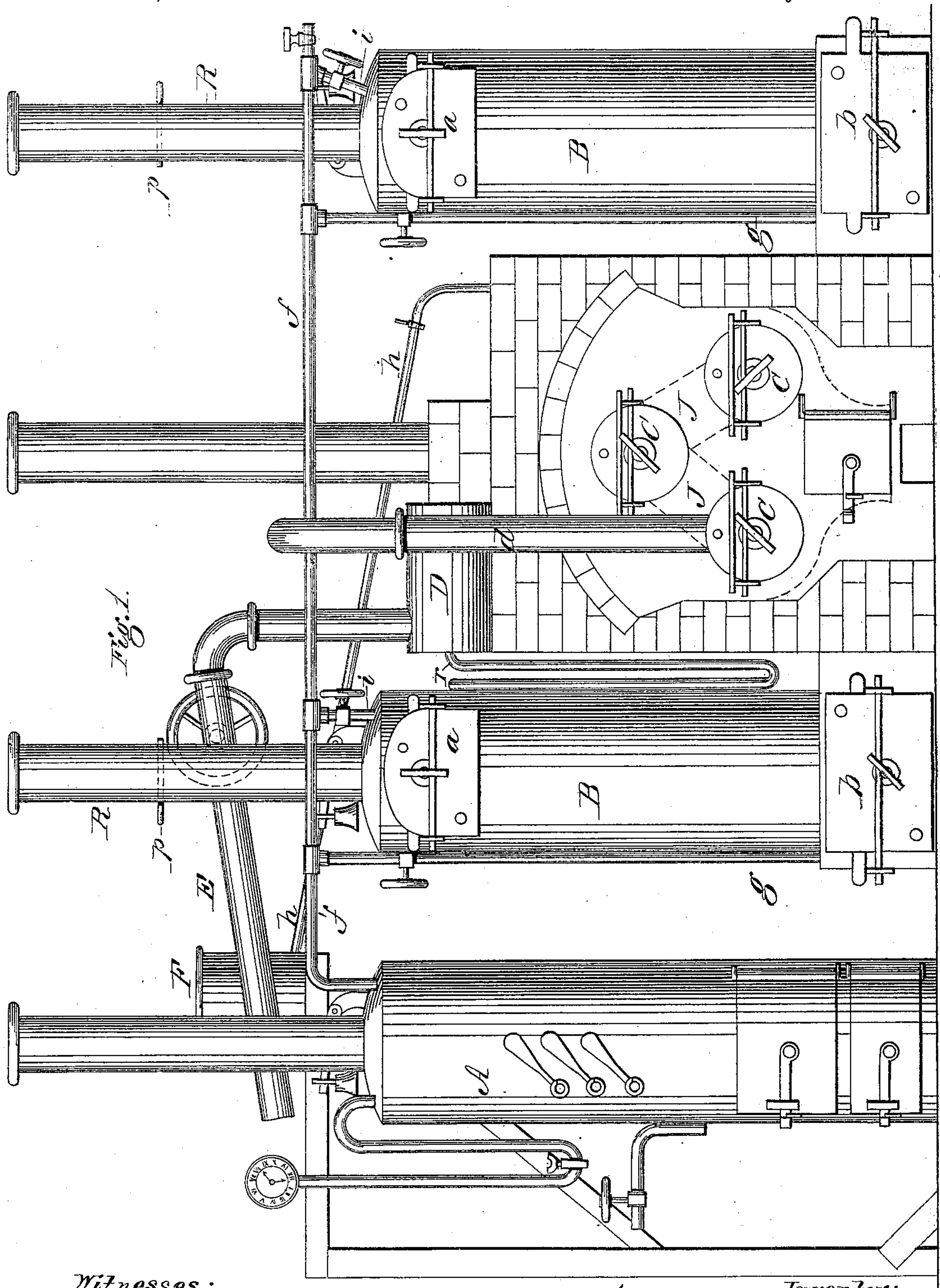


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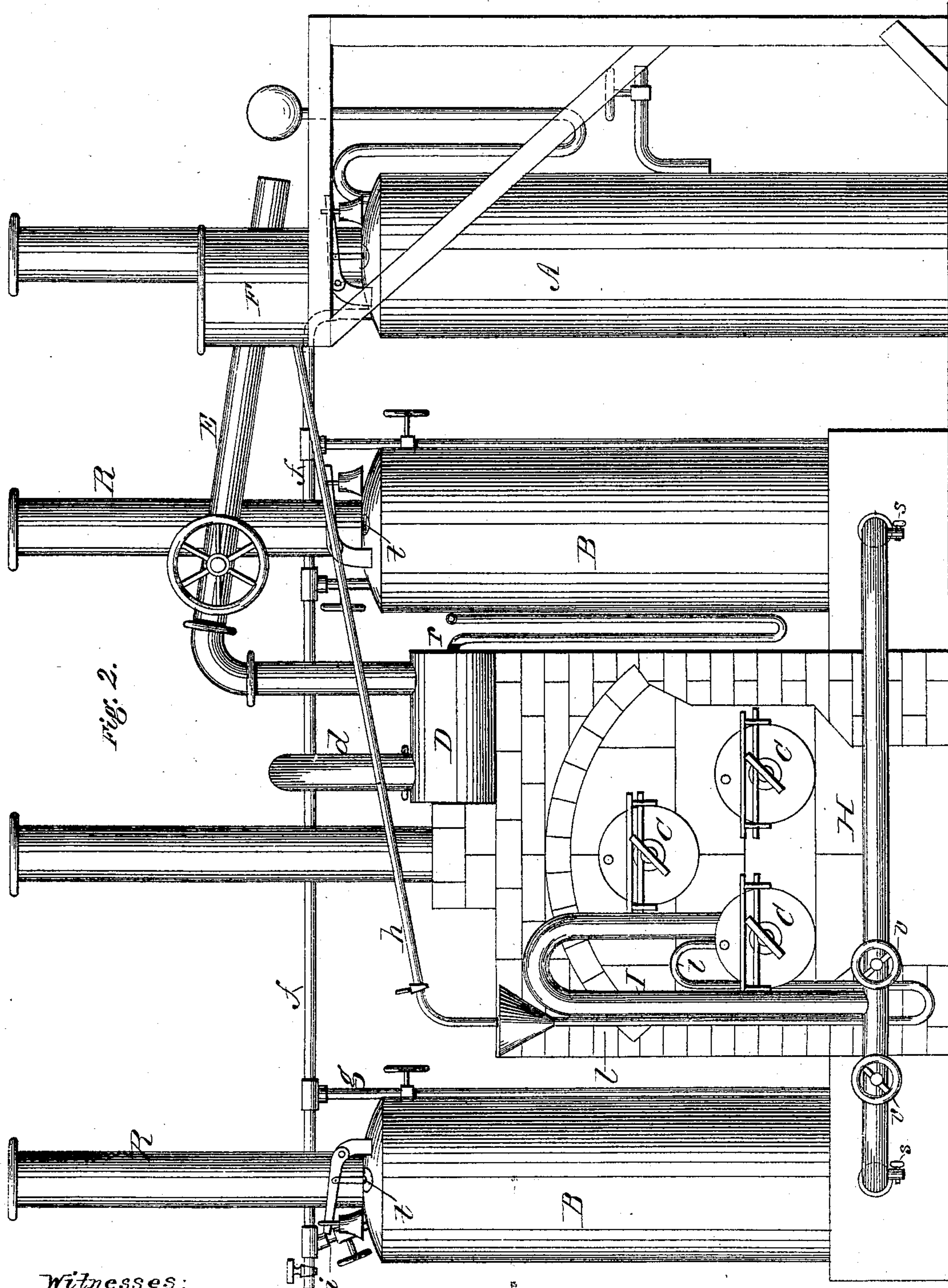


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3 Sheets--Sheet 2.

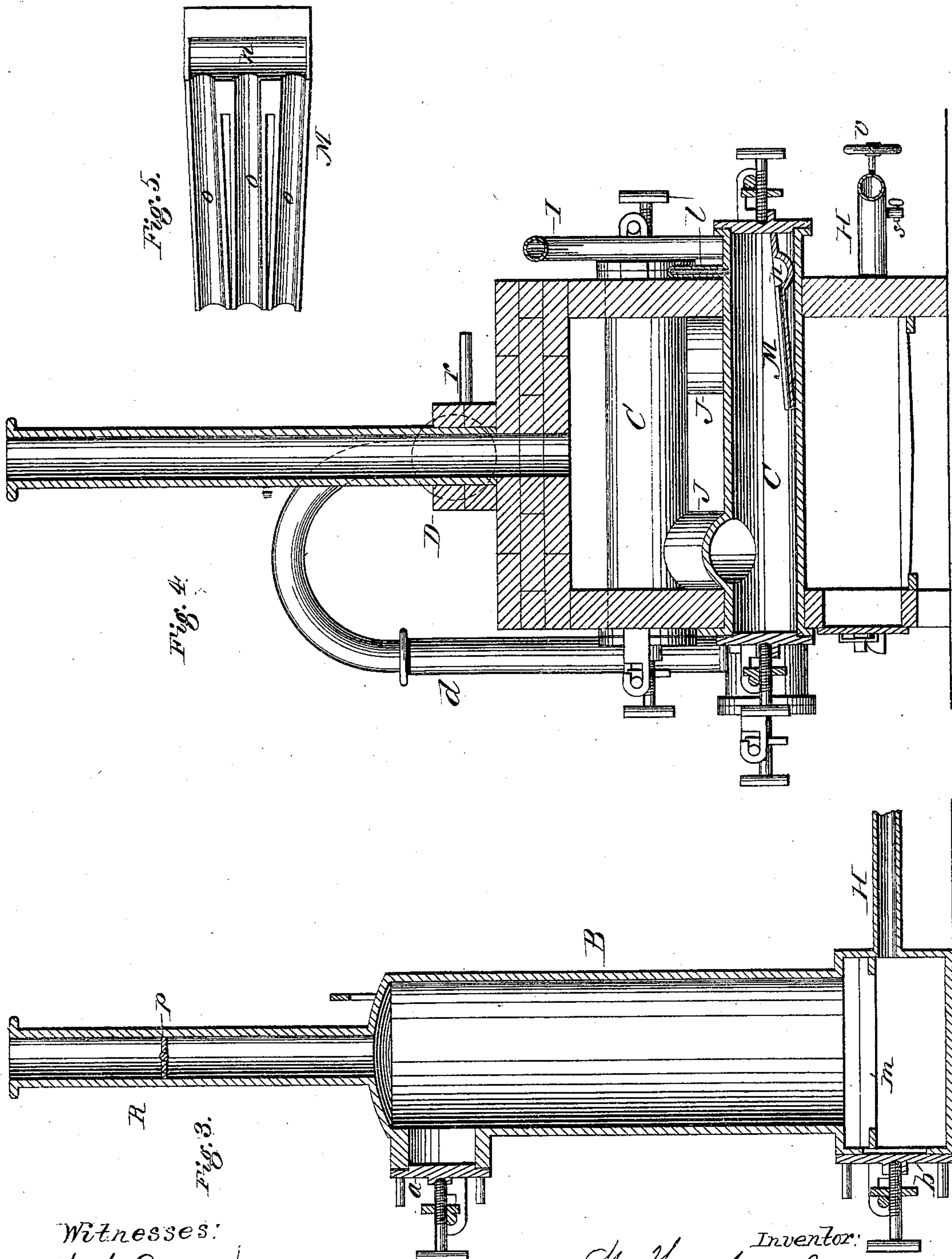
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UNITED STATES PATENT OFFICE.

WILLIAM HARKNESS, OF PROVIDENCE, RHODE ISLAND.

IMPROVEMENT IN THE PROCESSES AND APPARATUS FOR MAKING WATER-GAS.

Specification forming part of Letters Patent No. 151,283, dated May 26, 1874; application filed April 6, 1874.

To all whom it may concern:

Be it known that I, WILLIAM HARKNESS, of Providence, in the county of Providence and State of Rhode Island, have invented certain Improvements in Process and Apparatus for Making Gas, of which the following is a specification:

My invention consists of a novel apparatus and process for manufacturing illuminating-gas, the peculiarities of which I will proceed to describe.

In the accompanying drawings, Figure 1 is a front elevation of the apparatus complete. Fig. 2 is a rear elevation; and Figs. 3, 4, and 5, sectional and detached parts, showing the internal construction.

The object of this invention is to produce illuminating-gas by decomposing steam and uniting the resulting gas, together with the gases given off by red-hot coal when the steam is passed through it, with hydrocarbon vapors, by which a permanent or fixed gas of high illuminating power may be produced at a very cheap rate.

To accomplish this result I proceed as follows: First, I provide a steam-boiler, A, which, as represented in the drawings, may be of the upright style, or any other most convenient for the purpose. I also provide a bench of retorts, C, as represented in the drawings, suitably set in a furnace, these retorts C being connected by tubes J, as shown in Fig. 4, and by dotted lines in Fig. 1, in such a manner that the vapors entering them are compelled to traverse the entire length of them all, successively. For the purposes of illustration I have represented a series of three retorts, C, thus arranged, though it is obvious that any desired number may be used, or that a single retort having partitions arranged in it in such a manner as to cause the vapors to traverse to and fro therein may be used instead; the object being to subject the vapors for a considerable time to an extended heating-surface while in the retorts. I also provide two or more decomposing-furnaces or generators, B, which, as shown in Fig. 3, are made like ordinary cylinder-stoves, of considerable height, with a fire-grate, *m*, at their base, and an ash-pit underneath. Instead of being provided with ordinary doors, these generators B are provided at

the bottom with a mouth-piece or lid, *b*, like a gas-retort, so constructed that it can be clamped and rendered gas-tight, it being located below the grate *m*, as shown in Figs. 1 and 3. Another and similar lid, *a*, is arranged to close a mouth or opening near the top, and in the smoke-pipe R, extending from the top, I locate a valve, *p*, by which to close the pipe R also, thus rendering the generator B steam-tight. Each of these generators is also provided with a safety-valve, *t*, as shown in Fig. 2. These generators are connected with the retorts C by a pipe, H, which extends from their base along the back side, as shown in Fig. 2, and from which a vertical pipe, I, leads to the rear end of the first retort of the series, there being valves *v* arranged as represented in Fig. 2, so that either generator B may be shut off from communication with the retorts at will, the intention being to use them alternately, as hereinafter explained. The pipes H, leading from the generators B, are provided with pet-cocks *s*, to clear them of the condensed steam, as shown in Fig. 2. These generators B are connected with the steam-boiler A by a pipe, *f*, Figs. 1 and 2, the pipe *f* having one branch, *i*, entering the top of each generator, and another branch, *g*, which enters the space under their grates, these branches being provided with suitable cocks or valves, by which to shut off or let on the steam through either at will, so as to cause the steam to enter the generators at top or bottom, as may be desired. I also provide a reservoir or tank, F, for containing the hydrocarbon oil to be used, a pipe, *h*, serving to convey the oil to a siphon-tube, *l*, as shown in Fig. 2, which introduces it into the first retort, C, of the series at its rear end, near where the pipe I enters, as shown in Figs. 2 and 4. Within this retort, directly under the point where the oil is delivered, I place a vaporizer, M, as shown in Fig. 4. This vaporizer, which is shown detached in Fig. 5, consists of a plate having a transverse groove or trough, *n*, at one end, from which extends, at right angles, a series of grooves, *o*. The oil, as it is delivered from the pipe *l*, falls into the trough *n*, from whence it flows gradually along the grooves *o*, of which there may be any number, and is thus vaporized without coming in contact

with the retort while in a liquid state. A stand-pipe, *d*, extends from the front end of the last retort C, and connects with the hydraulic main D, from which the main pipe E extends to the gasometer, there being nothing unusual in these latter devices.

It is obvious that, instead of the separate or detached boiler A being used, a steam-boiler may be located so as to be heated by the same furnace as the retorts, the boiler being set above or alongside of the retorts, as may be found most convenient and practicable; and that in its details the apparatus may be varied more or less, without affecting or changing its principle or mode of operation.

The process of forming the gas is as follows: The generators B are filled partially or nearly full of coal, a fire being kindled, and the draft opened. It is allowed to burn until the mass of the coal is red hot, when the lower door or lid *b* of the generator is closed and rendered gas-tight, by luting or otherwise. Steam is then admitted from the boiler A through the pipe *g* into the base of the generator B; and if the coal be of the proper temperature and condition, the steam thus admitted, as it ascends through the incandescent mass, will be decomposed and converted into a gas or vapor that will burn at the surface of the mass of coal. As soon as this is ascertained the upper lid *a* is luted on and the valve *p* in the smoke-pipe closed. The valve in the pipe *g* is shut, and that in pipe *i* is opened, thus admitting the steam from the boiler into the top of the generator B; from whence it is forced down through the mass of hot coal, and passes out at the bottom through the pipe H, and thence through the pipe I into the first retort C, where it comes in contact with the vaporized hydrocarbon and unites with it, the gases all traversing together through the heated retorts, and passing out through the pipe *d* a permanent fixed gas. While one generator, B, is being thus used the other is being heated up, and when the first has been run for about an hour the steam is shut off from it and turned onto the second one, the first being replenished with coal and heated up, so as to be ready for use by the time the second is exhausted, and thus the operation is rendered continuous.

By so constructing and arranging the apparatus that the steam is made to pass downward through the mass of incandescent coal in the generators B, I get much better results than can be obtained by allowing it to pass either upward or horizontally through the coal. As the natural tendency of the steam and the gases of combustion is to rise, it follows that when admitted above the coal the steam will fill the entire cross-section of the generator, and as the volume increases will pass down through the coal, filling the entire space, until it escapes below. By this method the steam is not only made to take up all the oxide gas, but it is brought into direct contact with every particle of hot coal, envelop-

ing each and every piece of it on all their surfaces. Moreover, as it fills the entire generator from top to bottom, and will flow out at the bottom only as the volume is increased at the top, a much larger quantity of steam is held in contact with the hot coal, and for a longer time, whereby it is more effectually decomposed, and takes with it more of the gases of combustion, thus producing the desired result far more effectually than by any other means. When steam is admitted below and allowed to pass up through the coal, it may pass up along one side or at the center only, and as it is heated still by contact with the coal it will pass through very quickly, and without coming in contact with all the coal. So when it is passed through horizontally it will flow along the upper side of the vessel and not be brought into intimate contact with the entire mass of coal; hence this passing of the steam downward through the coal I consider a very important feature of my invention. So, too, I take the gas from a retort that is lower than the one immediately preceding it, by which means it is held in the previous retort until forced out by the volume behind, thus tending to retard its flow and hold it in the heated retort until the different vapors are thoroughly mingled and chemically united, thus rendering the product a fixed and permanent gas, not liable to condense at any ordinary temperature, even in the coldest winter weather.

The gas thus produced is carbureted hydrocarbonic oxide of specific gravity of 700, air being taken at 1000 as a standard. It is free from sulphur and phosphorus, and does not require to be washed or purified, but is ready for use as it comes from the works. I find by experience that it does not gum up the burners, nor condense even at a low degree of temperature, but remains a permanent fixed gas, at all times ready for use, the same as the ordinary illuminating-gas. It can be made of any degree of richness desired, up to at least thirty-candle power. In ordinary practice I use the steam at about forty pounds pressure, and use about one and three-tenths gallons of oil to one thousand feet of gas.

By this process I am enabled to produce a good illuminating-gas at a greatly-reduced price. Another advantage of the process is, that no carbon is formed in the retorts, and hence there is not the usual delay required for cleaning them. The vaporizer M, being detached, can be removed from the retort and a fresh one supplied whenever necessary.

In practice I make the generators from five to seven feet high, and from fourteen to twenty-five inches internal diameter, they being made of cast-iron and lined with fire-brick.

The retorts C I construct with a lid at each end, so as to afford more ready access to their interior, it not being necessary to remove them from the furnace, though, as previously stated, other forms of retorts may be used, if desired.

I am aware that various efforts have been

made to produce illuminating-gas by the union of the gases of decomposed steam and of hydrocarbon oils; also, that the steam has been decomposed in one retort and then united with the gas produced from hydrocarbon oil in another retort; and, therefore, I do not claim these, except when carried out by the means and process substantially as above described, one condition of my process being that the steam shall be forced downward through the incandescent coal.

Having thus described my invention, what I claim is—

1. The generator B, provided with a fire-grate, *m*, a smoke-pipe, R, having a valve for closing the same, and a mouth above and below, provided with lids *a* and *b*, respectively, the whole constructed to operate as shown and described.

2. In combination with the generators B, the pipes I and *g*, provided with suitable valves, and arranged to admit steam at the top or bottom of the generator, as set forth.

3. The removable vaporizer M, provided with the transverse groove *n* and the longitudinal grooves *o*, substantially as shown and described.

4. The combination, in a gas apparatus, of a steam-boiler, one or more generators, B, constructed and arranged to heat the coal therein and pass the steam downward through it, and one or more retorts arranged to vaporize a hydrocarbon and mingle and heat the vapors therein, substantially as herein described.

5. The herein-described process of making illuminating-gas—that is to say, by passing steam downward through a generator containing incandescent coal, and thence into a retort in which hydrocarbon oil is vaporized, and then passing these mingled gases through heated retorts, as set forth.

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