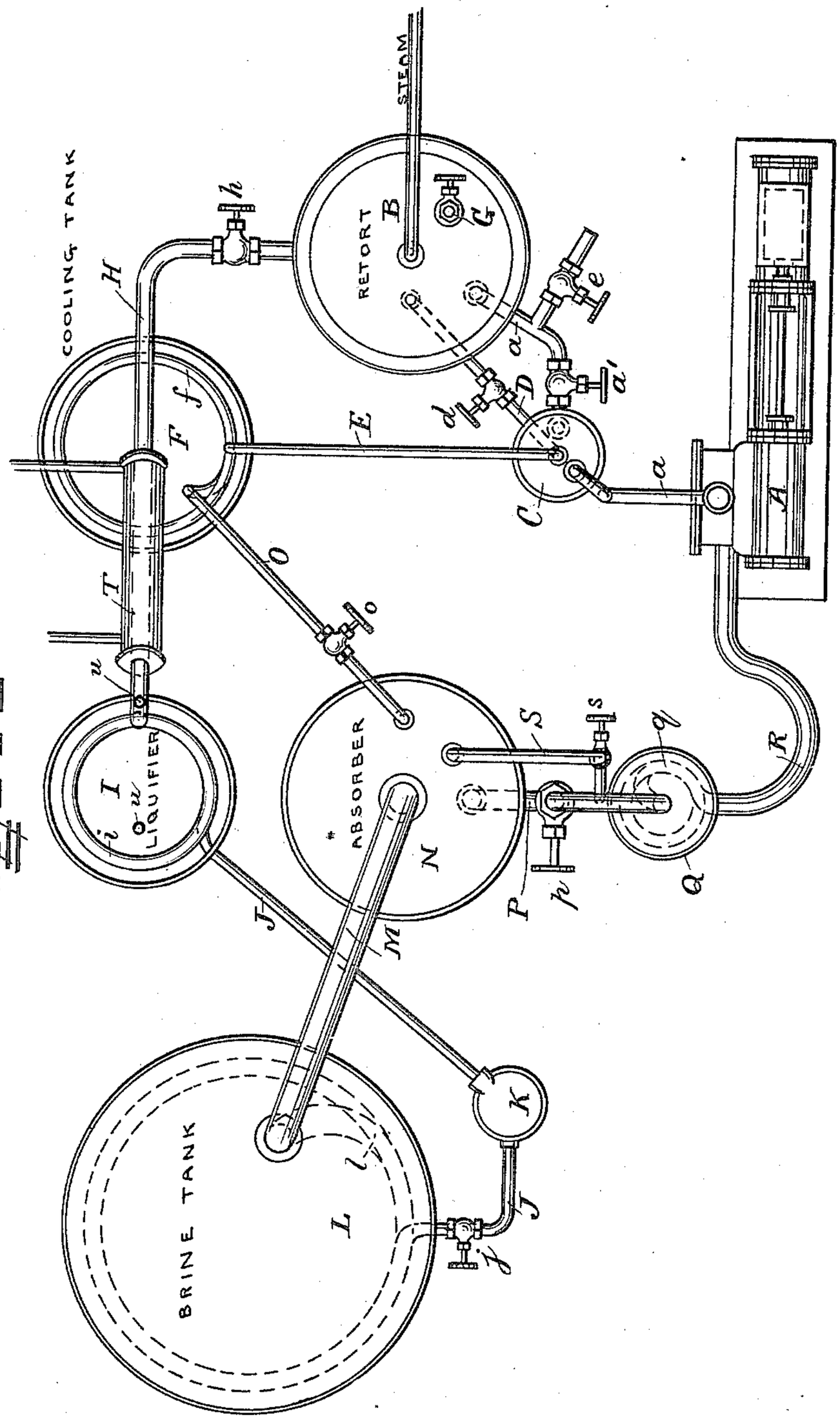
(No Model.) 3 Sheets—Sheet 1.

W. T. HILDRUP, Jr. & T. H. BUTLER.

ICE MACHINE AND METHOD OF OPERATING SAME.

No. 427,765. Patented May 13, 1890.

Fig. 1.



Witnesses

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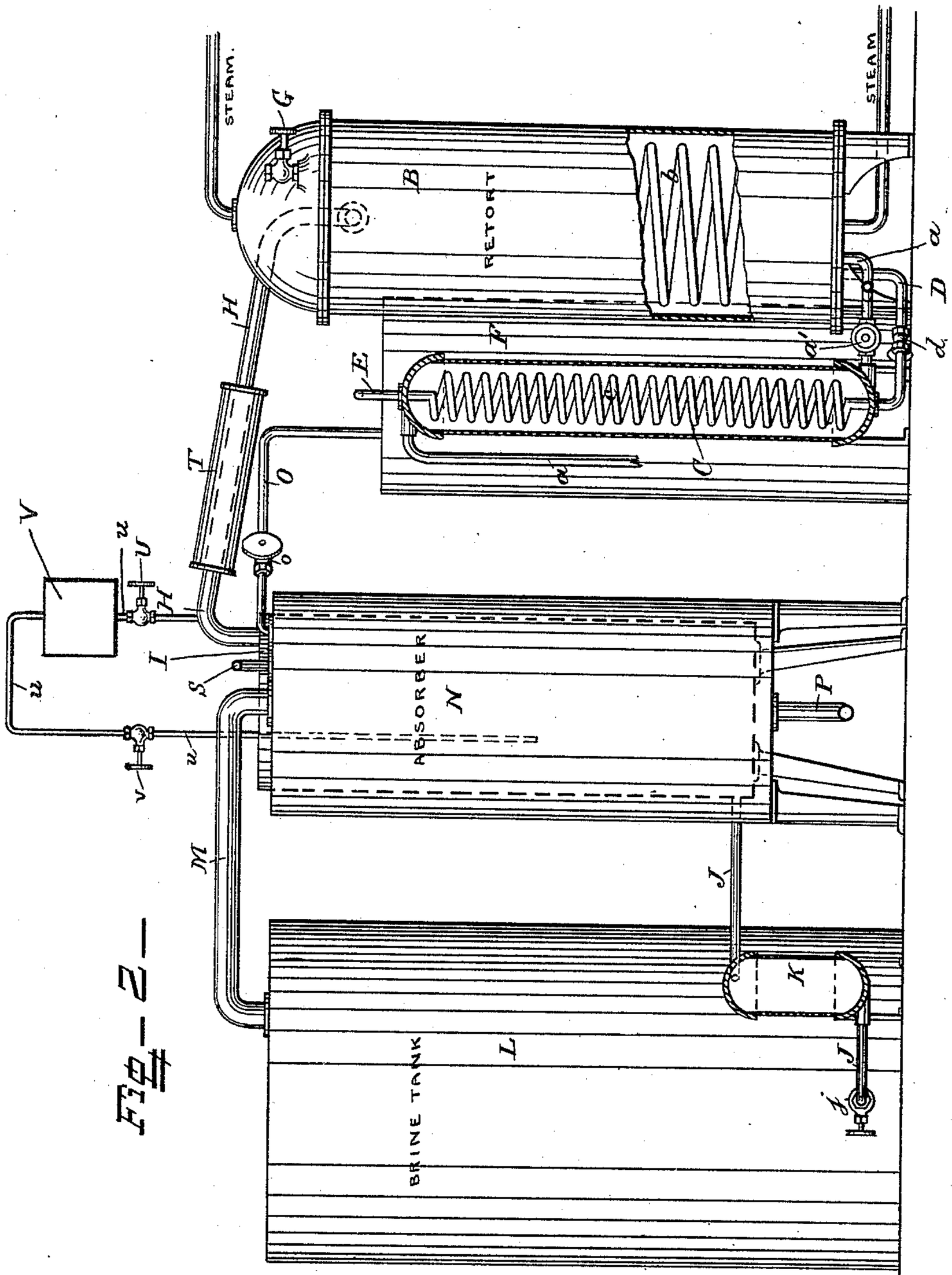

FIG. 2.

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(No Model.) 3 Sheets—Sheet 3.

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ICE MACHINE AND METHOD OF OPERATING SAME.

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Fig. 3.

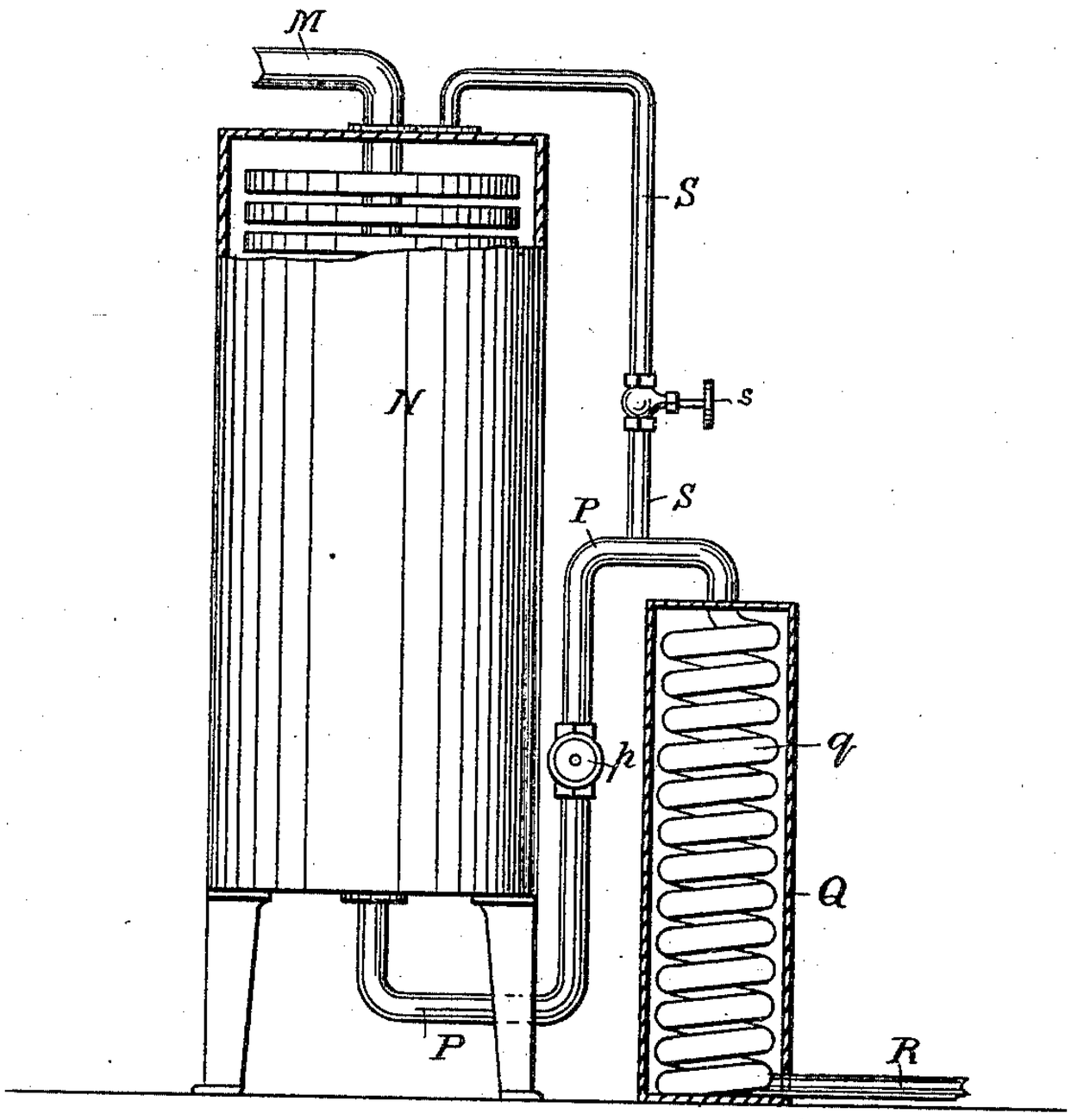
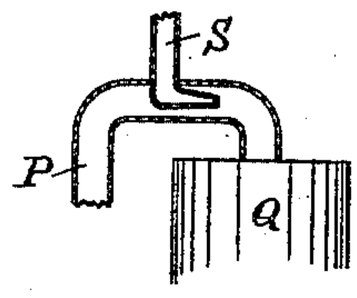


Fig. 4.



Witnesses

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UNITED STATES PATENT OFFICE.

WILLIAM T. HILDRUP, JR., AND THOMAS H. BUTLER, OF HARRISBURG, PENNSYLVANIA.

ICE-MACHINE AND METHOD OF OPERATING SAME.

SPECIFICATION forming part of Letters Patent No. 427,765, dated May 13, 1890.

Application filed June 10, 1887. Serial No. 240,905. (No model.)

To all whom it may concern:

Be it known that we, WILLIAM T. HILDRUP, Jr., and THOMAS H. BUTLER, citizens of the United States, residing at Harrisburg, in the county of Dauphin and State of Pennsylvania, have invented certain new and useful Improvements in Ice-Machines; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to ice-machines; and it consists in the novel construction and combination of the parts hereinafter fully described and claimed.

In the drawings, Figure 1 is a plan view of the complete apparatus. Fig. 2 is a front elevation showing various portions of the apparatus in longitudinal section, the pump and subsidiary cooling-tank being left out. Fig. 3 is a similar side view of the absorber and the subsidiary cooling-tank. Fig. 4 is a detail of the connection between pipes S and P.

A is the pump, which is a steam-pump of any approved construction, and *a* is its delivery-pipe, provided with the stop-valve *a'*, through which strong aqua-ammonia is forced into the retort or gas-generator B, which is provided with a steam-heating coil *b*.

C is the equalizer, intermediate between the pump and the retort. The delivery-pipe *a* is connected to the equalizer at the top and bottom, so that the strong cold aqua-ammonia enters at the top and passes downward through the equalizer in contact with the coil *c*, which contains hot aqua-ammonia from which the gas has been driven off in the retort.

D is a pipe provided with a stop-valve *d*, which connects the lower end of the equalizer-coil *c* with the retort, and E is a pipe which connects the upper end of the said coil with the coil *f* in the cooling-tank F. A stop-valve *e* is also connected to the retort direct, or to the delivery-pipe *a* close to the retort, the use of which valve will be more fully described hereinafter. The hot weak liquor is forced upward through the coil *c* of the equalizer by the pressure of the gas in the retort, and is cooled to some extent by the descending current of cold strong liquor outside the coil, which also absorbs heat from it. The arrangement of the parts is such that the coldest strong liquor meets the coil at the top where the weak liquor has least heat to give out, and the weak liquor can therefore become much colder, and the hottest weak liquor in the coil at the bottom of the equalizer is able to impart more heat to the cool strong liquor, which has been partly warmed by passing downward in contact with the coil. The ammonia-gas is driven out of the liquor by the heat of the coil in the retort, and the said retort is further provided with an air-valve G at the top, the use of which will be more fully described hereinafter.

H is an inclined pipe provided with a stop-valve *h*, through which the ammonia-gas leaves the retort and passes into the coil *i* of the liquefier I. The top of coil *i* is placed above the connection of pipe H to the retort, so that the said pipe ascends from the retort to the coil *i*. A condenser or water-jacket T is formed about the ascending pipe H, and is supplied constantly with water by means of suitable circulating-pipes. The pipe H may pass straight through the condenser T, as shown, or if the retort and liquefier are placed very near together the inclined pipe H may be coiled within the water-jacket. The object of the water-jacket T is to condense the aqueous vapor which passes off from the retort with the ammonia-gas without condensing any of the gas, which liquefies at 91°, a temperature much lower than that at which the aqueous vapor becomes liquid. The water runs down the inclined pipe H back into the retort as fast as it condenses, and the ammonia-gas passes onward into the coil *i* of the liquefier I. The liquefier is constantly supplied with cold water, which surrounds the coil and liquefies the gas within it. The liquid anhydrous ammonia passes out of the coil *i* through the delivery-pipe J, which is provided with a regulating-valve *j*.

K is a receiver for the anhydrous ammonia intermediate between the valve *j* and the liquefier. This receiver is a plain hollow vessel in which a supply of anhydrous ammonia accumulates, so that the pipe J will deliver a

regular supply even if the ammonia should not liquefy in uniform quantities.

L is the brine-tank, provided with the coil *l*, to the lower end of which the pipe J is connected. The anhydrous ammonia is expanded into gas within the coil *l*, thereby cooling the brine below the freezing-point of pure water. The brine is removed from the brine-tank by a small pump, (not shown in the drawings,) and is used in refrigerating-chambers to form ice or freeze any objects placed within them in the ordinary manner of using such chambers.

Any air which may get into the ammonia-spaces of the machine is found to be very detrimental to its working, more especially when it accumulates in the coils of the liquefier. To remove air, the highest point of pipe H has an air-cock U, and a pipe *u* is connected to the said cock, and is bent round and carried below the surface of the water in the liquefying-tank. The air is got rid of by closing valves *h* and *j* and allowing the pressure of the gas in the coil *i* to blow the air through the air cock and pipe into the water. Any ammonia-gas which blows through with the air will be absorbed by the water, so that there will be no unpleasant smell produced, and the complete discharge of the air will be indicated by the absence of air-bubbles rising to the surface of the water in the tank.

To increase the utility of this device, an air-reservoir V is provided in the pipe *u*, and an additional air-cock *v* is provided between the said reservoir and the open end of the pipe. The cock U is first opened or left partly open, so that the air will accumulate at the pressure of the gas in the coil within the reservoir. The cock U is then closed and the cock *v* opened, thereby allowing the air to expand out of the reservoir and pass down the air-pipe into the water in the liquefying-tank, and the same process is repeated as often as may be found desirable.

M is a pipe which connects the upper end of the brine-tank coil with the top of the absorber N.

The aforesaid cooling-tank F is constantly supplied with cold water to cool the weak liquor in the coil *f*, and the said coil is also connected with the upper part of the absorber by means of the pipe O, provided with the regulating-valve *o*. The absorber is provided with a series of internal trays or shallow vessels, in which the cold spent gas is brought into contact with the cold weak liquor from pipe O. The detailed construction of this absorber is not shown in the drawings, as the same is fully shown and described in a separate application, Serial No. 241,202, filed June 13, 1887.

P is the pipe through which the strong aqua-ammonia leaves the absorber. This pipe is provided with a stop-valve *p*, and is connected to the upper end of the coil *q* in the subsidiary cooling-tank Q.

R is the suction-pipe of the pump A. This pipe is connected to the lower end of the coil *q*, and the cold strong liquor is pumped through the equalizer into the retort, as hereinbefore described.

The subsidiary cooling-tank is constantly supplied with cold water by suitable pipes. The use of this tank is to still further cool the aqua-ammonia after it leaves the absorber, and thereby qualify it to take up an additional volume of gas when required. This volume of gas is obtained from the gas-space of the absorber through the pipe S, which is provided with the regulating-valve *s*. The cold ammonia-gas inside the absorber is ordinarily at a pressure of about two atmospheres. When this pressure increases, the valve S is opened and some of the gas allowed to escape through the pipes S and P into the coil *q* of the subsidiary cooling-tank, in which coil it is absorbed by the aqua-ammonia.

Before the machine can be put into operation it has to be tested to see that all the pipe-coils and joints are perfectly tight and allow no escape of ammonia-gas. This has been ordinarily done by steam; but air-pressure is preferable, as its escape from submerged coils and joints is more readily detected.

The novel method of testing the machine consists in opening the stop-valves *d* and *h*, by which, when closed, the retort is wholly cut off from the rest of the machine. The pump A, or the brine-pump, if desired, is then connected to the stop-valve *e*, the said valve *e* is opened, the stop-valve *a'* is closed, and water is pumped into the retort. This causes the air to be compressed, and, the air-valve G being closed, the air is driven through the stop-valves *d* and *h* into the various chambers of the machine, which have been placed in free communication before starting the pump by opening the stop-valves in their respective communicating pipes. When the retort is nearly full of water, the valves *d* and *h* are closed tightly, the pump is stopped, the air-valve G is opened, and the water is allowed to run out of the retort. The air-valve is then closed, the pump started, and the valves *d* and *h* opened, so that the retort is again pumped nearly full of water, and more air compressed into the machine. This process is repeated until a sufficient air-pressure is attained and the machine has been thoroughly tested.

In charging the machine with ammonia it is necessary to first take out the air, in order that the ammonia may go through its cycle of changes properly, and the nearer the interior of the machine can be brought to a vacuum the better the machine will work. The method of obtaining this vacuum is the reverse from that of testing. The valves *a'*, *d*, and *h* are first closed, the air-valve is opened, and the retort is filled with water. The air-valve is then closed and the water pumped out of the retort. The valves *d* and *h* are then reopened, and the air imprisoned in the rest of the machine allowed to flow freely into the retort. The valves *d* and *h*

are then closed and the air-valve is opened. The before-described operation of pumping out air from the retort is then repeated until the requisite vacuum is obtained for charging the machine with ammonia.

The usual method of charging the machine prior to this invention was to fill it with steam, which was then allowed to cool. The vacuum produced in this way was, however, too low, and was not reliable. Separate portable air and vacuum pumps were found too slow to be used advantageously, and they also formed an expensive addition to the machine.

What we claim is—

1. The combination, with an ice-machine comprising a series of chambers, substantially as set forth, of an ammonia-gas-generating retort, and pipes connecting the upper part of the retort with said chambers and provided with stop-valves, whereby the retort may be repeatedly cut off from and connected with the said chambers, a supplemental stop-valve and pipe connection secured to the bottom of the retort, whereby liquid may be repeatedly forced into or out of it, and a second supplemental hand-actuated stop-valve secured to the top of said retort, whereby air may be repeatedly let into or out of it for testing the said chambers of the machine by compressed air and charging them with ammonia, by the methods substantially as hereinbefore described.

2. In an ice-machine, the combination, with a liquefier provided with an ammonia-gas-inlet pipe, of an air-escape pipe connected to the highest point of said inlet-pipe at one end, and having its other end carried below the surface of the water in the liquefier, two hand-operated stop-cocks for regulating the passage of the air through the said escape-pipe, and a reservoir for air of large size and capacity secured to said pipe intermediate between the two said stop-cocks, substantially as and for the purpose set forth.

3. In an ice-machine, the combination of an absorber in which the spent ammonia-gas from the brine-tank coil is taken up by the cold weak liquor, a supplementary cooling-tank for further cooling the strong aqua-ammonia after it leaves the absorber, and a pipe provided with a regulating-valve connecting the gas-space of the absorber with the discharge-pipe therefrom and with the said supplementary cooling-tank, so that an additional volume of gas may be absorbed by the strong aqua-ammonia.

4. In an ice-machine, the combination of a retort for generating ammonia-gas, a liquefier for converting the gas into anhydrous ammonia, a brine-tank provided with a coil into which the anhydrous ammonia may expand, a cooling-tank provided with a coil for cooling the weak liquor from the retort, an absorber into which the spent ammonia-gas from the brine-tank coil is taken up by the cold weak liquor from the cooling-tank coil, a supplementary cooling-tank for further cooling the strong aqua-ammonia after it leaves the absorber, a pipe provided with a regulating-valve connecting the gas-space of the absorber with the discharge-pipe therefrom and with the said supplementary cooling-tank, and a pump for forcing the strong aqua-ammonia back into the retort.

5. In an ice-machine, the combination of a retort for generating ammonia-gas, a liquefier for converting the gas into anhydrous ammonia, a brine-tank provided with a coil into which the anhydrous ammonia may expand, a cooling-tank provided with a coil for cooling the weak liquor from the retort, an absorber in which the spent ammonia-gas from the brine-tank coil is taken up by the cool weak liquor from the cooling-tank coil, a supplementary cooling-tank for further cooling the strong aqua-ammonia after it leaves the absorber, a pipe provided with a regulating-valve connecting the gas-space of the absorber with the discharge-pipe therefrom and with the said supplementary cooling-tank, a pump for forcing the strong aqua-ammonia back into the retort, and an equalizer interposed between the pump and the retort and between the retort and the cooling-tank, so that the temperatures of the strong liquor and the weak liquor may be modified by each other, substantially as and for the purpose set forth.

6. In an ice-machine, the combination of a retort for generating ammonia-gas, a liquefier for converting the gas into anhydrous ammonia, a condenser placed intermediate between the retort and the liquefier for separating the aqueous vapor from the gas, a receiver for storing up a supply of the anhydrous ammonia formed in the liquefier, a brine-tank provided with a coil into which the anhydrous ammonia may expand, a cooling-tank provided with a coil for cooling the weak liquor from the retort, an absorber in which the spent ammonia-gas from the brine-tank coil is taken up by the cold weak liquor from the cooling-tank coil, a supplementary cooling-tank for further cooling the strong aqua-ammonia after it leaves the absorber, a pipe provided with a regulating-valve connecting the gas-space of the absorber with the discharge-pipe therefrom and with the said supplementary cooling-tank, and a pump for forcing the strong aqua-ammonia back into the retort.

In testimony whereof we affix our signatures in presence of two witnesses.

W. T. HILDRUP, JR.
THOMAS H. BUTLER.

Witnesses:
JAMES I. CHAMBERLIN,
R. S. CARE.