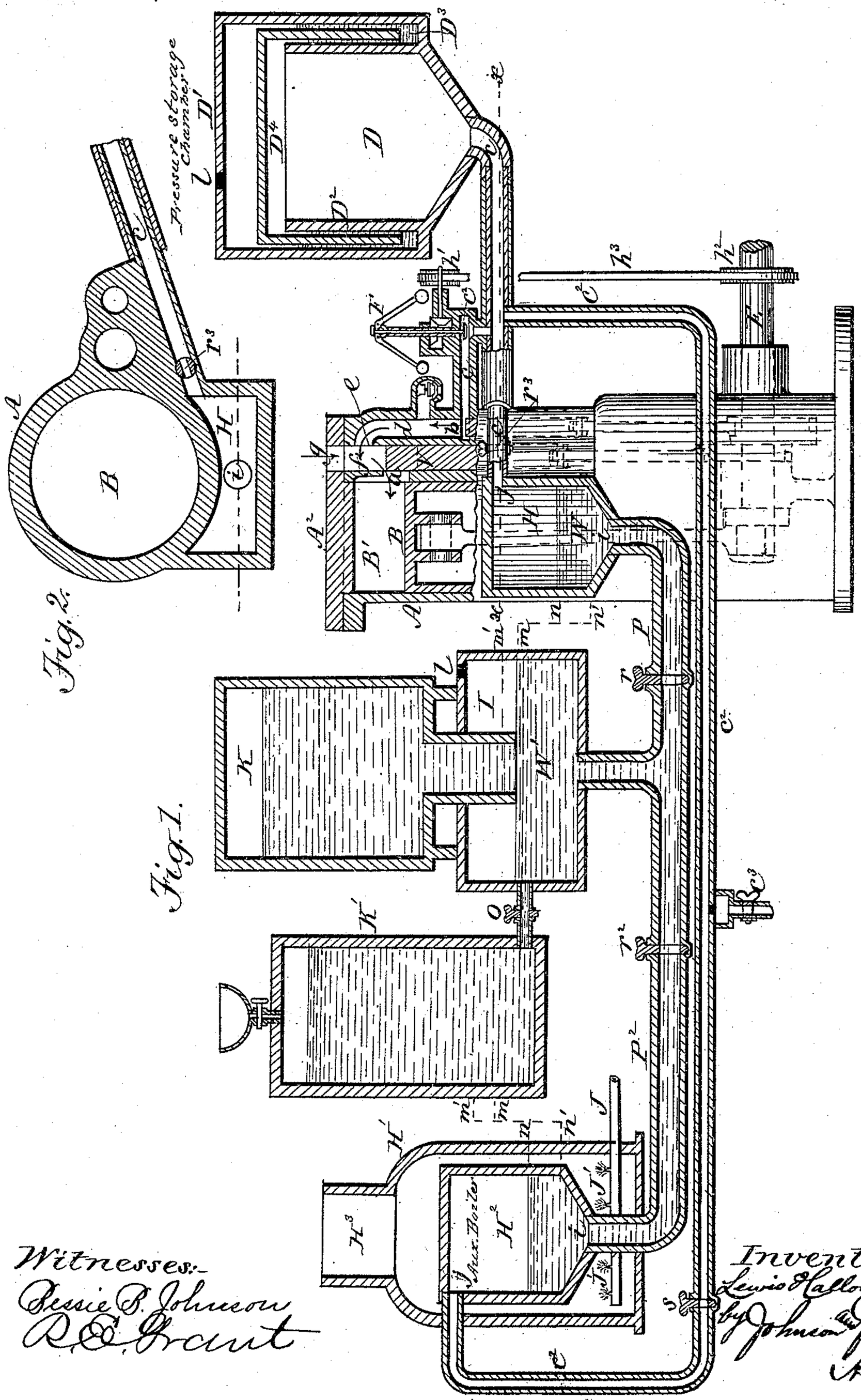
(No Model.) 3 Sheets—Sheet 1.

L. H. NASH.

EXPLOSIVE VAPOR ENGINE.

No. 331,210. Patented Nov. 24, 1885.



Witnesses:-
Bessie B. Johnson
R. D. Grant

Inventor:-
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by Johnson & Johnson
Atty's

(No Model.)

3 Sheets—Sheet 2.

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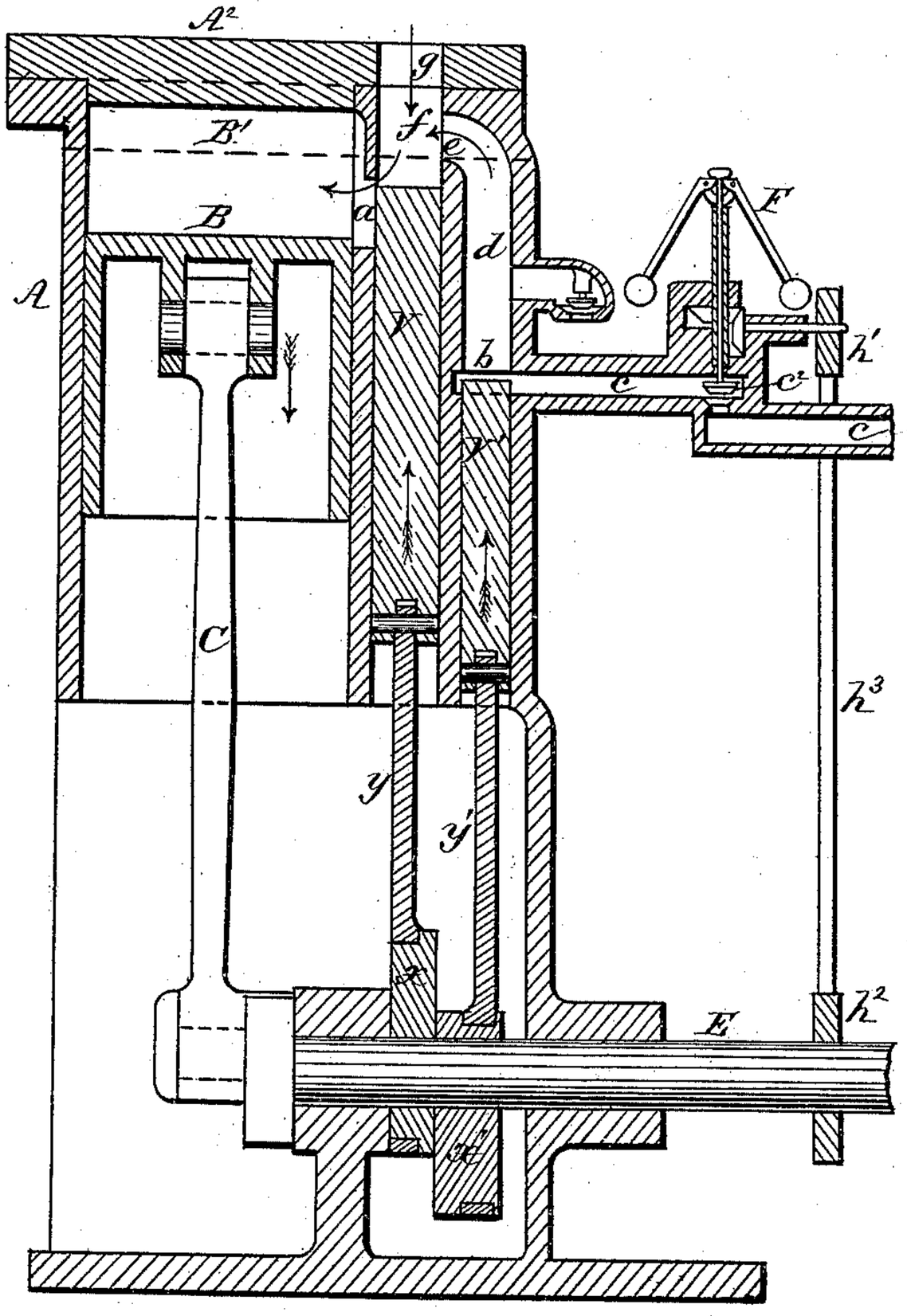
Fig. 3.



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3 Sheets—Sheet 3.

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Fig. 4.

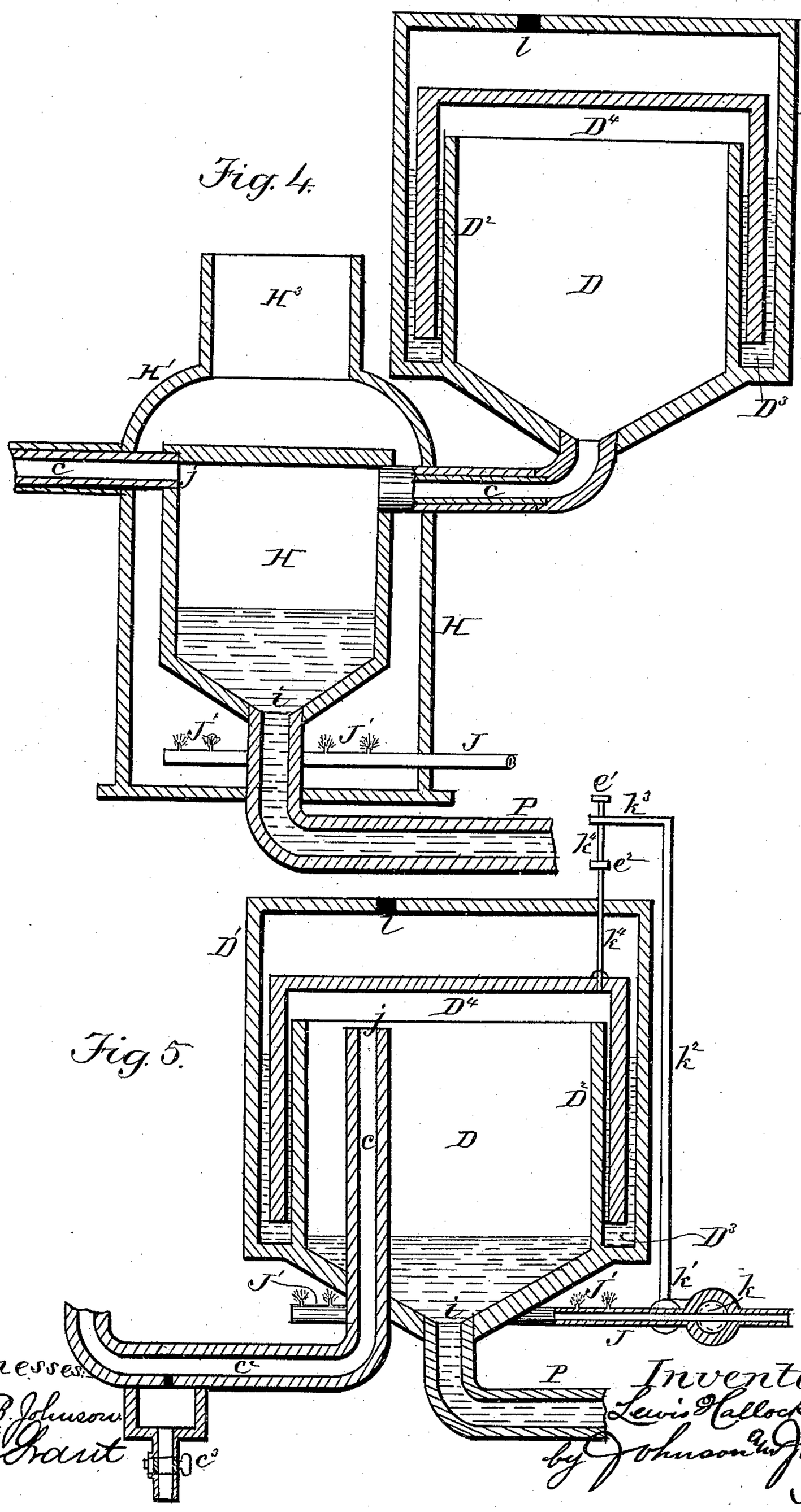

Fig. 5.

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Inventor:
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UNITED STATES PATENT OFFICE.

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

EXPLOSIVE-VAPOR ENGINE.

SPECIFICATION forming part of Letters Patent No. 331,210, dated November 24, 1885.

Application filed September 22, 1885. Serial No. 177,849. (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 Explosive-Vapor Engines, of which the following is a specification.

In applications for patents filed by me under Serial Nos. 146,263, 146,264, and 156,740, for improvements in explosive-vapor engines and methods of operating the same, I have described and claimed certain improvements in engines adapted to be operated by vapor generated from liquid fuel contained in a boiler arranged to deliver a dry vapor produced from a volatile oil into the engine direct from the boiler, and to control and regulate the production of the vapor, and also the amount of fuel evaporated in proportion to the pressure of the vapor generated within the boiler. For this purpose a vapor-generator is provided so as to be heated by the waste heat of the power-cylinder to supply the latter, and in another plan the vapor is generated by a boiler heated independent of the power-cylinder. In both cases the vapor is automatically supplied to the engine, and the supply of oil is controlled for producing the vapor by the pressure of the latter as it is produced.

The object of my present improvement is to combine the vapor-producer heated by the waste heat of the power-cylinder with an auxiliary vapor-producer heated independently of the power-cylinder and co-operating with the primary vapor-producer, whereby the engine may be started and operated by the vapor from one or both of said boilers, the communicating pipes being provided with controlling-cocks for this purpose. In places where there is no provision for supplying gas from street-mains, or where it may not be desirable to use illuminating-gas for the working-fluid, this invention is of special importance and advantage in providing a cheap and convenient motor for pumping and for driving light machinery. These objects I attain in the manner which I will now describe, reference being had to the accompanying drawings, in which—

Figure 1 represents in vertical section a gas-engine having a vapor-generating chamber or boiler heated thereby in communication with a liquid-fuel-supply reservoir and a pressure-storage chamber adapted to contain a variable volume of vapor, and also having an auxiliary vapor-generating chamber heated independently of the engine as a means of starting the latter, and of co-operating with the boiler of the engine-casing and the pressure-storage chamber to operate the engine; Fig. 2, a horizontal section on the line *x x* of Fig. 1, showing the power-cylinder and the vapor-generating boiler formed thereon. Fig. 3 represents a vertical section of the engine, showing its valved connection with the vapor-supplying pipe.

I have shown in connection with the evaporator or boiler a simple form of single-acting gas-engine provided with a simple form of governor for controlling the supply of vapor to the engine-valves, using a charge of air at atmospheric pressure; but my invention may be applied to any gas-engine.

The engine-cylinder A is shown only so much in section in Fig. 1 as illustrates its connection with the supply-valves and with the vapor-generators; but the engine, valves, and supply-pipes are better shown in Fig. 3, in which the piston B and the valves are shown in connection with the crank-shaft E. The main valve V is operated by the eccentric *x* and rod *y*, so as to control the inlet of the air and vapor into the cylinder and the discharge of the waste products therefrom. A vapor-supply valve, V′, is similarly connected and operated by the rod *y′* and eccentric *x′*, the two valves being placed side by side and operating in chambers which communicate with the air-inlet *g*, with the vapor-supply pipe *c*, and with the combustion-chamber B′ of the cylinder. The chamber of the valve V opens at the top of the cylinder-head A^2 at *g*, and into the combustion-chamber B′ by the side port, *a*, which is opened and closed by said valve. The vapor-supply valve V′ is of less length than the valve V, and its chamber *d* extends up and opens at *e* into the chamber *f* of the valve V, and forms the vapor-supply passage *d*, isolated from the direct communication with the cylinder-chamber. The valve V′ operates a port, *b*, at the bottom of the vapor-supply passage

d, which port *b* communicates with an outside vapor-supply pipe, *c*, upon which the governor F is arranged for operating the valve c^2, which controls the vapor-supply. The governor is operated by the pulleys h' h^2, by belt h^3, from the crank-shaft E and connecting-gear. In this construction the air required to complete the charge is sucked into the cylinder by the action of the engine through the passage *f*, which opens at the top cylinder-head.

The fuel-boiler or evaporating-chamber H may be formed within any suitable part of the casing or frame of the engine where it will receive a sufficient heat to evaporate the oil to form the working-vapor, the heat for this purpose being derived through the walls of the power-cylinder from the waste heat of the combustion of the working-vapor. As shown, this fuel-boiler is upon the outside wall of the power-cylinder, as cast therewith, having the inlet-opening *i* for the supply of the liquid fuel at the bottom, and the outlet-opening *j* for the vapor at the top, which communicates with the bottom of a storage-chamber, D, having a variable volume. The boiler or evaporating-chamber is supplied with the liquid fuel through the pipe P, which connects the bottom of said boiler with the bottom of a reservoir, I, having an air-vent, *l*, and which may be placed at any desired distance from the engine and at a height sufficient to cause the liquid to freely flow therefrom by gravity into the boiler, but not to fill the latter. The volume of the liquid in the boiler is regulated by the pressure of the vapor generated therein, and in proportion to the degree of such pressure the liquid W therein will be forced back into the supply-reservoir, so that the level of the liquid W′ in the latter will at all times be higher than the level of the liquid in the boiler. If the level of the liquid in the reservoir be represented by the line *m*, and that in the boiler by the line *n*, the height *m n* will be the measure of the pressure of the vapor in the boiler.

To keep the reservoir I constantly supplied with the liquid fuel it is supplemented by an air-tight reservoir, K, having a pipe extending into the reservoir I, so as to act upon the principle of the well-known student's lamp to maintain the supply in the reservoir with the boiler. I may, however, place this supplemental reservoir any desired distance from the reservoir I, and construct it of any desired capacity, as shown at K′, and connect it with the reservoir I by a pipe provided with a cock, O, so that the level of the liquid in the reservoir I will be governed by said pipe.

The pressure-storage chamber D is constructed so as to be capable of expanding and contracting according to the pressure of the vapor therein, to give out by its contracting pressure a sudden and free volume of the vapor into the cylinder the instant the engine-valves open. The chamber for this purpose may be of any suitable construction that will adapt itself to a variable volume and pressure. It may be formed by a flexible bag, such as that used with the gas-engine and the street-main gas-supply pipe for the same purpose. The chamber shown in the drawings consists of a metal box, D′, having a hopper-bottom and an inner circular partition, D^2, of less height than the box D′, whereby to form a mercury-chamber, D^3, into which an inverted hollow float or cup, D^4, dips and forms a cover for the vapor-storage chamber. The space above the inverted cup D^4 communicates with the outer air by the opening *l* for outside air-pressure, and the space under said cup forms the storage-chamber, and connects with the boiler by the pipe *c*, so that the condensation of the vapor will drain back into the boiler in the arrangement of the chambers shown in Figs. 1 and 4. This chamber may be placed any desired distance from the engine; but the vapor-conducting pipes should be covered by a non-conductor to prevent as fast as possible the condensation of the vapor in the pipes. The supply-pipe *c* carries the governor-valve c^2, and is arranged in Fig. 1 so as to drain into the pipe which connects with the storage-chamber, and the latter is connected so as to drain into the boiler.

The boiler may receive the drainage from the condensation direct from the vapor-supply pipe *c*, and also from the storage-chamber separately, because, to effect the desired result, it is not necessary that the storage-chamber should be placed in the vapor-supply pipe, or that the vapor should flow through it to the engine, as in Fig. 5, but it must have free communication with the boiler or with a pipe leading therefrom.

In the arrangement of the pressure-storage chamber shown in Fig. 1 the vapor will enter the storage-chamber through the pipe *c*, passing the governor-valve c^2, and when the engine-valves are open the float will fall quickly and force the vapor back in the required volume through the same pipe and through the governor-valve c^2 into the engine. The closing of the engine-valves causes the chamber to again fill and expand according to the quantity and pressure of the vapor generated in the boiler.

When the engine is not in use, the oil will stand at the same level in the boiler and in the supply-reservoir. When the engine is working, the vapor will fill the chamber of the boiler above the liquid and pass into and fill the expansible pressure-chamber, and in proportion to the pressure of the vapor generated the liquid will be increased or diminished in quantity in the boiler, and thus regulate the amount of surface of the liquid which is in contact with the hot walls of the boiler, and thus regulate the quantity of the fuel evaporated. This regulating action is illustrated in the drawings by the lines *m n*, and if *m* be the level of the liquid in the supply-reservoir, and *n* that of the liquid in the boiler, the latter will be under a pressure measured by the difference of level *m n*. An

increase of the vapor-pressure may cause the levels to change to m' n', which will then represent the pressure of the vapor in the boiler. Should the pressure increase sufficient to force all the liquid from the boiler into the supply-reservoir, then the evaporation of the liquid will practically stop until the pressure decreases sufficiently to allow the oil to again feed by gravity into the boiler. By this means the pressure in the boiler can never be greater than that of the hydraulic head, and the quantity of fuel evaporated will be controlled by the quantity of the fuel in the boiler.

By making the supply-reservoir of large surface in comparison with the volume of the boiler, the variations in the level of the liquid in the supply-reservoir will not be very great, and hence the pressure of the vapor in the boiler will be constant enough to render the pressure or discharge function of the storage-chamber always active.

For starting the engine, and as an auxiliary means for operating it, I employ an auxiliary boiler or vapor-generator, H^2, connected with the boiler of the engine-casing and with the pipe c, which supplies the engine, and also with the pressure-storage chamber of said supply-pipe. This auxiliary boiler communicates with the reservoir I by a pipe, P^2, leading from the bottom of said boiler to the bottom of said reservoir, and forming a branch of the supply-pipe P of the primary boiler, while a vapor-supply pipe, c^2, leads from the top of said auxiliary boiler to the vapor-supplying pipe c of the primary boiler, so that I may use either or both of the boilers, as stated. This auxiliary boiler may be of any suitable construction and heated in any suitable manner. It is not required to use a pressure-storage chamber with this auxiliary boiler, although I may use one outside of the boiler or within the boiler.

For economy of heat the auxiliary boiler is inclosed in a case or jacket, H′, provided with a chimney, H^3, and the necessary heat for the boiler is obtained by the burner-jets J′, which are supplied by the pipe J, which enters the jacket H′, so as to support the burners beneath the bottom of the boiler; or the boiler may be heated in any other desired way.

Provision is made for operating the engine by either boiler, or both combined, by means of cocks r r^2 r^3, placed in the pipes P P^2 c, between the boilers and the full supply-reservoir, and a cock, s, placed in the vapor-supply pipe c^2 of the auxiliary boiler between the latter and its connection with the supply-pipe c of the primary boiler. By closing the cocks r^2 and s the engine will be operated by the cylinder-boiler and supply itself in the way described, and by opening these cocks and closing cock r r^3 the engine will be operated by the auxiliary boiler H^2. By opening the cocks r, r^2, r^3, and s, both boilers will co-operate to supply vapor to operate the engine.

The drain in the vapor-supply pipe c^2 of the auxiliary boiler will be drawn off by the cock c^3. The cock r^3 in the pipe c is closed when the engine is operated by the independent boiler.

I claim—

The combination, with an explosive-gas engine, of a boiler for containing a volatile oil formed upon the power-cylinder and heated by the waste heat thereof, a pressure-storage chamber for the working-vapor, a reservoir for supplying a volatile oil, and an independently-heated auxiliary boiler connected with the reservoir and the vapor-supplying pipe of the primary boiler by pipes provided with controlling-cocks, whereby the engine may be started and operated by the vapor from one or both of said boilers, 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.