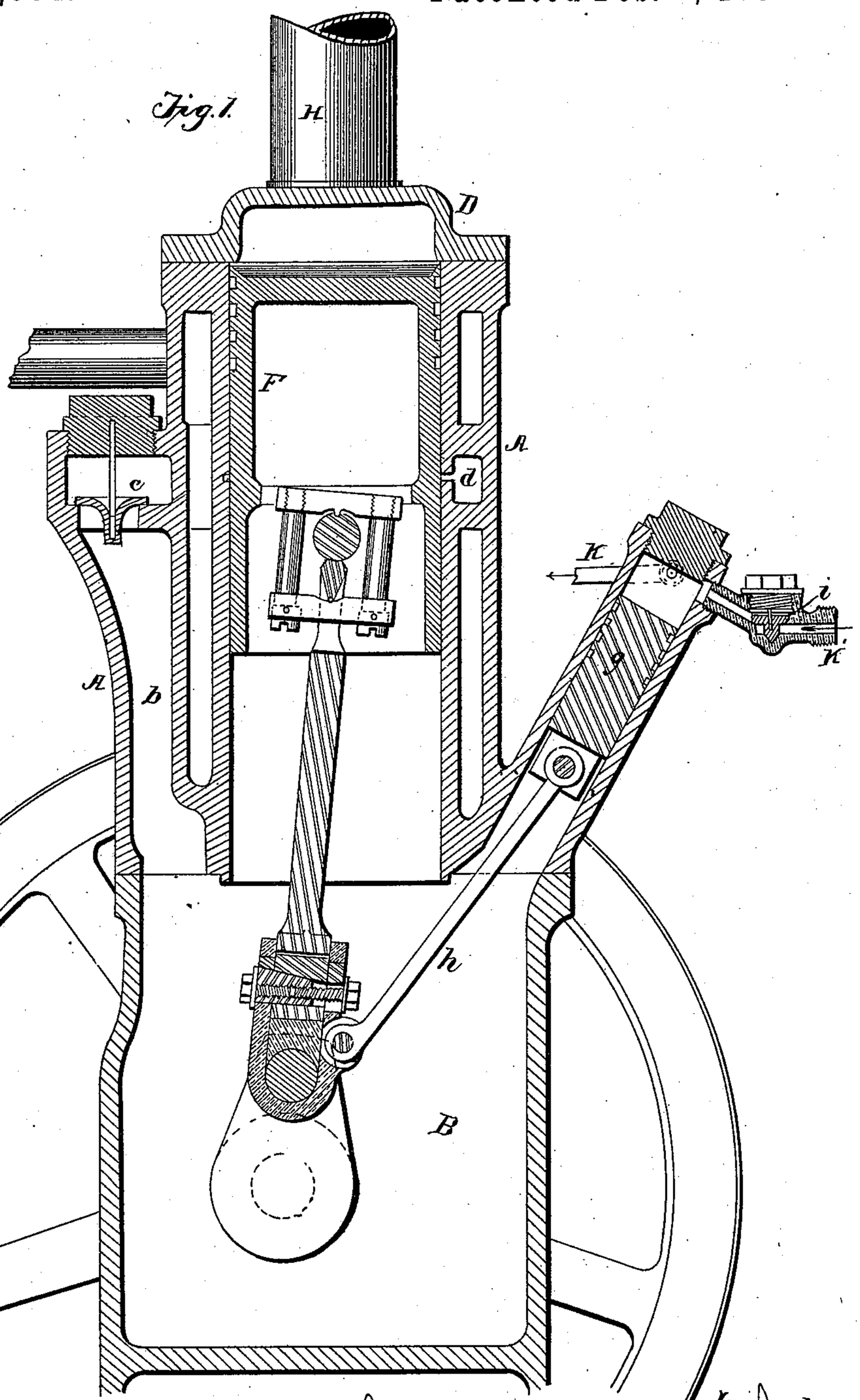
(No Model.) 2 Sheets—Sheet 1.

L. H. NASH.

GAS ENGINE.

No. 576,604. Patented Feb. 9, 1897.

Fig. 1.



Witnesses
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(No Model.) 2 Sheets—Sheet 2.

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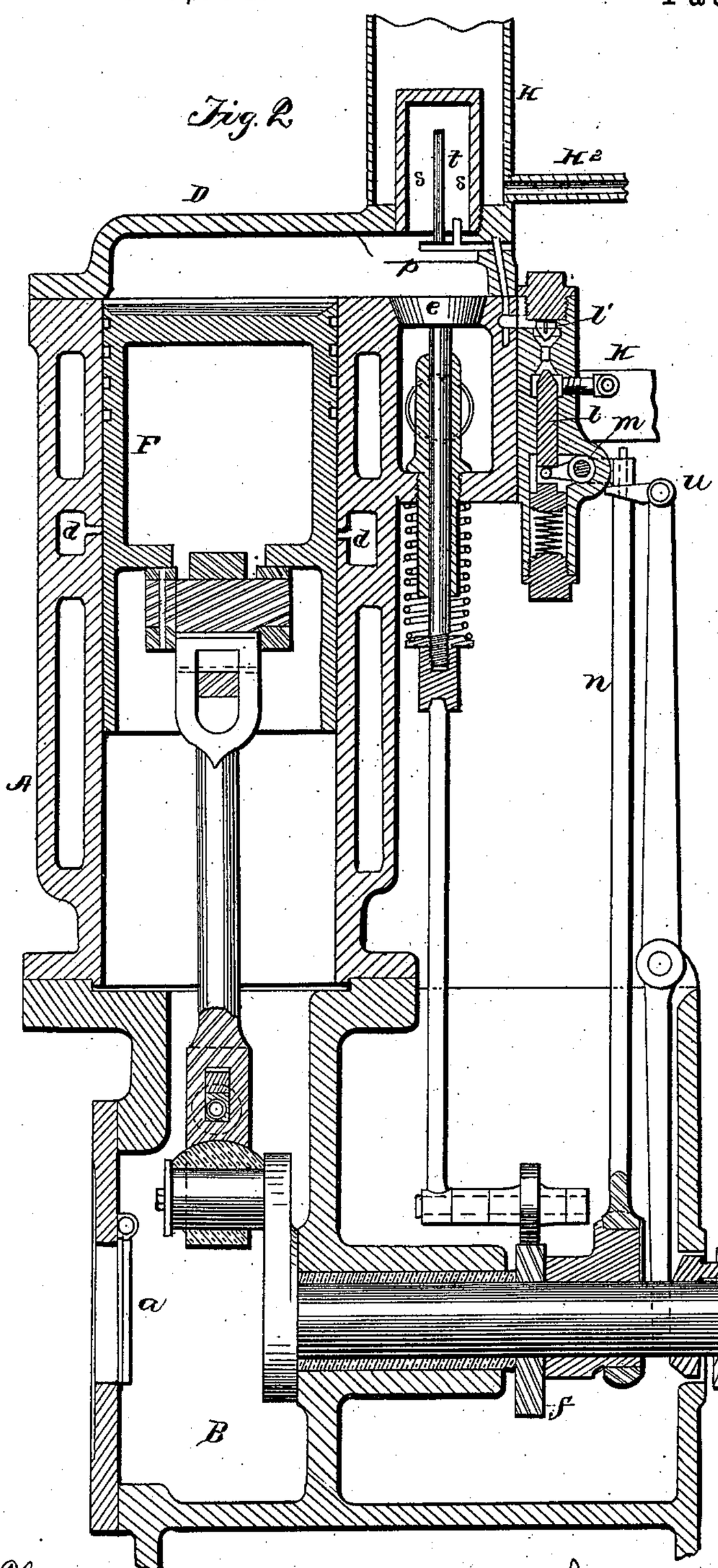
Fig. 2.



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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.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 576,604, dated February 9, 1897.

Original application filed May 22, 1890, Serial No. 352,736. Divided and this application filed August 16, 1890. Serial No. 362,194. (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, Fairfield county, in the State of Connecticut, have invented new and useful Improvements in Gas-Engines, of which the following is a specification.

My invention relates to explosive-engines; and it consists of certain novel parts and combinations of parts and certain novel methods of operating gas-engines, the separate features of which will be separately and specifically pointed out in the claims concluding this specification.

Referring to the accompanying drawings, Figure 1 represents a longitudinal vertical section through an engine involving my invention, taken at right angles to the crank-shaft. Fig. 2 is a longitudinal vertical section taken parallel to the crank-shaft.

I will now describe the engine, which is illustrated in the annexed drawings, which show a structure embodying the several features of my present invention in combination.

The following description, read in connection with the accompanying drawings, is sufficient to enable any person skilled in the art to which my invention relates to practice it; but it will be understood that my invention is not limited to the precise devices or combinations of devices illustrated and described, as various modifications may be made without departing from the spirit of my invention and without exceeding the scope of the claims concluding this specification.

The drawings show an upright engine.

A is the power or combustion cylinder placed over the crank-shaft. F is a piston of the trunk form suitably connected to the crank-shaft. These parts are inclosed within a chamber B, which chamber also acts as a compression-chamber. *a*, Fig. 2, is a valve arranged to open and permit air to enter said compression-chamber and to close and prevent its escape therefrom.

b is a passage leading from the compression-chamber B to the inlet-ports of the power-chamber.

c is a check-valve controlling the passage of compressed air from the compression-chamber to the power-chamber.

d are the air-inlet ports of the power-chamber, which ports are uncovered by the piston when in lower position and are covered by the piston when in the position illustrated by Figs. 1 and 2.

D is a hood forming the cylinder cap or head and also a part of the power-chamber. It is in this hood that the charge is ignited and in which the explosion takes place, as the piston when in its uppermost position leaves this space clear. This hood also forms a passage to the exhaust-valve, as shown in Fig. 2.

e is the exhaust-valve, which is operated by suitable connections with the cam *f* on the engine-shaft.

The engine is provided with an auxiliary cylinder E, which for convenience is cast on one side of the power-chamber. *g* is a piston working in this auxiliary cylinder, which piston is connected by a rod *h* to the connecting-rod strap of the power-piston. The power-piston F and auxiliary piston *g* are both connected, therefore, to the same source of power, and in the drawings I have shown them so arranged that the auxiliary piston is at or near the end of its inner stroke at the instant that the power-piston begins its forward stroke.

k' is a pipe leading from a suitable source of fuel-supply to the gas-compression chamber E. *i* is a check-valve controlling the passage of fuel through said pipe, which valve is raised to permit the entrance of fuel into the gas-compression chamber E when its piston reduces the pressure in said chamber below the pressure in the pipe *k'*, and is closed to prevent said fuel being forced back through the pipe *k'* when the said piston increases the pressure in said cylinder above the pressure in the pipe *k'*.

k is a duct (shown in Fig. 1 broken off) leading to the duct *k'*, (shown in Fig. 2,) through which the compressed fuel passes from the auxiliary cylinder to the power-chamber.

l (see Fig. 2) is a valve controlling the entrance of fuel under pressure to the combus-

tion-chamber, and this inlet-valve *l* is operated by a rock-shaft *m* and a rod *n*, connected to an eccentric strap attached to the engine-shaft. The fuel which has been admitted through the valve *l* rushes from the orifices *p* (one of which is shown in the drawings) into the power-chamber.

The igniter device shown is of peculiar construction, which, irrespective of the engine to which it may be applied, is made the subject-matter of a separate application for a patent filed by me May 22, 1890, Serial No. 352,736, of which this application is a division.

s is a chamber closed at one end and opened at the other to the power or combustion chamber of the engine. This tube is to be heated to a sufficiently high temperature by any suitable means. This igniter-tube is preferably placed near the line of the jet of fuel issuing from one of the jet-orifices *p* and is so related to the fuel-inlet that an induced or eddy current of fuel and air is caused to circulate within said tube. The object of so arranging the parts is to cause a certain portion of fuel and air to pass in contact with the heated surface of the igniter-tube and thus to render the ignition of the charge prompt and certain. Any arrangement of the parts which will cause a portion of the charge to be brought in contact with the hot walls at the proper time will answer the purpose. In the structure shown the fuel is mixed with the air and the combustible mixture is made there, but it might be made in the power-chamber and thus projected against the walls. The igniter is in the form of a supplemental chamber in free communication with the power-chamber. My object in making it so is the facility thus afforded for heating it, but any form of igniting device maintained at the necessary temperature will, broadly considered, be the equivalent of that shown. In order to assist and to render more certain this action, I prefer to employ in the igniter-tube a partition *t* to divide the upward-flowing currents from the return-current, and this partition may with advantage project below the bottom of the igniter-tube to direct the currents into the interior of said tube. A partition so arranged makes in effect a passage in the igniter through which a portion of the combustion mixture is caused to flow, thereby causing it to pass over a considerable extent of the heated surface and insuring a prompt ignition of the charge.

The igniter-tube may be heated in any suitable way. I have shown it heated by a burner which consists of an inclosing tube or chamber H, preferably lined with a non-conducting material, such, for instance, as asbestos or fire-brick, provided with fuel through the tube H^2.

Certain features of invention covered by this patent relate to the engine only and are not dependent on the character of igniter employed. In this aspect of the case any suitable form of igniter may be employed, such, for example, as one of the intermittent igniters known in the arts.

The governor shown consists of a weight attached to the fly-wheel balanced by a spring and connected so as to impart motion to a wedge *u*, placed on the eccentric-rod *n*, to vary the lift of the valve *l*, and thus to control the quantity of fuel admitted to the engine each time the valve opens. As the governor does not form any part of my present invention, and as any suitable governor may be employed, a further description of this part of the structure is considered unnecessary.

The operation of the engine illustrated in the drawings and above described is as follows: The pistons F and *g* are shown in Fig. 1 in their highest position and just ready to begin their downward strokes. As the piston F moves down it compresses the air contained in the chamber B. As the piston *g* moves down it raises the check-valve *i* and draws a charge of fuel into the cylinder E. When the piston F is near its lower position, the exhaust-valve *e* is opened and the piston F uncovers the ports *d*, so that at this instant the compressed air from the chamber B rushes through the passages *b* and *d* into the power-chamber and drives out the spent gases contained therein through the exhaust-port. After the piston F has made a portion of its return stroke the valve *e* is closed and the air remaining in the power-cylinder is compressed by the back stroke of the piston F. At the same time that the piston F is making its back stroke the piston *g* is compressing the fuel contained in the cylinder E, and when the piston F is just ready to begin its next forward stroke the fuel in the cylinder E will be under high compression. At this instant the valve *l* is opened and quickly closed. While this valve is open the fuel contained in the cylinder E rushes through the passage *k* and through the orifices *p* with a high velocity, so that during a period of time probably not greater than one one-hundredth part of a second a complete mixture of the gas entering the power-chamber and the air under pressure within the power-chamber is effected. A portion of the fuel so admitted enters the igniter-tube and forms therein a combustible mixture, which is ignited by its hot walls, the ignition being instantly communicated to the body of the charge. The complete mixture of air and fuel takes place in an engine so constructed, practically speaking, instantaneously while the piston is at the beginning of its downward stroke and before it has made any appreciable movement. In fact, so instantaneous is this action that the cards taken from the engine thus operated are practically the same as those taken from engines in which a combustible charge already mixed is introduced into the chamber and ignited, as in ordinary gas-engines. The piston F now moves forward by the pressure of the exploded gases and also by the pressure of the remnants of gas remaining in

the cylinder E. The action of the gas-compression cylinder E and the gas-compression piston *g* effects a direct gain in economy, while the structure shown commends itself on account of its simplicity. The clearance-space of the gas-compression cylinder E, together with the passages *k*, forms a storage-reservoir which is in free communication with the gas-compression cylinder E at all times—that is to say, no check-valve separates the passage *k* from the clearance-space in the gas-compression cylinder. If no gas were used by the engine, (that is, if the valve *l* did not lift,) the gas contained in this reservoir would be compressed and expanded at each stroke of the piston without expenditure of fuel, because the pressure in the reservoir would never fall below the pressure in the passage *k'*, and hence no gas would enter said reservoir. If, however, a given quantity of gas is admitted to the power-cylinder by the valve *l*, the remaining portion of gas contained in said reservoir expands back until the pressure therein is below the pressure in the passage *k'*, when the valve *i* opens to admit to the reservoir a quantity of gas just equal to that used by the engine in the preceding stroke. The power therefore expended compressing the gas is by self-regulation proportional to the quantity consumed, and the pump is ready instantly to supply a full charge to the engine or no charge, just as the engine may require.

In the drawings I have shown the fuel-supply pump in free communication with the gas-reservoir; that is, no check-valve intervenes between them. I prefer to construct it in this way, as the pressure on the valve by which the fuel is admitted to the combustion-chamber is instantly reduced when the piston of the pump recedes, and the liability to leak is thereby diminished. A check-valve might, however, be introduced between the storage-reservoir and the pump, and the gas contained in said reservoir by expanding back would still effect the useful purpose above described; that is, would still automatically regulate the amount of gas drawn into the pump on its succeeding stroke.

In Fig. 2 I have shown a check-valve *l'*, with small range of motion or lift, arranged in the passage between the gas-compression chamber and the gas-cylinder. In case the ignition of the charge should take place before the valve *l* closes this check-valve *l'* will, by mean of the pressure due to the explosion, instantly close.

In the foregoing specification I have incidentally referred to a few of the modifications which may be adopted in practicing my invention; but I have not endeavored to specify all the modifications which might be employed, the object of this specification being to instruct persons skilled in the art to practice the several novel features of my invention in their present preferred forms and to enable them to understand their nature; and I desire it to be distinctly understood that mention by me of a few modifications is not in any way intended to exclude others not referred to, but which are within the spirit and scope of my invention.

As I have before remarked, many of the combinations and details illustrated and above described are not essential to the several features of my invention separately and broadly considered. All this will be indicated in the concluding claims, as in any given claim the omission of an element or the omission of the particular features of the elements mentioned is intended to be a formal declaration of the fact that the omitted elements or features are not essential to the invention therein covered.

Concerning that part of my present invention which consists of methods of operation it will be understood that these methods are independent of the structures in which they are carried on and may be employed in engines altogether different from that herein described and illustrated.

I do not in this case claim the particular construction of the permanent igniter herein described, nor do I claim such igniter irrespective of the type of engine to which it is applied, as said igniter is the subject of another pending application, of which this is a division, filed May 22, 1890, Serial No. 352,736.

Having thus described a machine embodying in preferred forms all the several features of my present invention in combination, what I separately claim, and desire to secure by these Letters Patent, is the following:

1. In a gas-engine, in combination with a power-cylinder, a fuel-supply pump having an auxiliary chamber or clearance-space of sufficient capacity substantially to contain the full charge of the pump and means for maintaining the eduction-passage of the pump closed until the piston has substantially completed its forward stroke.

2. In a gas-engine, in combination with a power-cylinder, means for producing therein a compressed charge of atmospheric air and means for subsequently introducing therein a charge of suitable fuel and for cutting off the supply of said fuel at or before the instant of explosion.

3. In a gas-engine, in combination with a power-cylinder, means for introducing into said cylinder atmospheric air where it is compressed by the back stroke of the piston, a pump for compressing and introducing into said compressed air a suitable fuel and a governor controlling the passage from said pump to said power-cylinder.

4. In a gas-engine, in combination with a power-cylinder, means for introducing into said cylinder atmospheric air where it is compressed by the back stroke of the piston, a pump for compressing and introducing into said compressed air a suitable fuel; said pump having an auxiliary chamber or clearance-space of sufficient capacity to contain

the full charge of the pump and a governor controlling the passage from said pump to said power-cylinder.

5. In a gas-engine, in combination with a power-cylinder, means for introducing into said cylinder atmospheric air under pressure to drive out the old charge, where said air is further compressed by the back stroke of the piston, a pump for compressing and introducing into said compressed air a suitable fuel and a governor controlling the passage from said pump to said power-cylinder.

6. In a gas-engine, the combination of the power-cylinder having air-supply valved passages *b* and *d* and an air-compression chamber B, the power-piston an auxiliary gas-compression cylinder and a piston working therein, a valve-controlled pipe *k'* entering the latter cylinder, a pipe *k* connecting the two cylinders, a gas-supply valve *l* and a check-valve *l'* and the exhaust-valve *e*, the two pistons being connected to operate in the way described.

7. In a gas-engine, in combination, the power-cylinder having an inclosing air-compression chamber into which said cylinder opens, an air-inlet valve seated in one side of said casing and an auxiliary gas-compression cylinder on the other side of said casing, the power-piston, a piston for the auxiliary cylinder, the piston-rods connected to each other and to the crank-shaft for effecting simultaneous compression in the two cylinders as stated.

8. In a gas-engine, in combination with a power-cylinder and a permanent igniter therein, means for producing therein a compressed charge of atmospheric air and means for subsequently introducing therein a charge of suitable fuel and for cutting off the supply of said fuel at or before the instant of explosion.

9. In a gas-engine, in combination with a power-cylinder and a permanent igniter therein, means for introducing into said cylinder atmospheric air where it is compressed by the back stroke of the piston, a pump for compressing and introducing into said compressed air a suitable fuel and a governor controlling the passage from said pump to said cylinder.

10. In a gas-engine, the combination of a power-cylinder, a passage *b* at the side of the latter in free communication therewith through which the charge of compressed air is supplied from the compression-chamber to the combustion-chamber, a valve *c* in the said passage controlled by varying pressures on its opposite sides, and a valve *l* controlled mechanically to control the entrance of the gaseous fuel under pressure to the combustion-chamber in the way described.

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

LEWIS HALLOCK NASH.

Witnesses:
JNO. H. NORRIS,
CHRISTOPHER WHITTEMORE.