5.

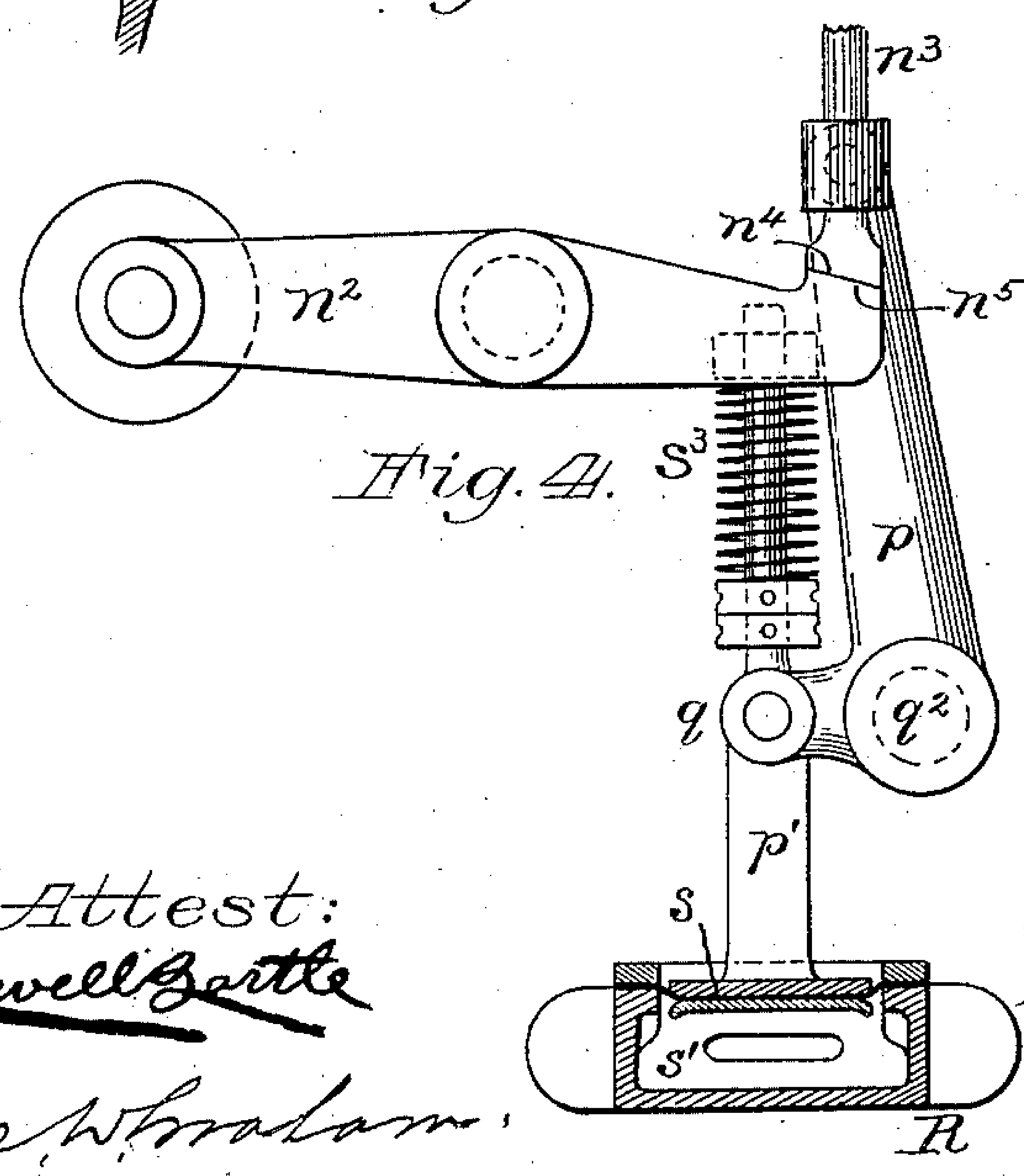


Fig. 4.

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UNITED STATES PATENT OFFICE.

LEWIS HALLOCK NASH, OF SOUTH NORWALK, CONNECTICUT, ASSIGNOR TO THE NATIONAL METER COMPANY, OF NEW YORK, N. Y.

METHOD OF OPERATING GAS-ENGINES.

SPECIFICATION forming part of Letters Patent No. 418,418, dated December 31, 1889.

Application filed February 14, 1888. Serial No. 263,948. (No model.)

To all whom it may concern:

Be it known that I, LEWIS HALLOCK NASH, a citizen of the United States, residing at South Norwalk, in the county of Fairfield and State of Connecticut, have invented new and useful Improvements in the Method of Operating Gas-Engines, of which the following is a specification.

My invention consists of certain improvements in the method of operating a gas-engine, which are specifically pointed out in the claims concluding this specification.

The accompanying drawings illustrate one form of engine capable of carrying out my invention.

Since my present invention consists of an improved method of operating a gas-engine, it will of course be understood that any other form or combination of devices embodied in my improved method may be employed instead of those here illustrated and described.

Referring to the drawings, Figure 1 represents in elevation two engines A and B, connected for conjoint operation in producing power. Fig. 2 represents engine A enlarged, showing the supply and exhaust valves in section and their operating parts. Fig. 3 shows the same valve parts in section, the operating parts of the exhaust-valve being shown in different positions from that shown in Fig. 2. Fig. 4 shows in sectional elevation a pressure device connected with the exhaust-valve and controlled by the pressure of the gaseous charge for controlling the variations in the period of the exhaust of the waste gases. Fig. 5 is a central longitudinal section of the compression and power cylinders of engine A, showing the combustion-chamber of the power-cylinder in communication with a reservoir to relieve the back-pressure in starting the engine.

The points of novelty in my invention will be particularly designated in the claims concluding this specification.

Referring to Fig. 1, the engine B therein shown is of the twin-cylinder type patented to me January 12, 1886, the compression-cylinder shown in said patent being omitted, while the engine A serves to furnish the compressed charge for the engine B, and hence the latter does not require its own compressor, and can therefore be made more simple and is more easily operated. Its two cylinders W and X are separated from each other by a space sufficient to accommodate the motion of a rock-arm E, (shown by dotted lines,) to which the pistons are connected. This engine B has all the necessary valve appliances for its proper operation, and since its construction is not illustrative of my present invention and can be readily understood by reference to my said patent it is deemed unnecessary to give a particular description thereof herein further than to state that the engines A and B are connected by a pipe *f*, which conveys the compressed charge from the former to the latter in the operation of the engine.

The engine A is shown as having the same general type as the engine B, in which two cylinders C and D are mounted in the engine-frame, being separated by a sufficient space to accommodate the motion of a rock-arm E, to which the plungers F F′ are secured by the connecting-rods *a a*, as seen in Fig. 5. The rock-arm E is pivoted at the base of the engine-frame, and is connected to the crank of the shaft I by a connecting-rod H, as shown by dotted lines in Figs. 2 and 3.

While the engine A has two cylinders, as stated, only one D is the power-cylinder, the other C being a compression-cylinder wherein the gas supplied through an inlet-valve *b*, Fig. 2, is compressed and from which the charge is discharged through a valve *c* and pipe *d* into the reservoir *e* of the engine A, and also into the engine B by the branch pipe *f*, and into the power-chamber D by the pipe *g*. The reservoir *e* is shown in dotted lines as being formed in the base of the engine-frame, and the pipe *d* communicates with the reservoir by a branch d^2. Since in the present instance the engine A is designed to furnish the charge both for itself and for the engine B, the compression-cylinder C is made large enough for the purpose; but, as before stated, it will be understood that my invention is not confined to the particular engine shown.

In the drawings are illustrated two valves of the puppet type for controlling the inlet of the charge to the power-cylinder of the engine A. These valves are arranged to open in opposite directions, one h downward and the other k upward. They are in form truncated cones. The lower valve h may open downward by a positive movement to allow the charge to pass upward by it, while the upper valve k may open upward by the pressure of the inflowing charge to allow the latter to pass into the combustion-chamber. While both valves operate in the same inlet-passage, yet each has a separate and independent seat, the one k, when closed, serving to sustain the back-pressure from the ignited gases in the power-cylinder, and the other h serving to resist, when closed, the pressure of the compressed charge, which pressure is always active upon this valve. In this way the upper valve prevents the lower valve from being opened by the back-pressure from the combustion-chamber, and the two valves co-operate to open and to close the inlet, and it will be seen that they act to seat themselves by the pressure of the gases in opposite directions, so that no matter whether the excess of pressure be in the power-cylinder or in the storage-reservoir e one or the other of these valves will make the joint, unless one of them is moved by mechanical means. It is, however, only necessary to positively move one of them, as the lower valve, to admit the charge, and I prefer to let the other valve open by means of the inflowing charge and to seat itself by means of gravity or the force of a spring or by the back-pressure of gases or otherwise, and for this purpose the stem of the upper valve is fitted to move in a guide in the valve-case against a spring 7, which constantly tends to close said valve. The lower valve h is opened against the pressure of the charge by the operation of the engine, as I will now describe. The stem v of this valve passes down through a stuffing-box in the valve-case, and is connected by a link i to one end of a lever j, pivoted on the engine-frame and acted upon at its other end by a cam l, secured upon the crank-shaft in a position to open the lower valve to admit the charge at the desired time.

In the arrangement shown the lower valve opens into a passage g^2, which connects with the charge-conveying pipe g, while the upper valve opens into a passage k^2, which connects with the combustion-chamber of the cylinder D.

The exhaust-valve m is also of the puppet type, and is arranged to open upward in the cylinder-passage k^2, while the exhaust-passage m^2, formed in the valve-case, opens into an escape-pipe T. The stem of this valve passes down through a stuffing-box in the valve-case and is connected by a link n^3 to one end of a lever n^2, pivoted at n^6 to the engine-frame and acted upon at its other end by a cam n, secured upon the crank-shaft in position to open the exhaust at the proper time. This connection of the valve-rod with the lever is made by a free bearing or seat n^4, which stands inclined to the length of the rod, so that the joining is made by an inclined seat n^4 at the end of the valve-rod and by an inclined seat n^5 at the end of the lever. This inclined seat-forming end of the valve-link n^3 is held in place by a lever p, pivoted at q^2 to the engine-frame, and to the valve-link n^3 just above its seat-forming end, so that the inclined link-seat will have a lateral sliding movement upon the lever-inclined seat end, for a purpose and by means which I shall presently describe. The lever p is operated by a rocking movement, so as to vibrate the seat-forming end of the valve-link n^3. This lever p is connected by a bell-crank arm q to a pressure-regulating device R, the function and purpose of which are to vary the period of the exhaust of the waste gases from the power-cylinder in accordance with the power developed. This pressure-regulating device, in its connection with and relation to the inclined seat-forming connection with the exhaust-valve link, is best seen in Figs. 3 and 4. It consists of a chamber-forming device R, in communication with the reservoir e by a passage s^2, one of the sides of its chamber s' being formed by a piston-diaphragm s, which is connected to the bell-crank arm of the lever p by a piston-rod p'. Therefore any movement of the diaphragm will cause the lever p to rock, and thus slide the inclined seat end of the valve-link n^3 upon the corresponding seat end n^5 of the cam-operated lever n^2. In this movement the diaphragm is operated by the changes in the pressure of the charge in the reservoir e, and the movement of the valve-link will be in a direction up or down the inclined seats n^4 and n^5. An upward movement on said incline serves to hold the valve m up longer in the stroke of the piston of the power-cylinder and to lengthen the period of the exhaust, while the reverse movement on said incline will act to lessen said period of the exhaust. By this means the variations of pressure in the reservoir are caused to regulate the point in the stroke at which the exhaust-valve will seat itself, and thereby to control the amount of the waste gases retained in the power-cylinder.

A spring s^3, connected to the engine-frame and to the piston-rod p' of the diaphragm, is adapted by suitable adjustment to sustain and balance the pressure upon the diaphragm, so that it is only the variation in such pressure that operates the valve in the way described.

The charge may be ignited by the electric spark, a permanent flame, or otherwise, and I deem it unnecessary to show such exploding device.

The operation of the engine is as follows: Referring to Fig. 2, the operating parts are shown in the positions they occupy when the engine is just completing its back-stroke. The exhaust-valve has just been closed, and the inlet-valve h is just on the point of opening to admit the charge, as seen in the positions of the cams n and l. The engine is now operating with a full charge, and the exhaust-valve is held open during the greater portion of the return-stroke to cushion the charge, as is common in steam-engines. To reduce the power of the engine, the valve m is caused to close earlier in the stroke, as seen in Fig. 3, wherein the valve-link connection n^3 is moved down upon its inclined seat n^5, and therefore the valve m is caused to seat when the lever n^2 is acted upon by a higher portion of the cam n, and so earlier in the stroke of the engine; hence a quantity of the waste gases will be retained in the cylinder and will be compressed by the piston in the combustion-chamber, so that when the inlet-valve is opened there will be just that much less space in said chamber to be filled by the new charge, and the amount of the new charge will therefore be smaller by that amount. In other words, the incoming charge will be regulated by the amount of the waste gases retained in the power-cylinder. I have shown the pressure-regulating device as adapted to control the point of closing of the discharge-valve, so that the engine is regulated by the pressure of the compressed gases; but my invention is not confined to an engine acting as a compressor, but may be applied to any engine furnishing power, and in such case a speed-governor—such, for instance, as an ordinary centrifugal governor—may be used to control the arm p or other device employed to determine the closing length of time the exhaust-valve is open.

It will be seen that the compression-pump C will furnish its own charge, while also furnishing the charge for the engine B, and that such charging of the compressed products will be self-regulating, for if the consumption is great the pressure in the reservoir will fall and the valve m will be caused to remain open a longer period of time, thus increasing the speed of the engine to keep up the supply; but if the consumption is small the reverse action will take place. As the engine B receives its charge from the engine A, the latter will therefore operate with more regularity than engines that compress their own charges, and it is more easily started.

In order to aid in starting the engine A, I have illustrated the combustion-chamber of its power-cylinder D, provided with a relief-chamber a', Fig. 5, which communicates with the combustion-chamber by a passage t, which is closed by a screw-plug u. This relief-chamber may be formed on the end of the power-cylinder, as shown, and provided with the screw-plug in the end of said chamber, so as to open and close the interior wall-passage t, opening into the combustion-chamber. With this pressure-relief provision in starting the engine by hand the passage t is opened, and hence on the back-stroke of the piston some of the gases will be forced into such relief-chamber and the pressure in the combustion-chamber will be much less than it would be otherwise. When the engine begins to run, the plug u is closed, and the charge is then compressed only in the combustion-chamber at the desired degree. I may, however, dispense with this provision for aiding in starting the engine, or I may adopt other devices for the purpose. My invention is not limited to such particulars.

I have used the word "charge" to indicate the compressed combustible mixture which forms the charge in the power-cylinder of a gas-engine, such as a mixture of gas and air or of a volatile fuel and air.

Except for the purpose of effecting the method of operation set forth in the claims, I do not in the Letters Patent to be issued on this application claim the combustion-chamber of a gas-engine supplemented with an external valved communicating chamber placed between the charge-supplying port and the combustion-chamber for relieving the pressure in said chamber in starting the engine, in combination with a piston compressing the charge upon its back-stroke, as the said invention and combination of devices constitute the subject-matter of the claim of a patent granted to me April 19, 1889, numbered 401,453, for gas-engine.

Having thus described an organized and operative engine in which the several features of novelty of my present invention are illustrated and are shown in combination, I specifically claim and desire to secure by Letters Patent the following:

1. The method substantially herein described of operating a gas-engine, which consists in compressing the charge by an independent compressor and controlling the speed of said compressor by means of the pressure of the charge so compressed.

2. The method substantially herein described of operating a gas-engine, which consists in compressing a charge into a reservoir and in controlling the speed of the engine by variations in the pressure of the said compressed charge.

3. The method substantially herein described of operating gas-engines in series, which consists in compressing the charge by an independent engine, operating said engine by a portion of the charge so compressed, and operating one or more additional engines by the other portions of said charge.

4. The method substantially herein described of operating a gas-engine, which consists in supplying a compressed charge, effecting the compression of the charge by the use of a part of said charge, and controlling the amount of such compression at an inverse ratio to and by the pressure of the charge.

5. The method substantially herein described of operating a gas-engine, which consists in compressing the charge by an independent compressor, controlling the speed of said compressor by closing the exhaust at va-

rious points in the back-stroke of the piston of the same, and determining such points of closing in accordance with the degree of compression of the charge.

6. The method substantially herein described of operating a gas-engine, which consists in compressing the charge by an independent compressor, controlling the speed of said compressor by closing the exhaust at various points in the back-stroke of the same, thus cushioning said back-stroke by the compression of the waste gas, and controlling the duration of such closing or cut-off in a corresponding ratio to and by the pressure of such charge.

7. The method substantially herein described of operating a gas-engine, which consists in compressing the charge by an independent compressor, operating said compressor by a part of the compressed charge, controlling the speed of said compressor by cushioning the back-stroke of its piston by the waste gas, and controlling the force of such cushioning in a corresponding ratio to and by the pressure of the compressed charge.

8. The method of operating a gas-engine substantially herein described, which consists in opening and maintaining without interruption a free communication between the combustion-chamber and a supplemental chamber during the first strokes of the piston at the starting of the engine, whereby to enlarge the compression and expansion area of said chamber, and subsequently closing and maintaining closed said communication while the engine is under way, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

LEWIS HALLOCK NASH.

Witnesses:

JNO. H. NORRIS,

PERCY MACCALLUM.