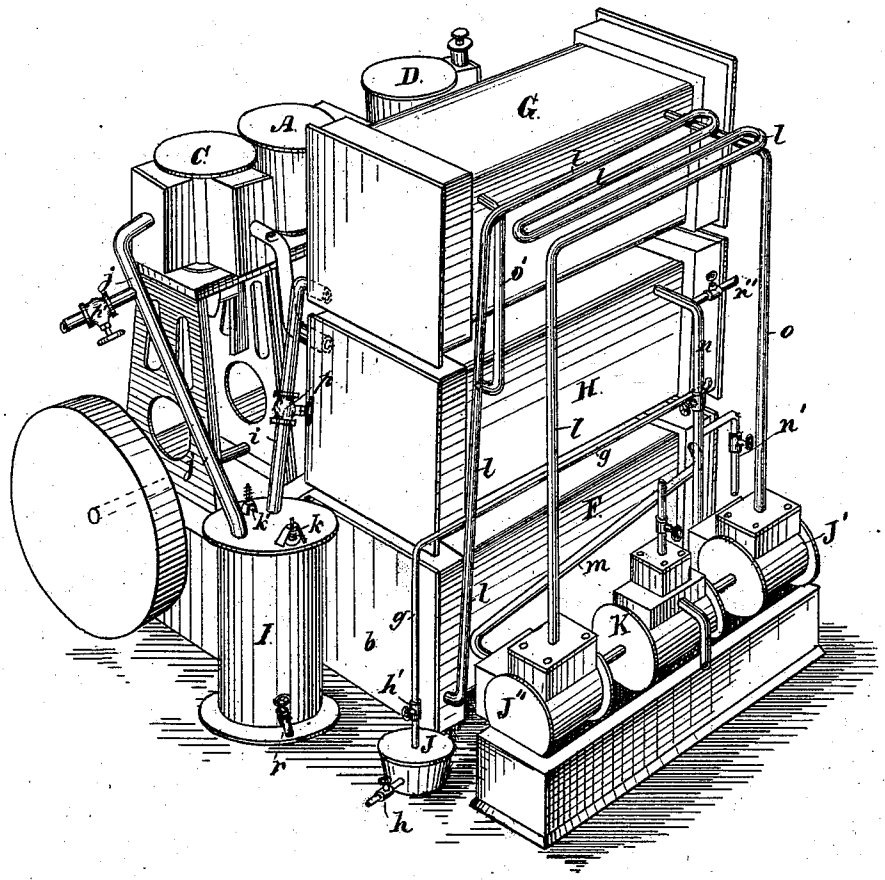
2 Sheets—Sheet 1.

W. A. LIGHTHALL.

Refrigerating Apparatus.

No. 224,785. **Patented Feb. 24, 1880.**

Fig. 1.



Witnesses:

Henry Eichling.

B. E. Clark

Inventor

Wm. A. Lighthall

By J. P. Tilt

his atty

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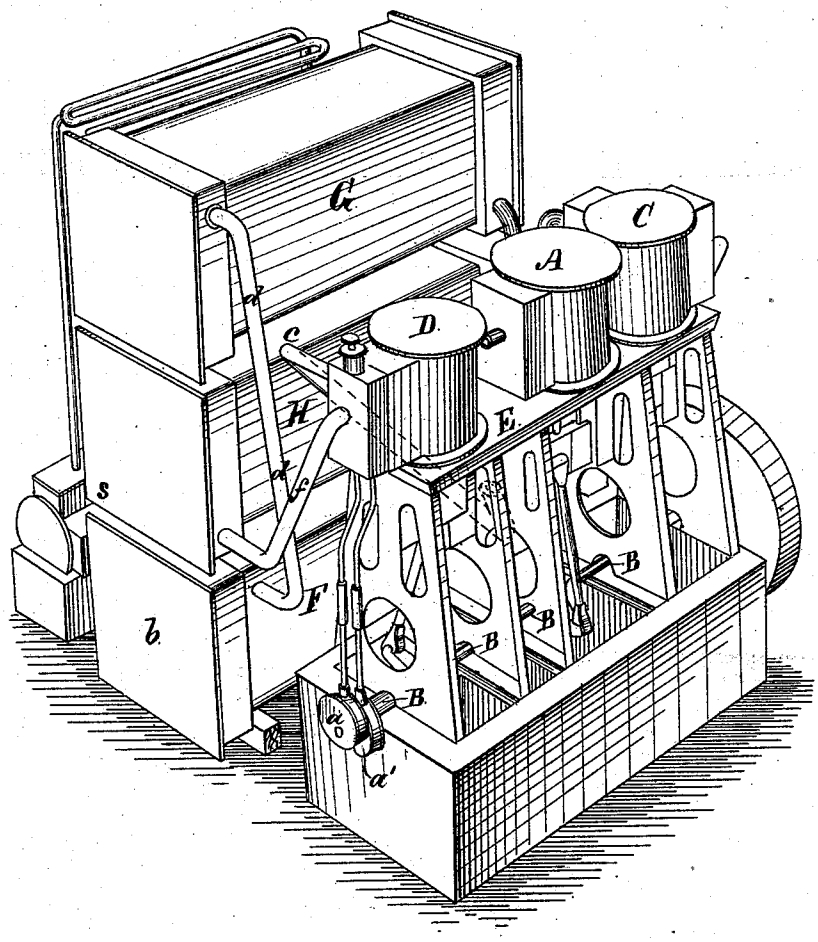
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Refrigerating Apparatus.

No. 224,785. Patented Feb. 24, 1880.

Fig. 2.



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UNITED STATES PATENT OFFICE.

WILLIAM A. LIGHTHALL, OF BROOKLYN, ASSIGNOR TO HIMSELF, WILLIAM H. JEWELL, EDWD. G. FURBER, AND CHARLES M. HASTINGS, OF NEW YORK, N. Y.

REFRIGERATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 224,785, dated February 24, 1880.

Application filed July 26, 1879.

To all whom it may concern:

Be it known that I, WILLIAM A. LIGHTHALL, of Brooklyn, Kings county, State of New York, have invented a new and useful Improvement in Pneumatic Refrigerating Apparatus, of which the following is a specification, reference being had to the accompanying drawings, forming part of the same.

Figure 1 is a perspective view of my apparatus, showing one side and end of the same; and Fig. 2 is a similar view, showing the opposite side and end of the said apparatus.

My invention relates to mechanism whereby cold is produced by the expansion of compressed air.

The mechanism to which my invention is applied consists, ordinarily, of an air-compressing pump, C, driven by a steam-engine, A, or other motor; a cooling-receptacle, H, to receive the compressed air from the pump C; an air-expanding cylinder and piston, D, in which the compressed air conducted from H is permitted to expand against resistance, thereby parting with its heat and becoming chilled; a refrigerator, F, into which the cold expanded air is conducted from D, and in which the said cold air is utilized in the production of frigorific effects; a cooling-receptacle, G, into which the air is conducted from the refrigerator F, where, still having a low temperature, it is employed to chill the water that is used to cool the heated compressed air in H, and from which the air is conducted back to the compressing-pump C, the air in the apparatus being used over and over again, instead of being discharged after producing its frigorific effects by expansion, and a new supply taken in by the compressing-pump from the external atmosphere.

The several receptacles F, G, and H may be of substantially similar construction, and consist of a case in which is arranged a series of tubes, the air passing through the tubes, and the fluid to act upon the air or be acted upon by it circulating around the tubes. Suitable pipe-connections are provided for conducting the air to the several parts, as shown in the drawings. A suitable apparatus is also provided for circulating both the water used for cooling the air heated by compression and the fluid that is cooled by expanded cold air. This apparatus is shown in Fig. 1 of the drawings, in which K is a common steam-cylinder and piston.

J′ and J″ are two force-pumps, J′ being designed to circulate through H and G the water for cooling the compressed air, and J″ to circulate the non-congealable fluid that has been chilled in F.

A more particular description of the above-named apparatus is deemed unnecessary, as I do not claim it.

I will now proceed to describe parts of the machine which are of my invention.

It is important that a very uniform degree of compression of the air or air-pressure should be maintained in the apparatus, in order that the consumption of power and the consequent rate of refrigeration should be uniform. The air being used over and over again, if there is absolutely no loss of air by loose joints or otherwise, there will necessarily be this uniformity after the apparatus is once properly charged; but loss of air will, practically, always take place to a greater or less extent. In order to supply this loss, I have provided an automatic equalizing apparatus consisting of the valve-chamber I, which may be a small hollow cylinder strong enough to bear the air-pressure in the apparatus. To this cylinder the expanded air is conducted, by a pipe, *i*, from the receptacle in which the air is expanded, and from it the air is conducted, by the pipe *j*, to the compressor C, so that the air, on its way from the refrigerator back to the compressor, passes through this cylinder. The cylinder is provided with two valves, *k* and *k′*, one opening in and the other out, which are controlled by springs. These springs are so adjusted that when the air-pressure in the cylinder rises above a certain degree the valve *k* will open and permit escape of air until the pressure falls below the tension of the spring; and if the pressure in the cylinder falls below the ordinary pressure of the external atmosphere to a certain degree, valve *k′* will open and permit the admission of air. The valves thus act automatically to regulate the amount of air

which is being subjected to alternate compression and expansion in the apparatus, and the consequent degree of air-pressure which may be desired.

The moisture contained in the air, as it is introduced into the apparatus from the external atmosphere, has to be removed as it condenses; otherwise it is liable, by freezing, to interfere with the action of the compressing-pump and the expander. I provide an apparatus whereby, as this moisture condenses in the receptacle H by contact with the surfaces of the pipes therein, that are chilled by the cold water flowing around them through that receptacle, it may be drawn off and discharged without the escape of air. As it condenses, the water, of course, finds its way down to the bottom of the receptacle H. To be able to draw off this water without allowing the escape of air, I provide a closed receptacle, J, which must have the requisite strength to resist the air-pressure in the apparatus. A pipe, *g*, leads from the bottom of H to J, which pipe is provided with a stop-cock, *h'*. The receptacle J has an escape-pipe, which is also provided with a stop-cock, *h*. When *h'* is open and *h* closed, the water, as fast as it is formed by condensation, will run down from H through *g* into J; then, by closing or nearly closing *h'* and opening *h*, the water may be discharged from J without the escape of air, care being taken to close one or both of the cocks just before or at the instant the water is all discharged.

The general operation of this description of compressed-air refrigerator, being well-known, need not be particularly described, and the operation of the above-described air-regulator and device for drawing off the water of condensation is obvious from the description given.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination, in a pneumatic refrigerating apparatus, of the valve-chamber I, provided with the valves *k* and *k'*, with the compressor C and receptacle for the expanded air, as and for the purpose described.

2. The combination, in a pneumatic refrigerating apparatus, of the receptacle J, provided with a discharge-pipe having a stop-cock, *h*, with the receptacle H, being connected therewith by the pipe *g*, provided with a stop-cock, *h'*, all constructed and operating as and for the purpose described.

Subscribed by me this 24th day of July, 1879.

WM. A. LIGHTHALL.

Witnesses:

M. F. CLIFTON,

B. S. CLARK.