(No Model.)

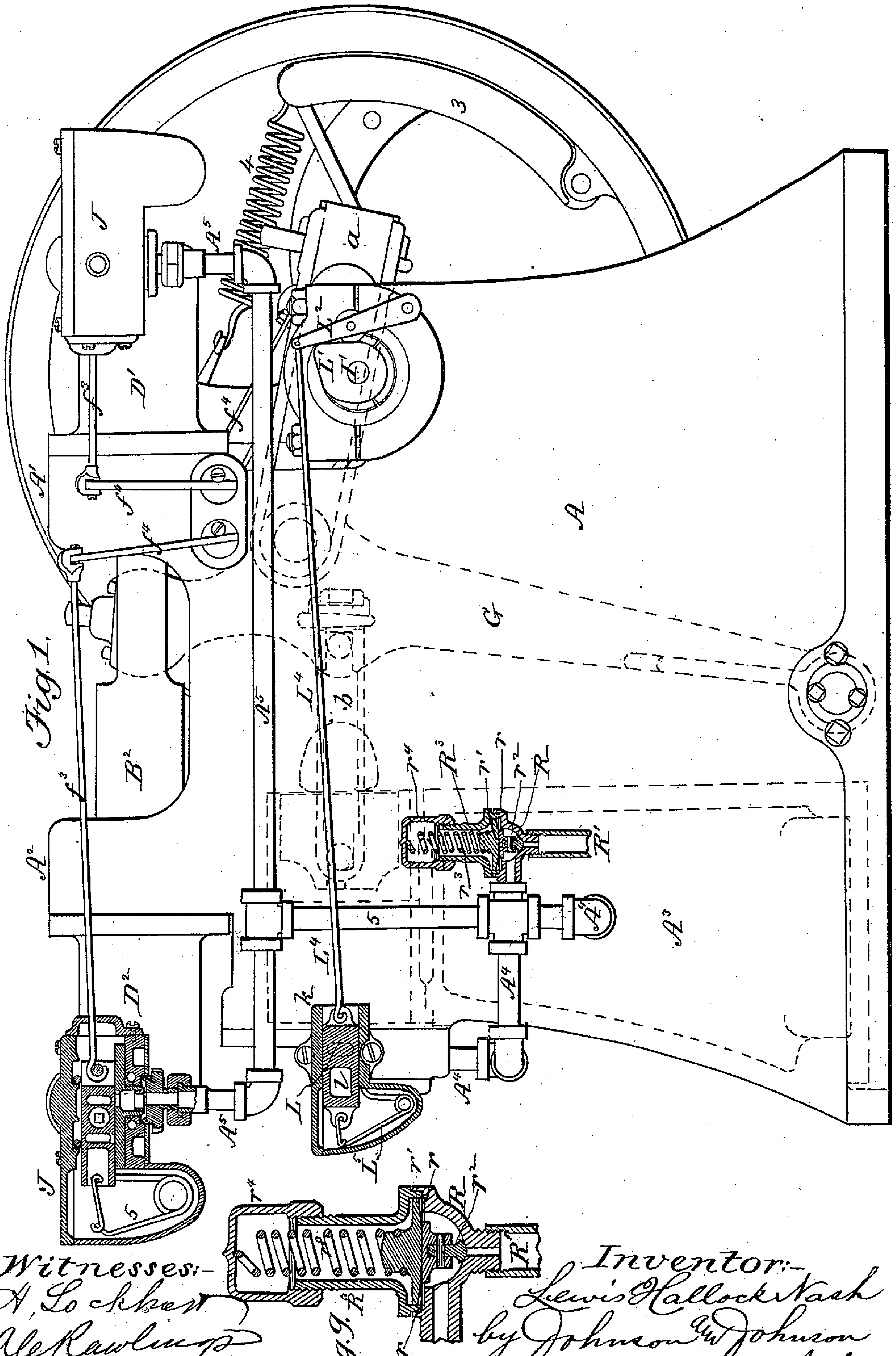
5 Sheets—Sheet 1.

L. H. NASH.

METHOD OF FEEDING AND OPERATING GAS ENGINES.

No. 334,040.

Patented Jan. 12, 1886.



Witnesses:-
H. Lockhart
Alex Rawlins

Inventor:-
Lewis Hallock Nash
by Johnson & Johnson
Attys.

N. PETERS. Photo-Lithographer, Washington, D. C.

(No Model.)

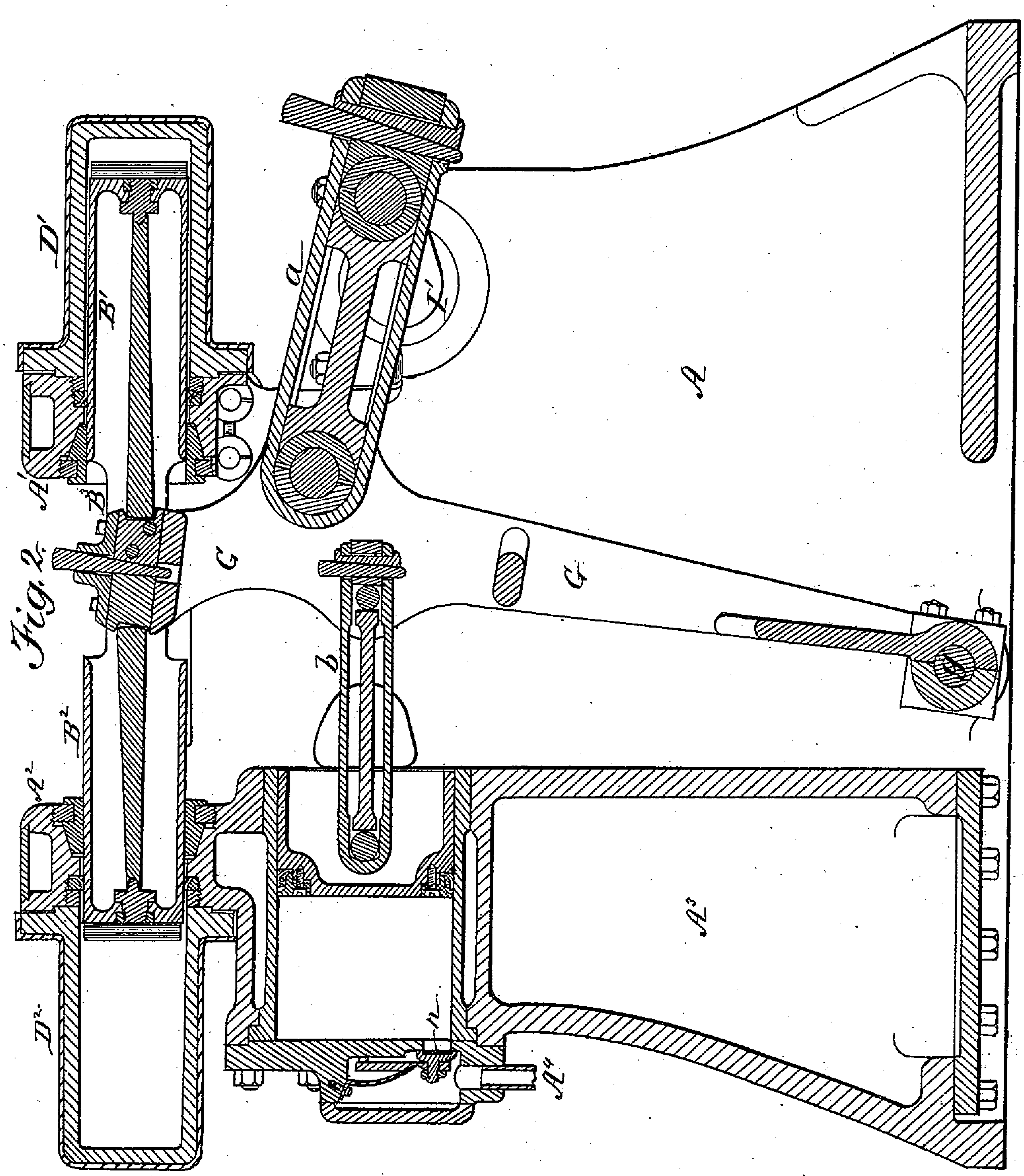
5 Sheets—Sheet 2.

L. H. NASH.

METHOD OF FEEDING AND OPERATING GAS ENGINES.

No. 334,040.

Patented Jan. 12, 1886.



Witnesses:-
H. Lockhart
A. C. Rawlings

Inventor:-
Lewis Hallock Nash
by Johnson and Johnson
Attys.

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.)

5 Sheets—Sheet 3.

L. H. NASH.

METHOD OF FEEDING AND OPERATING GAS ENGINES.

No. 334,040. Patented Jan. 12, 1886.

Fig. 3.

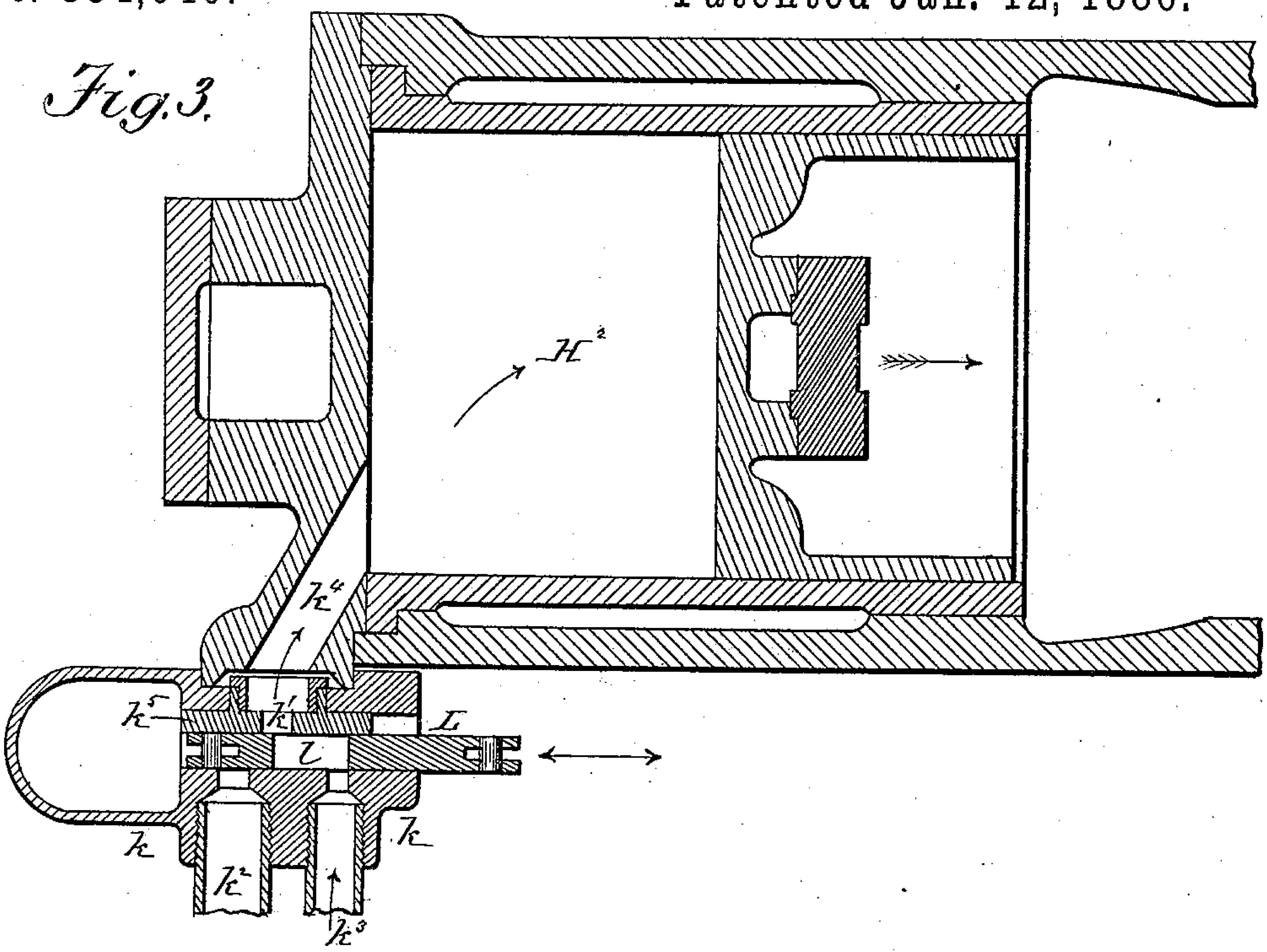
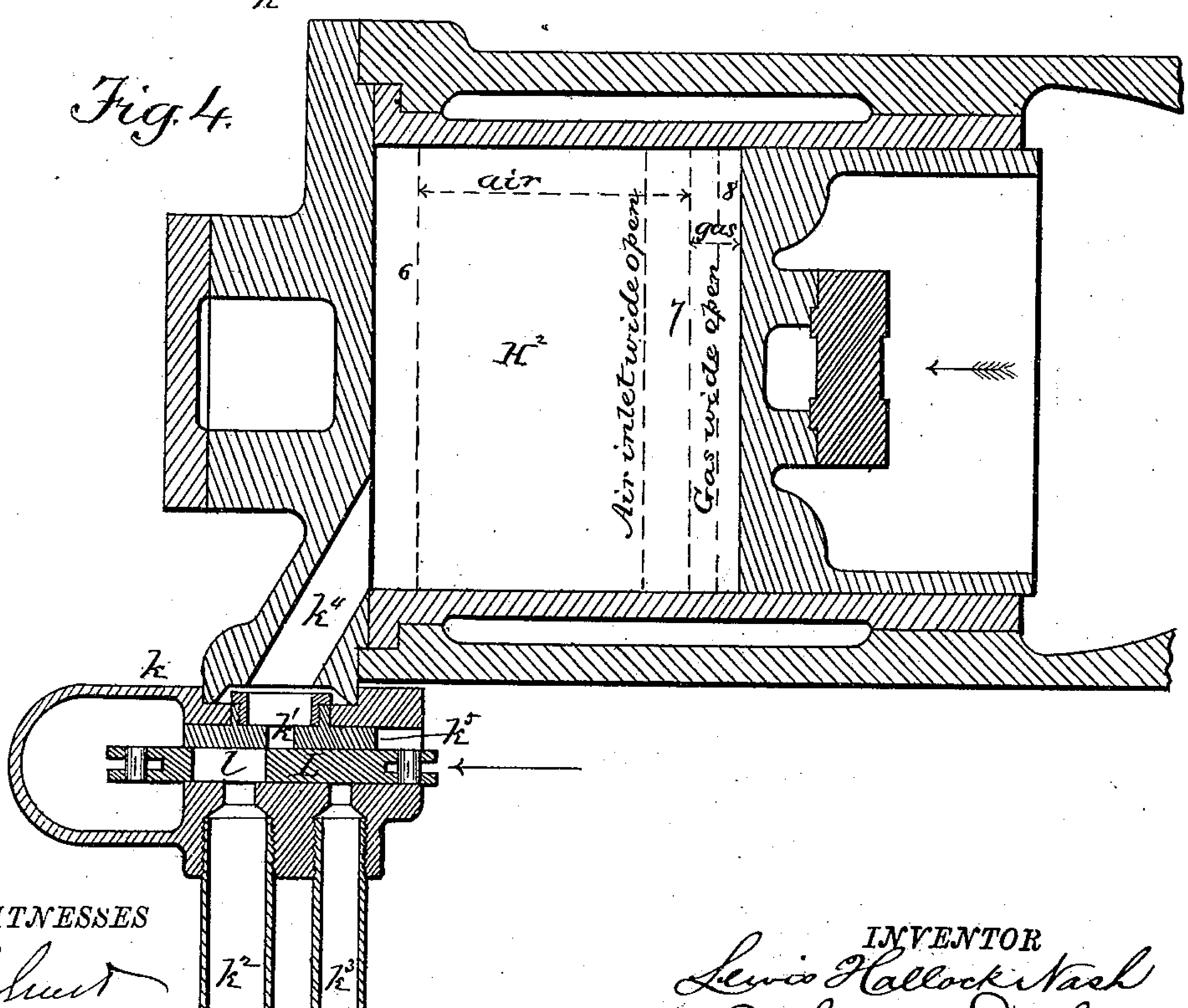


Fig. 4.



WITNESSES

H. Locklund

A. E. Rawlings

INVENTOR

Lewis Hallock Nash

by Johnson and Johnson

Attorneys.

(No Model.) 5 Sheets—Sheet 4.

L. H. NASH.

METHOD OF FEEDING AND OPERATING GAS ENGINES.

No. 334,040. Patented Jan. 12, 1886.

Fig. 5.

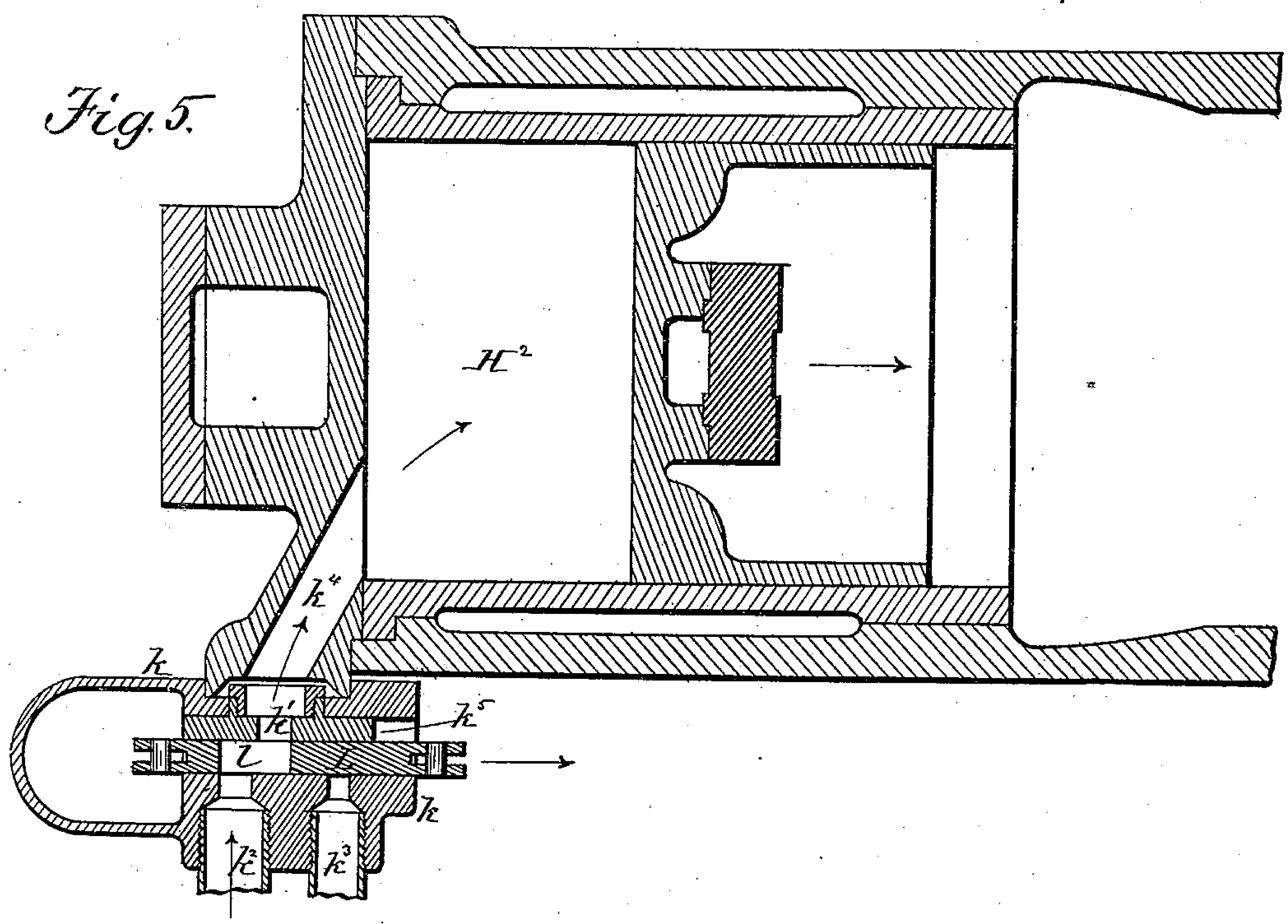
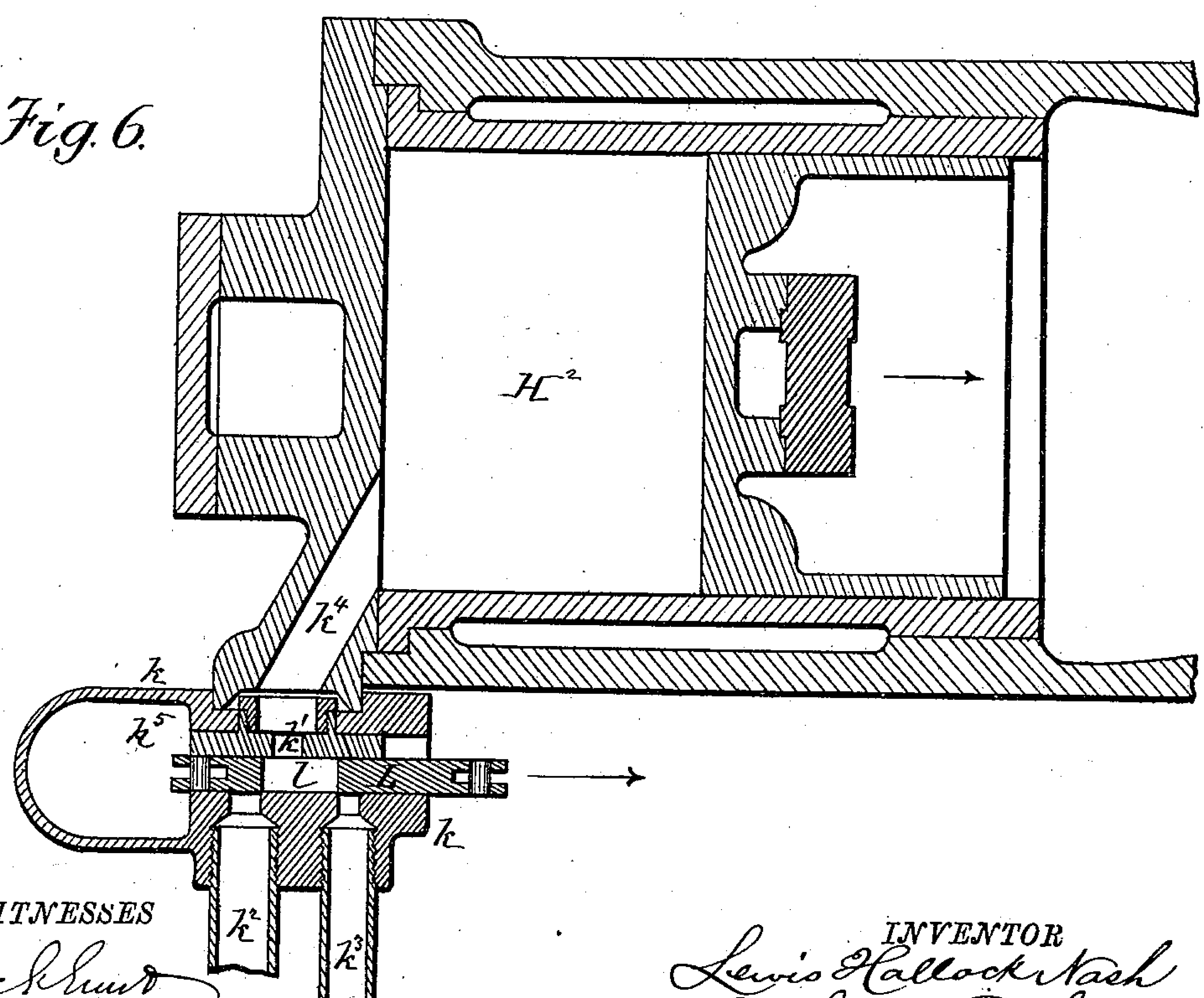


Fig. 6.



WITNESSES

A. Lockhart

A. C. Rawlings

INVENTOR

Lewis Hallock Nash

by Johnson and Johnson

Attorneys.

(No Model.) 5 Sheets—Sheet 5.

L. H. NASH.

METHOD OF FEEDING AND OPERATING GAS ENGINES.

No. 334,040. Patented Jan. 12, 1886.

Fig. 8.

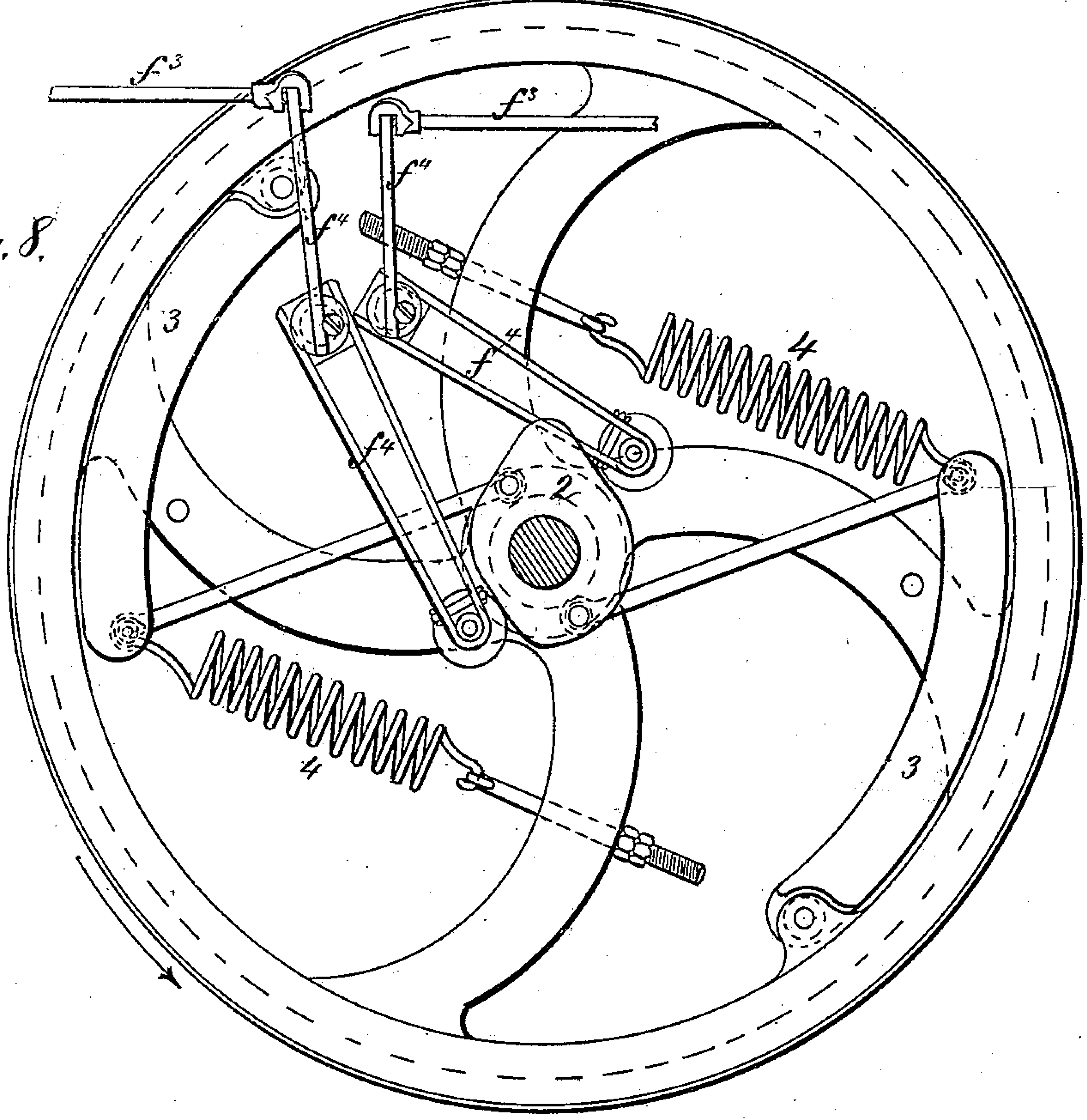
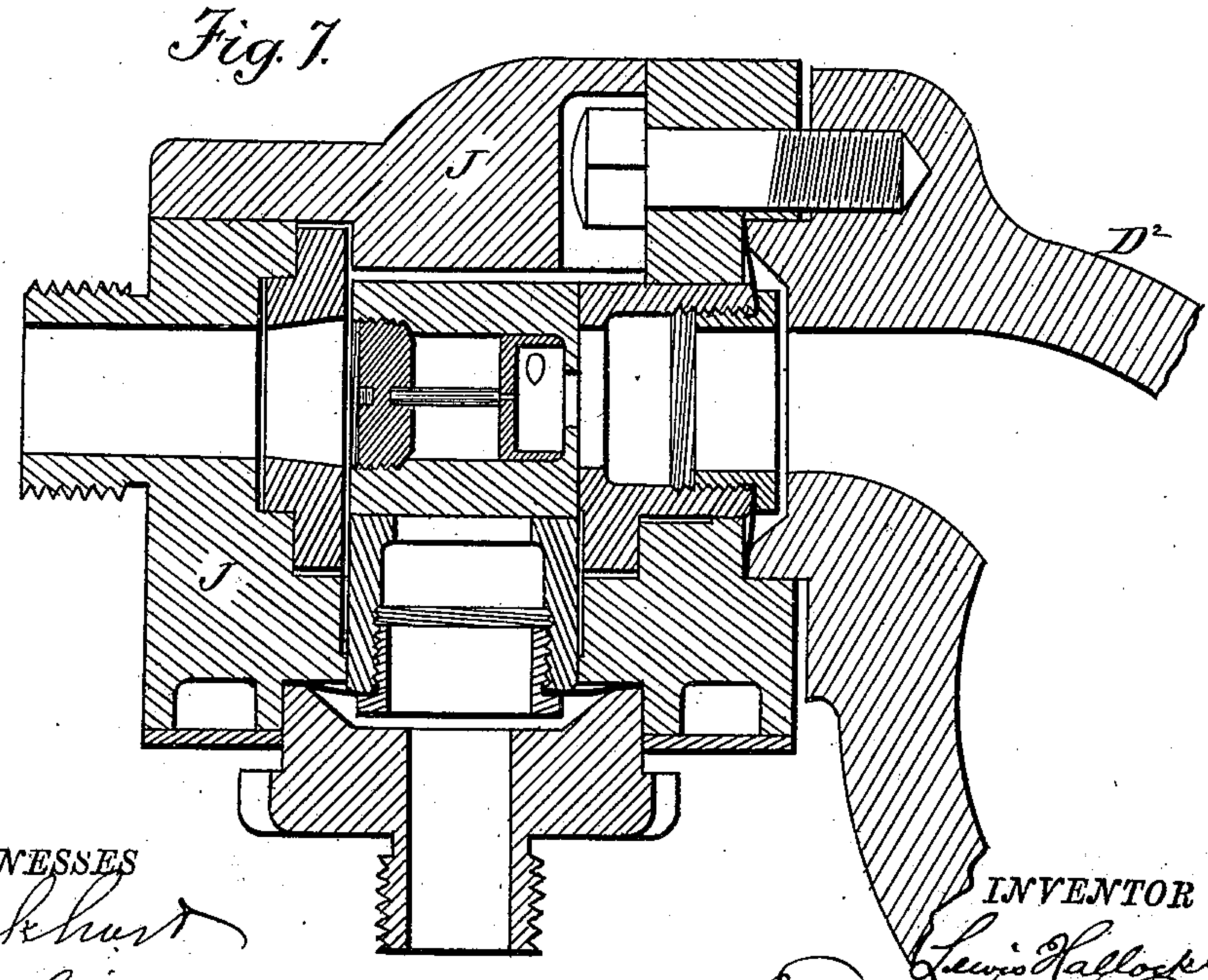


Fig. 7.



WITNESSES

H. Lockhart

A. C. Rawlings

INVENTOR

Lewis Hallock Nash

by Johnson & Johnson

Attorneys.

UNITED STATES PATENT OFFICE.

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

METHOD OF FEEDING AND OPERATING GAS-ENGINES.

SPECIFICATION forming part of Letters Patent No. 334,040, dated January 12, 1886.

Application filed August 20, 1885. Serial No. 174,894. (No model.)

To all whom it may concern:

Be it known that I, LEWIS HALLOCK NASH, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented new and useful Improvements in Methods of Feeding and Operating Gas-Engines, of which the following is a specification.

My invention has for its object an improved method of forming the charge to supply a gas-engine, whereby a perfectly uniform mixture of gas and air is formed by means of a single independent compression-pump, wherein they are compressed in an imperfectly-mixed charge which, in being forced into the passages connecting the combustion-chamber, thoroughly mixes the constituents therein before ignition, and thereby obtain a complete combustion of the charge. In thus feeding the engine the successive charges already mixed are controlled by a governor in the operation of the engine. The proper mixture of the gas and air to obtain perfect combustion cannot be effected in a single-power cylinder, because it not only requires a definite measurement of the constituents of the charge, but also an intimate and uniform admixture of these constituents before their ignition in the power-cylinder. Therefore I admit the constituents into a compression-chamber independent of the power-cylinder. I measure each constituent in the compressor by the space moved over by the compressor-piston. I compress the constituents partially in a mixed condition, and force the volume so compressed through a valved passage into a storage-reservoir in completely-mixed relation, whose proportions of gas and air are determined in quantities, so as to render it certain that the engine cannot receive more than the proper amount of charge required for a regular speed and power of the engine.

By my method the compression of the combustible charge is effected after the measurement of the separate constituents which make the charge, and this cannot be effected within the combustion-chamber and obtain a perfect mixture, as proposed in English Patents Nos. 1,655 of 1857 and 335 of 1860, wherein the combustible charge is admitted into the combustion-chamber in separately-measured constituents of gas and air. I also know that Otto, in his United States Patent of August 14, 1877, forms within the combustion-chamber a combustible mixture having varying degrees of density. I am also aware that in patents granted to Baldwin under dates of May 1, 1883, November 6, 1883, and December 18, 1883, the charge of gas and air are measured in separate and independent compression-chambers, and are then passed in separate volumes into the power-cylinder wherein the constituents are for the first time brought together and mixed. In fact, in these patents it is provided that the constituents of the charge shall not be mixed before their introduction into the power-cylinder. Moreover, as I prefer to store the perfectly-mixed gases in a reservoir, having in practice found such storage safe from explosion, it is not necessary that the compression-pump should measure the quantity of charge required for each stroke of the engine, as the storage of the mixed constituents permits of the supply of the charge to any number of power-cylinders, and therefore measurement of the constituents is not necessarily effected to form every charge. I seek to form an intimate uniform gaseous mixture in the operation of forcing it from the compression-pump through a valved passage into the combustion-chamber, or into a storage-reservoir, and this in connection with the measuring action of a compressor-piston, so far as I know and can find, is new, and I believe better than any method that I know of for supplying successive charges of combustible mixture to a gas-engine.

By my improved method of forming the charge I am able to form a perfectly-mixed charge of measured proportions by the use of a single compression-cylinder for both gas and air, thereby securing the advantage of simplicity in the construction of the engine, and also of obtaining a perfectly uniform mixture of gas and air, so that the engine will operate with perfect regularity. My method also contemplates storage of the compressed mixture of uniform density within a storage-reservoir in which the pressure is maintained uniformly at any degree desired.

In the construction shown I use two coacting power-cylinders supplied from the reservoir, and the engine-governor admits a charge to each power-cylinder just the quantity of this uniform mixture required to do the work of the engine. By this means of regulating the power of the engine the speed of its running will be as regular as that of a steam-engine, since every charge is composed of the same uniform combustible mixture, but in quantities varying according to the work.

An organized double-acting gas-engine composed of single-acting cylinders placed in line is represented in the accompanying drawings as one type of engine for carrying out my improved method of forming a combustible mixture and of operating the engine, in which—

Figure 1 represents in elevation a gas-engine of separate and distinct coacting single-acting power-cylinders placed in line, and showing their valve-governor-operating connections. Fig. 2 represents a vertical longitudinal section taken through the coacting power-cylinders and the compressor. Fig. 3 represents a horizontal section of the compressor and mixing-valve, showing the compressor as taking in gas. Fig. 4 represents a similar section showing the inlet-ports for the gas and air closed just as the compressor-piston begins its return-stroke. Fig. 5 represents a similar section showing the position of the mixing-valve when the compressor-piston is on its forward stroke, taking in air. Fig. 6 represents a similar section showing the mixing-valve as just having closed its air-port and ready to open its gas-port. Fig. 7 shows in section the connection of the supply-valve case with the combustion-chamber. Fig. 8 shows the governor device; Fig. 9, the relief-valve.

Referring to Figs. 1 and 2, the engine-frame A supports separate and distinct trunk-cylinders, A' A^2, in the same horizontal line, each cylinder having its combustion-chamber formed by separate cylindrical caps, D' D^2, within which operate a double-ended plunger, B' B^2, suitably connecting with and operating the power-transmitting shaft I' of the balance-wheel. The supply-valve cases J J are mounted directly upon the combustion-chambers, and one of said valve-cases is shown in section with its slide-valve and its connecting-rod f^3, which, by means of the lever-arm f^4, is connected with the governor device of the balance-wheel. A compression-cylinder is placed in the frame, preferably beneath one of the power-cylinders, for compressing the charge for the engine, and the power-transmitting shaft I' is mounted in the frame beneath the other cylinder and connections for this shaft. The compressor-piston and the double-ended plunger are made with a rocker-arm, G, which is pivoted at g to the foot of the frame, and rising from said pivot passes at its upper end into an opening, B^3, made in the middle of the length of the double-ended plunger, to which it is connected by means of separate and distinct plunger-rods between the trunk-bearing cylinders of the plunger, so as to drive the rocker-arm back and forth with the movement of the double-ended plunger. Between the pivot of the rocker-arm and its connection with the double-ended plunger the crank-shaft and the compressor-piston are connected to the rocker-arm by connecting-rods a b, standing in opposite directions, so that the back and forth movements of the rocker-arm G will drive the piston of the compressor on one side of the rocker-arm and drive the crank-shaft on its opposite side. This places the rocker-arm between the power-cylinder and the compressor and the crank-shaft in a compact arrangement to utilize the rectilinear movement of the double-ended plunger. The connections of the double-ended plunger with the pivoted rocker-arm have rolling or rocking bearings for reducing the friction and accommodating the movement described by the rocker-arm. One of the rocker-arm bearings is made adjustable, for taking up the wear of the bearings.

The supply-valves for the combustion-chambers are operated by the connecting-rod f^3, and controlled by a governor or device carried by the balance-wheel. One of these slide supply-valves is shown in such connection with a governor device carried by the balance-wheel, and in its connection with the compression-pump and storage-reservoir in Fig. 1, and in communication with the combustion-chamber in Fig. 7.

I deem it unnecessary to specifically describe the governor device, since it is the subject of a separate and distinct application for a patent filed by me of even date herewith, further than to state that the valve-connecting rod f^3 is connected to said governor device by a lever-arm, f^4, which is operated by a cam, 2, placed loosely upon the crank-shaft and controlled by suitable weights, 3, pivoted to the rim of the fly-wheel, which are controlled in their movements by springs 4, one for each weight, as shown in Fig. 8. The backward movement of the valve is effected by a spring, 5, which I prefer to arrange in the valve-case.

I deem it unnecessary also to specifically describe the supply-valves further than to state that they (the valves of both cylinders) are in communication with the compressor and storage-reservoir by the pipes A^4 A^5, (shown in elevation in Fig. 1,) the compressed products being discharged from the compressor into the reservoir A^3 by the pipe-connection A^4, from whence the charges are conveyed by the pipes A^5 to the supply-valves.

I will now describe the mixing-valve in connection with my improved method of forming a uniform combustible mixture. This valve is a simple slide-valve, L, fitted in a case, k, having a bearing-piece, k^5, at one side containing the port k', connecting, by the passage k^4, with the compression-cylinder H^2, and at the other side of the case is placed the air-inlet port k^2 and the gas-inlet port k^3, which are controlled by the valve-port l, as shown in the several detail views. The valve is operated by the cam L′ on the crank-shaft and the lever L^2 and the connecting-rod L^4, the said lever being pivoted to the frame and maintained in contact with the cam by a spring, L^5, preferably placed in the valve-case, which serves to constantly pull back the valve, and thereby take up the lost motion, which would otherwise occur from the wear of the connections.

The measuring action of the compressor-piston and valve L is best illustrated in Fig. 4, in which the position of the piston during the operation of admitting the products are indicated by dotted lines; and, referring to said figure, now suppose the piston to have just completed its back-stroke forcing out a charge, and is now at the beginning of its forward stroke. The cylinder clearance spaces will contain a certain quantity of compressed gases of the previous charge, which will expand as the piston advances until a point is reached where their pressure is reduced to that of the atmosphere. At this point in the stroke (indicated by dotted line 6, Fig. 4) the valve opens the port k^2 to take in air and the piston advances, drawing in an air-charge, as shown in Fig. 5, until the piston has reached the position of line 7, Fig. 4, which position of parts is shown in Fig. 6. At this instant the valve quickly closes the air-port k^2 and opens the gas-port k^3, and the piston now draws in gas, as shown in Fig. 3. At the end of the stroke the valve quickly closes to shut off both air and gas, as shown in Fig. 4, and the return of the piston forces the charge through the valve h and pipe A^4 to the storage-reservoir A^3, where it is held ready for use. (See Fig. 2.) Hence while the piston is moving the distance between the lines 6 and 7 a volume of air will enter the cylinder-chamber equal to the volume of the cylinder between these points; and while the piston is traveling from 7 to 8 a volume of gas will enter the cylinder equal to the volume of the cylinder between these points and the relative amount of gas to air taken in at that stroke will be proportional to the volume between these positions of the piston.

It will be understood that the air and gas do not in reality occupy the positions indicated by these dotted lines, for when the gas enters in a flowing stream through the channel k^4 it will circulate within the cylinder and mix to a large extent with the charge already contained therein; but the movement of the piston will be the correct measure of the volume of the constituent entering at that time, since it is the suction caused by the movement of the piston which causes the inflowing current which supplies just enough of gas or air to fill the space behind the piston as fast as the piston advances, and the volume of each constituent is thus determined by the distance moved by the piston during the time the constituent is being admitted.

By the back-stroke of the piston the gases are compressed and forced out through the valve h, and pass through the pipes A^4 into the storage-reservoir. To prevent the pressure in the reservoir from becoming too great, I provide a relief-valve, r^2, (shown in vertical section in Fig. 1,) upon the side of the engine-frame, which will allow of the escape of the compressed gases after the pressure reaches a certain point in the same manner as the safety-valve of a steam-boiler. The gas so escaping I may return to the compressor through the air-supply pipe k^2, and again force it into the reservoir.

The safety-valve consists of a case, R, having a poppet-valve, r^2, seated therein to control the escape-passage R′. The valve is secured to a disk-piston, r', which forms the cover of the valve-chamber, and is sealed in relation to the latter by a diaphragm, r, secured at the joining of said disk-piston. The valve is maintained upon its seat by a spring, r^3, confined in an extension, R^3, of the valve-case, and having its tension adjusted by a screw-cap, r^4. The chamber of the valve-case connects with the pipes of the reservoir, so that the pressure of the gas in the latter will be constantly exerted upon the disk-piston r', and tend to open the valve. Therefore when the pressure in the reservoir increases sufficient to overcome the tension of the spring it will raise the valve, and thereby allow of the escape of the gases from the reservoir through the valve-chamber and pipe R′, and thereby maintain a constant pressure in the reservoir, and the engine receive charges under a uniform pressure.

In the operation of the engine the supply-valves open at the beginning of the stroke of the pistons, admitting the uniformly-mixed charge while the piston is advancing. When a sufficient quantity of the charge has been admitted, as determined by the governor, the valve quickly closes the supply-ports and the charge is ignited, driving the piston forward by its expansion to the end of its stroke and opening the exhaust-ports.

The force of each charge is regulated by the governor, as follows, viz: When the engine is developing light power, the governor causes the supply-valve to cut off the inlet of the charge at an early point in the stroke, and therefore only a small amount of the uniform combustible mixture will be admitted; but when the engine is developing a greater amount of power the governor causes the valves to admit the charge through a greater portion of the stroke of the piston, whereby a greater charge is admitted and more power developed by the engine. In this controlling action of the governor a very important result is obtained, viz: Whether the engine is developing a large or small amount of power every charge will be composed of a gaseous mixture having exactly the same density—that is, composed of a charge containing the proper proportions of gas and air to give the best economical results, and therefore every charge, whether large or small, will be equally adapted for developing power with economy, because I use all the time the same proportions of gas to air in the charge, whether the engine be developing a greater or less amount of power. It is from this cause that I obtain the advantage of operating the engine with the same economy of fuel under all conditions of the working of the engine, which is not the case with engines which are governed by varying the proportions of the combustible mixture to regulate the power of the engine. To illustrate this point: All the gas-engines in use, so far as I know, must operate to their full capacity of power to give the greatest economy in the use of the fuel under conditions in which the charge is composed of the most efficient proportions of gas and air. On the contrary, in order to develop less power a weaker combustible mixture must be used without giving the same economical results, and this is the disadvantage which my method of governing the engine is designed to avoid.

I have shown my engine as adapted to compress its own charge; but it will be understood that my method of governing the engine may be carried out by an engine in which the charge is composed by a compressor driven by an independent source of power.

The engine, illustrated in the accompanying drawings, in its parts, devices, and combinations is not claimed herein, as such matter is made the subject of separate and distinct applications by me.

I claim—

1. The method herein described of feeding a gas-engine, which consists in measuring each constituent separately by admitting each separately into a compression-pump during a time corresponding to a definite movement of the piston, compressing the constituents in their imperfectly mixed state, and effecting their complete mixing in their passage into the power-cylinder, as set forth.

2. The method herein described of feeding a gas engine, which consists in measuring each constituent separately by admitting each in separate succession into a compression-pump during a time corresponding to a definite movement of the piston, and compressing the partially-mixed constituents into a supply-reservoir, as described.

3. The method herein described of forming a gaseous mixture, which consists in measuring each constituent separately, by admitting each separately into a cylinder during a time corresponding to a definite movement of the piston, and completely effecting the mixing of the separate constituents by forcing them out of said cylinder into service-pipes, as described.

4. The method herein described of operating and governing the power of an explosive-gas engine, which consists in measuring each constituent separately into a cylinder during a time corresponding to a definite movement of the piston, mixing them to the same density under all conditions of the running of the engine, and controlling the power of the engine by varying the volume of the charge by a governor, as described.

5. The method herein described of governing the power of an explosive-gas engine, which consists in forming an intimate gaseous mixture of uniform density, admitting it in charges into the power-cylinder, igniting the charge therein, and controlling the power of the engine by a governor, which regulates the quantity of the uniform combustible mixture for each charge, as described.

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

LEWIS HALLOCK NASH.

Witnesses:

A. E. H. Johnson,

J. W. Hamilton Johnson.