(No Model.) 2 Sheets—Sheet 1.

L. H. NASH.

EXPLOSIVE VAPOR ENGINE.

No. 331,078. Patented Nov. 24, 1885.

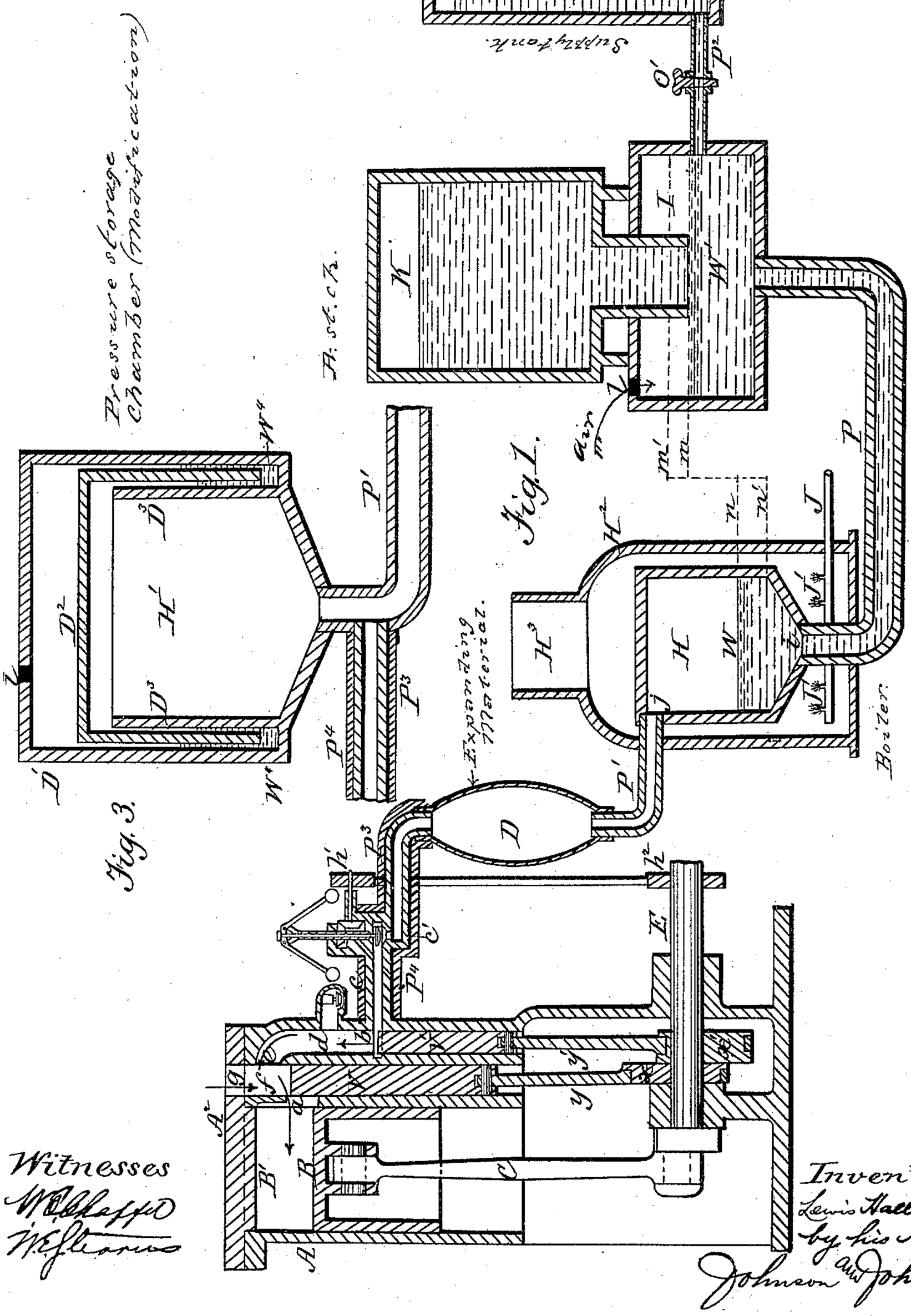

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Fig. 2.

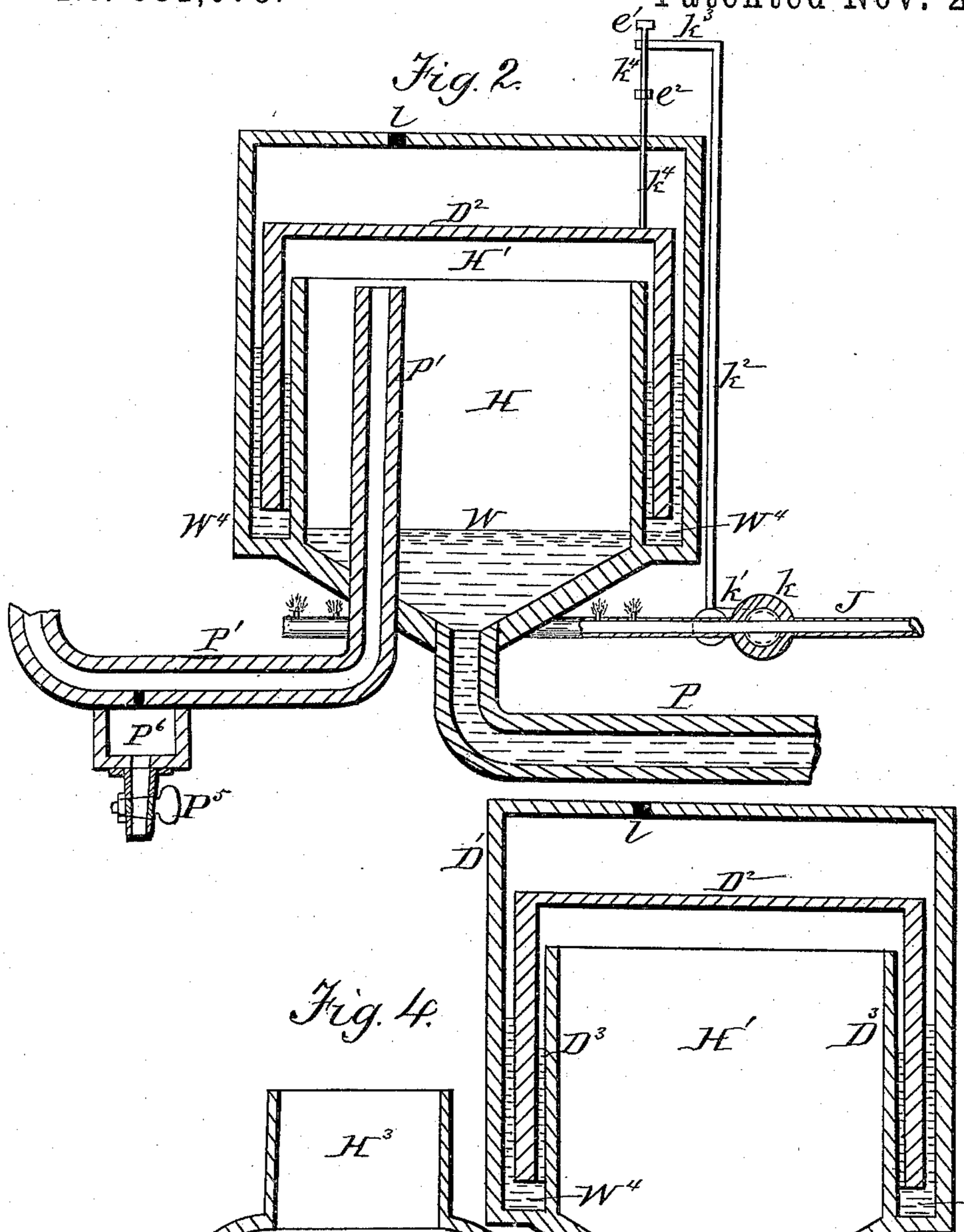
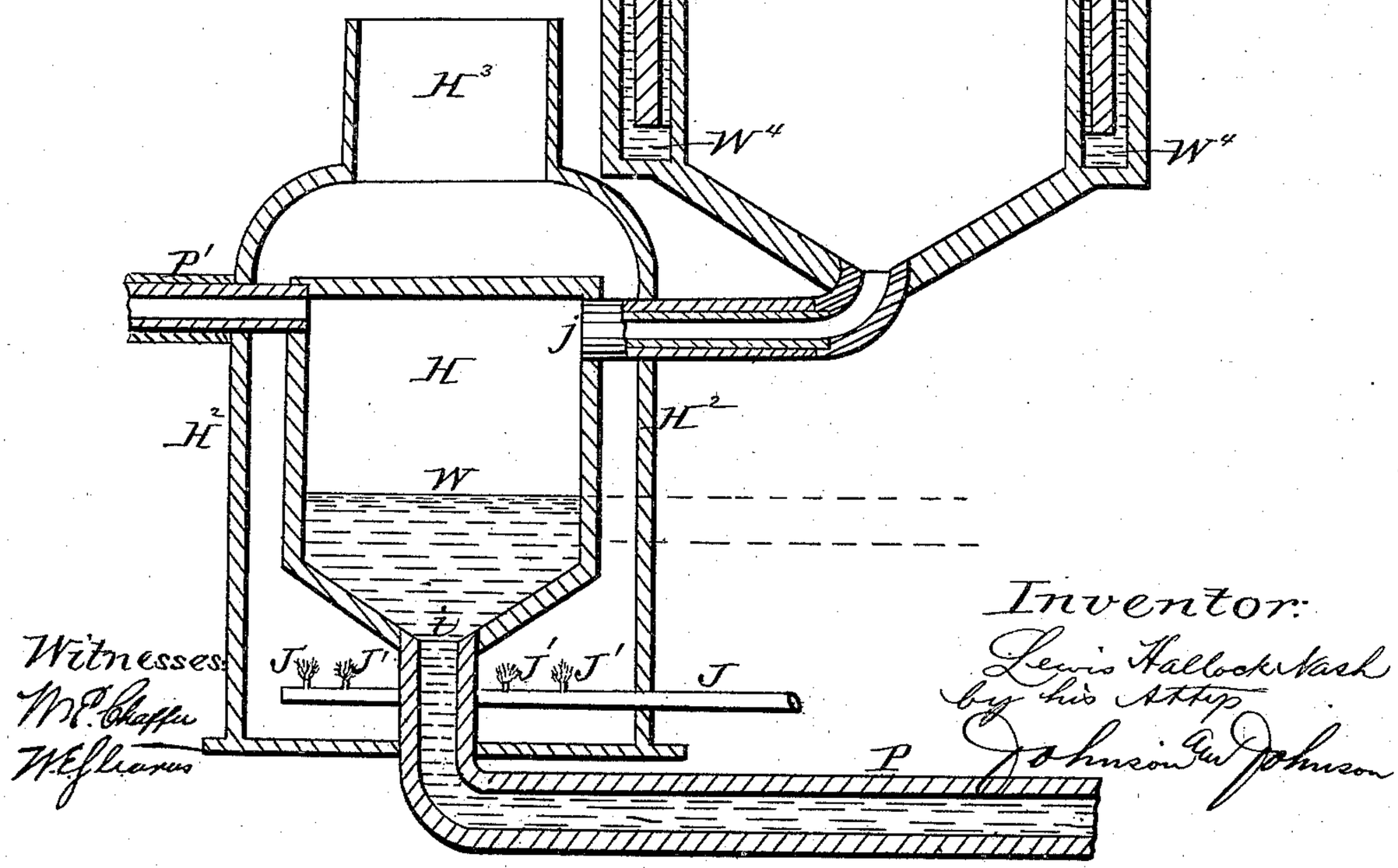


Fig. 4.



Inventor:
Lewis Hallock Nash
by his Attys
Johnson & Johnson

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. 331,078, dated November 24, 1885.

Application filed October 23, 1884. Serial No. 146,263. (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.

My invention relates to improvements in explosive-vapor engines; and the object of my improvements is to provide for operating an explosive-vapor engine by a vapor produced from kerosene or other volatile oil supplied to the engine in a dry and superheated condition, and thereby prevent the entrance into the cylinder of liquid particles, which would render the action of the engine unsteady by their vaporization within the cylinder at the instant of the explosion of the charge. As the vapor produced from volatile oils will condense rapidly and carry with it more or less liquid particles into the power-cylinder, their evaporization by contact with the hot valves and cylinder would produce an irregular supply of fuel, and thereby render the engine unsteady, as stated, and therefore objectionable.

My improvement avoids this objection by provision for draining the vapor-supplying pipe and superheating the vapor within the pipe-section which joins a hot portion of the engine, thereby evaporating the liquid particles as fast as they may condense on the walls of the supply-pipe, whereby the engine may be used in places where there is no provision for supplying gas from street-mains, or for use in ships' launches, or otherwise where it may not be desirable to use illuminating-gas for the working-fluid. My improvement also provides that the supply of the working-vapor shall be self-regulating as to the pressure of the vapor-supply and as to the quantity of the supply, so as to respond instantly to the demands of the engine.

My invention embraces, in combination, an engine, a boiler independent of the engine, for containing the oil for producing the working-vapor arranged to drain the vapor-supplying pipe, a pressure-chamber for receiving and storing the vapor, also arranged to drain into the boiler, and means for supplying or injecting the liquid fuel into the boiler, all co-operating to deliver a dry vapor produced from a volatile oil into the engine, and to control and regulate the production of the vapor and the amount of fuel evaporated in proportion to the pressure of the vapor generated, all making one operative mechanism, one concrete organization, tending to the accomplishment of a simple result—viz., to operate the engine with dry vapor delivered therein direct from a boiler with a pressure practically constant, with a production regulated by the degree of such pressure, and with provision for draining the engine connecting-pipes into said boiler, to the end that the disarrangement of the regular action of the engine will be prevented, which would otherwise result from the employment of a wet vapor of oil introduced into the engine direct from a boiler. These objects I attain in the manner which I will now proceed to describe, reference being had to the accompanying drawings, in which—

Figure 1 represents in vertical sectional elevation an explosive engine connected for operation with a boiler for producing vapor from volatile oil, a pressure-storage chamber for the vapor, and an oil-supplying reservoir, the vapor-supplying pipes and the said pressure-storage chamber being arranged to drain into the boiler; Fig. 2, a vertical section of a boiler having a pressure-storage chamber inclosed therein; Fig. 3, a vertical section of a modified form of pressure-storage chamber, and Fig. 4 a vertical section showing a modification in the arrangement of the pressure-storage chamber in relation to the boiler.

I have shown in connection with the evaporator or boiler a simple form of an explosive 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 form of explosive engine—as, for instance, the engine shown and described in an application for a patent filed by me May 8, 1884, under Serial No. 130,786, which is a single-acting gas-engine.

In the drawings which illustrate such engine, A represents a cylinder; B, the piston, and C the rod connecting the piston with the crank-shaft. 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 cylin-

der and the discharge of the waste products therefrom. A supply-valve, V′, for the vapor 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, with the vapor-supplying pipe, and with the combustion-chamber 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-supplying valve V′ is of less length than the valve V, and its chamber 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 communicates with an outside vapor-supply pipe, *c*, upon which the governor is arranged for operating the valve *c′*, which controls the vapor-supply. The governor is operated by the pulleys *h′* h^2 from the crank-shaft E and connecting-gear. In this construction the air required to complete the combustible charge is sucked into the cylinder by the action of the engine through the passage *f*, which opens at the top of the cylinder-head.

The fuel-boiler or evaporating-chamber H may be of any suitable construction and heated by any suitable means, having an inlet-opening, *i*, for the liquid fuel at the bottom, and the outlet-opening *j* for the vapor at the top, which communicates with the bottom of a pressure-storage chamber, D, having a variable volume. The boiler or evaporating-chamber is supplied with the oil through a pipe, P, which connects the bottom of said boiler with the bottom of a reservoir, I, having an air-inlet, *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 oil in the boiler is regulated by the pressure of the vapor generated therein, and in proportion to the degree of such pressure the oil, W, therein will be forced back into the supply-reservoir, so that the level of the oil, W′, in the latter will at all times, under such pressure, be higher than the level of the oil in the boiler. If the level of the oil 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 oil 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 having direct communication with the boiler. I may, however, place this supplemental reservoir K 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, at the level of the oil in the latter, by a pipe, P^2, provided with a cock, O′, so that the level of the oil in the reservoir I would be governed by said pipe.

The 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 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, such as the rubber bag used with the gas-engine and the street-main gas-supply pipe for the same purpose. This chamber is connected at the bottom to the boiler by the pipe P′, and at the top to the engine by the pipe P^3, so that the vapor condensed will drain back into the boiler. This chamber may be placed at any desired distance from the engine; but the vapor conducting pipes should be covered by a non-conductor, P^4, to prevent as far as possible the condensation of the vapor in the pipes. The pipe *c*, which carries the governor-valve *c′*, should be arranged so as to drain into the pipe P^3, which connects the storage-chamber, and the latter is connected so as to drain into the boiler. The boiler may, however, receive the drainage from the condensation direct from the vapor-supplying pipe P^3, 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, nor that the vapor should flow through it to the engine, but it must have free communication with the boiler, or with a pipe leading therefrom.

In Fig. 3 I have shown a modification of the pressure-storage chamber, consisting of a metal box; D′, having a hopper-bottom and an inner circular partition, D^3, of less height than the box D′, whereby to form a mercury-chamber, W^4, into which an inverted hollow float or cup, D^2, dips and forms a cover for the vapor-pressure chamber. The space above the inverted cup D^2 communicates with the outer air by the opening *l* to allow the float to rise freely, and the space under said cup forms the storage-chamber H′, and connects with the boiler by the pipe P′, so that the condensation of the vapor will drain back into the boiler, while the pipe P^3 drains from the engine-valves directly into the boiler-vapor supply-pipe P′ at its connection with the storage-chamber.

In Fig. 4 I have shown the storage-chamber having the sealing-float shown in Fig. 3 connected with the chamber of the boiler independent of the pipe P′, which connects the boiler-chamber with the engine-valves, so that in this arrangement the pressing function of the storage-chamber is made active by pressing the vapor through the boiler into the engine.

For economy of heat the boiler is inclosed

in a case or jacket, H^2, 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, so as to support the burners beneath the bottom of the boiler, or the boiler may be heated in any other desired way.

In Fig. 2 I have shown a convenient way in which the boiler may contain the pressure-storage chamber. In this modification the boiler is formed, like the storage-chamber shown in Fig. 4, with a circular partition, so as to form a mercury cup, within which an inverted-cup float is placed, so as to form a movable sealed or pressure-chamber for the boiler. In this modification the vapor-outlet pipe P′ passes up through the bottom of the boiler, and extends above the surface of the fuel therein, so as to open into the vapor-space, and the float is caused to rise and fall within the boiler, according to the pressure of the vapor, and to fall to press out the vapor into the engine at every opening movement of the valves. In this modification I have made provision for automatically controlling the heat of the boiler. The jet-supplying pipe J has a cock, *k*, which is operated to control the supply to the burners by a lever, *k′*, which connects with a vertical rod, k^2, having a horizontal arm, k^3, at its upper end, which extends over the top of the boiler-case and connects with the upper end of a rod, k^4, which, passing through the top of the boiler-case, is attached to the top of the pressure-regulating storage-chamber. This rod is provided with collars e' e^2 above and below the end of the rod k^3, so that when the float rises high enough by the pressure of the vapor the collar e^2 will lift the rod k^2, which, by its connection with the lever *k′* of the cock *k*, will turn the latter and shut off the fuel-supply to the burners, and thus reduce the quantity of oil evaporated. When the float falls, the collar *e′* will engage the arm k^3 and open the cock to give full supply to the burners and again increase the quantity of fuel evaporated. In this way the expansion and contraction of the storage-chamber is utilized to control the heat of the boiler and the quantity of the oil evaporated in the boiler. In this construction the drain from the vapor-supply pipe P′ will be by a draw-off cock P^5 in the lowest part of said pipe in a drip-chamber, P^6. In proportion to the pressure of the vapor generated the quantity of the oil in the boiler will be increased or diminished, and thus regulate the amount of surface of the oil which is in contact with the hot walls of the boiler, and thus regulate the quantity of the oil evaporated. This regulating action is effective in the constructions shown in Figs. 1, 3, and 4 without the controlling-cock, as I will now describe.

In Fig. 1 the lines *m n* illustrate the level of the oil in the boiler, and in the pressure-storage chamber when the engine is working, so that the pressure of the vapor in the boiler will be measured by the difference of the level *m n*. An increase of the vapor-pressure may cause the levels of the oil 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 oil from the boiler into the supply-reservoir, then the evaporation of the oil will practically cease 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 oil evaporated will be controlled by the quantity of oil 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 discharging function of the storage-chamber always active.

I have stated that the vapor-supplying pipes are arranged to communicate with the engine-valves at a hot portion of the engine, and I mean by this such connection must be in such proximity to the combustion-chamber of the engine as to be so highly heated by the waste heat thereof as to superheat the vapor before its entrance into the cylinder. This provision, in connection with draining the vapor-supplying pipes, is of essential importance in operating an engine by the vapor of a volatile oil.

I have shown no means for igniting the charge, as I may use any of the known methods by which such ignition may be effected.

I have shown an engine operating with a charge at atmospheric pressure, but my invention may be applied to any engine operating to compress its charge.

The invention embraced in the method which I have herein described of operating an explosive-vapor engine is not claimed herein, but is made the subject of a separate and distinct application for a patent filed by me February 24, 1885, under Serial No. 156,740, and entitled "method of operating gas-engines."

I claim—

1. The combination, with an explosive-vapor engine, of a boiler for evaporating a volatile oil for operating the engine, a vapor-pressure-storage chamber, the vapor-supply pipes arranged to enter a hot portion of the engine and to drain into the boiler, and a supply-reservoir automatically supplying the boiler, according to the pressure of the vapor therein.

2. The combination, with an explosive-vapor engine, an independent boiler for evaporating a volatile oil for operating the engine, of a pressure-storage chamber and a supply-reservoir, the vapor-supply pipe being arranged to drain into the boiler, and the oil-supply pipes arranged to maintain an automatic regulated supply to said boiler, and a regulated vapor-supply to said engine, substantially as herein set forth.

3. The combination, with an explosive-vapor engine, of an independent boiler for evaporat-

ing a volatile oil for operating the engine, an automatic movable pressure-storage chamber for the vapor, and a supply-reservoir for the oil, the communication of said reservoir with the boiler being such as to supply the latter by gravity controlled solely by the pressure of the vapor therein, substantially as described, for the purpose specified.

4. The combination, with an explosive-vapor engine and an independent oil-evaporating boiler for operating the engine, of a pressure-storage chamber acting by a positive movement of itself, a supply-reservoir for the oil in perpetual communication with said vaporizing-boiler, and a gas-burner supply-pipe, all constructed and arranged for co-operation, substantially as described.

5. The combination, with an explosive-vapor engine, of an oil-evaporating boiler for operating the same, containing (within a liquid seal) a pressure-storage chamber for the vapor movable within said boiler, whereby to displace by gravity the vapor under pressure to the engine, substantially as described, for the purpose specified.

6. The combination, with an explosive-vapor engine, an independent boiler for evaporating a volatile oil for operating the engine, and a movable pressure-storage chamber for the vapor seated within a liquid seal within said boiler, of a burner-pipe and supply-controlling cock for said pipe controlled in its regulated position by connections with said movable pressure-storage chamber, substantially as described, for the purpose specified.

7. In combination, in an explosive-vapor engine, the evaporating-boiler H, the movable pressure-storage chamber for the vapor, and a supply-reservoir for the oil, both having free communication with said boiler, the vapor-supplying pipes being arranged to drain into the boiler, and the oil-supply pipes arranged to maintain, by gravity controlled solely by the pressure of the vapor in said boiler, an automatically-regulated supply to said boiler and an automatically-acting regulated vapor-supply to the engine, substantially as herein set forth.

8. The combination, with an explosive-vapor engine, an independent boiler for evaporating a volatile oil for operating the engine, and a pressure-storage chamber connecting with both contained within said boiler, of a gas-burner pipe, J, having a controlling-cock, *k*, and means for connecting it with the pressure-storage chamber, consisting of the connecting-rods k^2 and k^4, the latter having a fixed connection with the storage-chamber, and the collars e' e^2, for operating the cock-connecting rod, substantially as herein set forth.

9. The combination, with a boiler for evaporating liquid fuel having a suitable source of fuel-supply, of a pressure-storage chamber for the vapor, connected with the vapor-space of said boiler, and an explosive engine receiving its charge of vapor direct from said boiler, for the purpose specified.

10. The combination, with an explosive engine, of a boiler independent thereof, a pressure-storage chamber, and a supply-reservoir communicating with the bottom of said independent boiler, whereby the pressure of the vapor in the boiler will act to regulate the quantity of the oil exposed to its evaporating-surfaces, substantially as herein set forth.

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

LEWIS HALLOCK NASH.

Witnesses:
H. W. BRINCKERHOFF,
W. C. WESTERVELT.