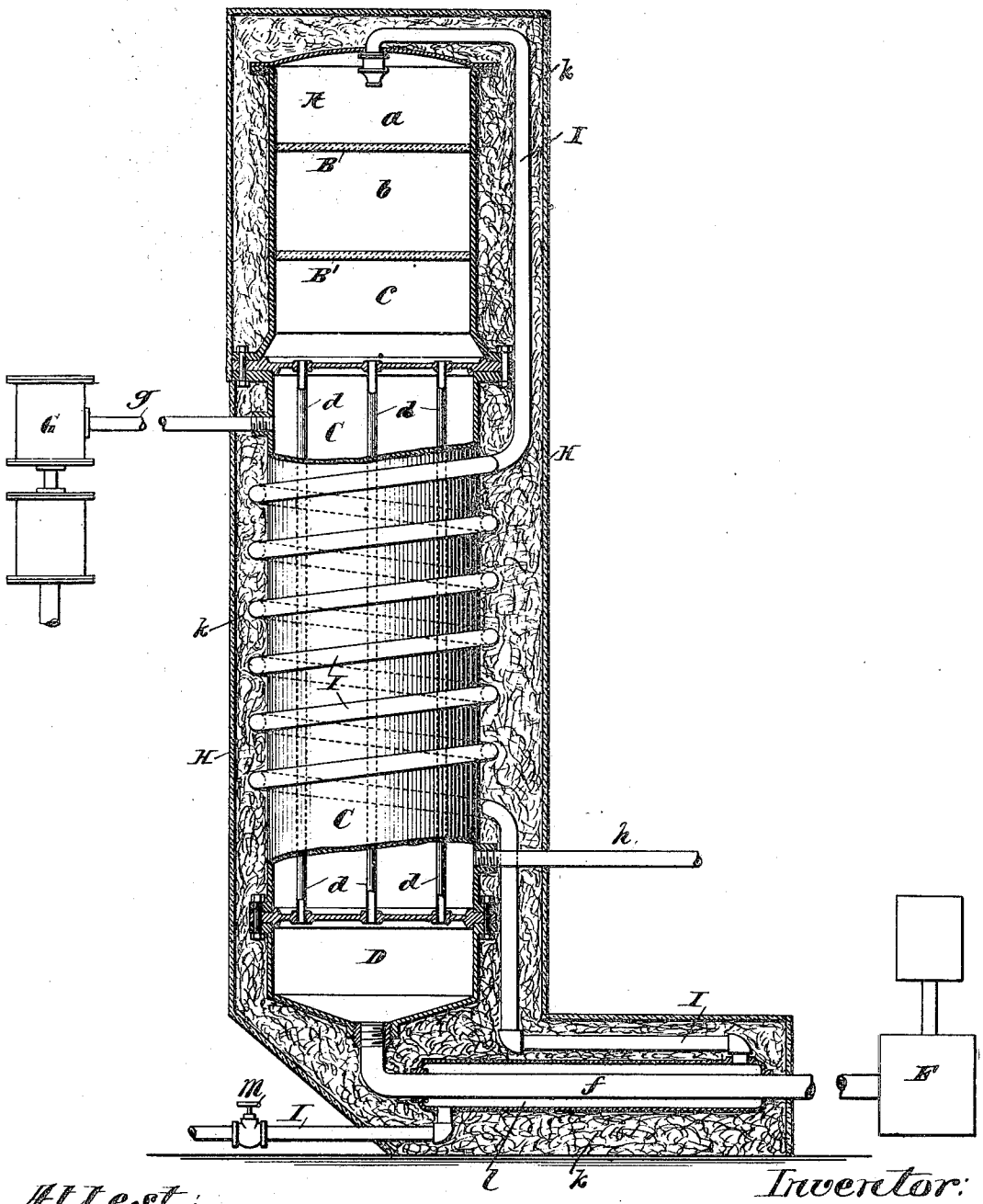
(No Model.)

O. KUPHAL.

COOLING AND REFRIGERATING APPARATUS.

No. 537,535. Patented Apr. 16, 1895.



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UNITED STATES PATENT OFFICE.

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COOLING AND REFRIGERATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 537,535, dated April 16, 1895.

Application filed March 29, 1894. Serial No. 505,538. (No model.)

To all whom it may concern:

Be it known that I, OTTO KUPHAL, a citizen of the United States, residing at New York, county of New York, and State of New York, have invented certain new and useful Improvements in Cooling and Refrigerating Apparatus, fully described and represented in the following specification and the accompanying drawing, forming a part of the same.

The present invention is applicable to apparatus for the production of cold air and ice and generally for cooling and refrigerating purposes, including the cooling of liquid and of inclosures of all sizes, such as houses, vaults, vessels, provision safes, &c.

The principle upon which apparatus embodying the invention operates is that of cooling by the expansion of water into water vapor, and this principle is carried out by atomizing water by passing it through material of the requisite porosity to secure the passage of the water in a finely divided state, and evaporating the water thus atomized from the outer surface of the porous material into a vaccum expansion space, the vapor thus produced being applied to the cooling space or material to be refrigerated, preferably by being drawn through pipes which traverse the chamber containing the air, liquid or other material to be cooled, which chamber may be the ice chamber of an ice machine, or a refrigerating chamber of any kind, or a chamber through which air is forced or in which the cooled air is held under pressure sufficient to secure its transfer to the point where it is to be used.

In another application, Serial No. 467,168, filed March 22, 1893, I have described and claimed broadly such apparatus, and the present invention consists of improvements thereon, being more especially applicable to apparatus of the general construction shown and described in said application.

For a full understanding of the invention a detailed description of an apparatus embodying the same in the preferred form as applied to cooling air forced through or compressed within the cooling chamber will now be given, reference being had to the accompanying drawing forming a part of this specification, and the features forming the invention then specifically pointed out in the claims.

The drawing shows the apparatus with the cooling chamber in elevation, but partially broken away, and the other parts of the apparatus in central vertical section.

At the top of the apparatus is a water tight tank A divided into three air tight chambers *a*, *b*, *c* by slabs of porous material B, B′. The upper chamber *a* is the water chamber, into which the water to be evaporated is introduced. From the lower chamber *c* a number of vertical pipes, which may be widely spaced, as shown, or set quite closely together according to the degree of cooling required, pass downward through the cooling chamber C to another tank D which is also air tight, and from which a pipe *f* leads to a vacuum pump F indicated in diagram, and which may be of any suitable construction. It will be seen that the lower chamber *c* of the tank A, the pipes *d* and the tank D form a vacuum expansion chamber, the vapor in which is applied to cooling the chamber C, through which the pipes extend.

As shown, the tanks A D and the central tank forming the cooling chamber C, are made separate and secured together at the ends by flanges and bolts, but it will be understood that this is simply a matter of convenience in construction, and that any other suitable process of manufacture may be used. As above stated, the cooling chamber C may be used in any suitable manner, but the apparatus shown is designed especially for cooling air, and an air compressor or pump G is shown as used to force the air into the top of the cooling chamber C through the pipe *g*, the cooled air passing out at the bottom of the chamber through the pipe *h*, either continuously or being compressed within the chamber C by closing the pipe *h*, and passing outward when the pipe is opened to withdraw the air for use.

The slabs B, B′ by which the tank A is divided into three chambers may be of any suitable material of such porosity as to secure the desired effect, and for certain purposes it may be found that only one slab need be used while for others more than two slabs may be desirable. The pipes *d*, *f* are shown as straight pipes of the same diameter throughout, but it will be understood that they may be of any other form suitable for the purpose.

The construction thus far described is or may be substantially the same as shown in

the application above referred to except that the water chamber *a* is made air tight, and this with the other features embodying the present invention will now be described.

To aid the cooling or refrigerating process the entire construction, exclusive of the pumps F, G, is inclosed within a casing H and the space about the apparatus within the casing is filled with suitable non-heat-conducting material *k*. It is desirable that the water entering the water chamber *a* should be cooled as far as practicable, and it is preferable to cool this water supply within the apparatus. This result is secured by entering the water supply pipe I at the base of the apparatus, passing it through a jacket *l* about the pipe *f*, so as to utilize the low temperature therein, and then passing it upward through the packing *k* within the casing H to the water chamber *a*, this water pipe preferably being coiled about the cooling chamber C so as to lengthen the course of the water and lower its temperature as far as possible.

The closing of the water chamber *a* air tight forms an important part of the invention, this feature aiding materially in securing a low temperature, and by cooling the water before introduction a further considerable economy is secured. By the use of a substantially air tight water chamber, moreover, I am enabled to secure an automatic regulation of the water supply, and further to use an apparatus without a pump and with any source of water supply, no head being required, the water being forced in by atmospheric pressure, as a vacuum is formed in the water chamber by the pump F, so that the water supply is dependent upon the vacuum in the air chamber, and, by the use of a pipe of suitable size or suitably throttled, a perfect regulation can be secured. I have shown a throttle valve *m* on the water pipe for controlling the inlet. It will be understood that some or all of the water may be vaporized in entering the chamber *a* from the pipe I, this depending upon the degree of vacuum in the air chamber, but this does not interfere with the operation of the apparatus, nor does any freezing of the water in the water chamber thus interfere. While this air tight water chamber is of especial value as securing automatic regulation when the water supply is dependent upon the vacuum, it will be understood that this air tight water chamber may be used with water fed independently of the vacuum, as by a pump, or under sufficient head, and such a chamber forms a part of the invention independently of the character of the water supply.

The operation will be understood from a brief description.

Assuming that the machine is to be started without water in the water chamber *a*, and with the water pipe I connected to a tank or other similar source of supply, the vacuum pump F being started, a vacuum is produced in the apparatus including the water chamber *a*, and upon the production of a sufficient vacuum, the water is forced in by atmospheric pressure through the pipe I. This water passes through the slabs B, B′, being thus atomized, and is rapidly evaporated from the bottom of the slab B′ into the vacuum produced by the air pump in the chamber C and expands to a very large volume relatively to the volume of the water. This vapor then passes through the pipes *d* into the tank D, and is drawn out and expelled by pump F. The heat within the pipes *d* and the chamber C is absorbed by this vapor, and the air or other material in the chamber C thus cooled to a very low degree of temperature. The water enters the chamber *a* at a low temperature due to the cooling of the water in the supply pipe F as it passes through the jacket *l*, and upward through the packing *k*, thus increasing largely the economy of the apparatus, and this economy is further increased by the packing of the apparatus within the casing H.

It will be understood that the invention may be embodied in constructions of widely different form, depending to some extent upon the results to be attained, and, while the construction shown forms a very convenient and efficient apparatus, I am not to be limited to it.

What I claim is—

1. The combination with a vacuum chamber arranged for the application of vapor therein to cooling a space or body, of an air tight water chamber separated from said vacuum chamber by porous material, substantially as described.

2. The combination with a vacuum chamber arranged for the application of vapor therein to cooling a space or body, of an air tight water chamber separated from said vacuum chamber by porous material, and a water supply controlled by the pressure in the water chamber, substantially as described.

3. The combination with a vacuum chamber arranged for the application of vapor therein to cooling a space or body, of an air tight water chamber separated from said vacuum chamber by porous material, and a water supply below said water chamber and under pressure sufficient to raise the water into the water chamber only against a pressure below atmospheric pressure therein, substantially as described.

4. The combination with a vacuum chamber arranged for the application of vapor therein to cooling a space or body, of an air tight water chamber separated from said vacuum chamber by porous material, and a water supply pipe arranged to secure the cooling of the water in the apparatus before reaching the water chamber, substantially as described.

5. The combination with a vacuum chamber arranged for the application of vapor therein to cooling a space or body, of an air tight water chamber separated from said vacuum chamber by a plurality of separated layers of porous material, substantially as described.

6. The combination with a vacuum chamber

arranged for the application of vapor therein to cooling a space or body, of an air tight water chamber separated from said vacuum chamber by porous material, and a pump connecting with said vacuum chamber, substantially as described.

7. The combination with a vacuum chamber arranged for the application of vapor therein to cooling a space or body, of an air tight water chamber separated from said vacuum chamber by porous material, and non conducting packing inclosing said chambers, substantially as described.

8. The combination with a vacuum chamber arranged for the application of vapor therein to cooling a space or body, of an air tight water chamber separated from said vacuum chamber by porous material, a pump, a pipe connecting the vacuum chamber and pump, and a casing and non-conducting packing inclosing said vacuum chamber, water chamber and pipe, substantially as described.

9. The combination with a vacuum chamber arranged for the application of vapor therein to cooling a space or body, of a water chamber separated from said vacuum chamber by porous material, a casing surrounding said vacuum chamber and water chamber, a non-conducting packing inclosing said chambers, and a water supply pipe passing through said packing to the water chamber from the opposite side of the apparatus, substantially as described.

10. The combination with a vacuum chamber arranged for the application of vapor therein to cooling a space or body, of a water chamber separated from said vacuum chamber by porous material, a casing surrounding said vacuum chamber and water chamber, a pump, a pipe connecting said vacuum chamber and pump, a jacket on said pipe, a non-conducting packing inclosing said chambers, and a water supply pipe passing through said jacket and packing to the water chamber, substantially as described.

11. The combination with the chamber C, of tanks A, D, porous material dividing the tank A into air tight chambers, pipes *d* connecting the inner chamber with tank D, pump F and pipe *f* connecting tank D therewith, water supply pipe I passing through the apparatus to the outer or water chamber of tank A, casing H, and non-conducting packing *k* within said casing about the tanks and pipe I, substantially as described.

12. The combination with the chamber C, of tanks A, D, porous material dividing the tank A into chambers, pipes *d* connecting the inner chamber with tank D, pump F and pipe *f* connecting tank D therewith, jacket *l* on said pipe, water supply pipe I passing through said jacket and through the apparatus to the outer or water chamber of tank A, casing H, and non-conducting packing *k* within said casing about the tanks, jacket *l* and pipe I, substantially as described.

13. The combination with the chamber C, of tanks A, D, porous material dividing the tank A into chambers, pipes *d* connecting the inner chamber with tank D, pump F and pipe *f* connecting tank D therewith, jacket *l* on said pipe, water pipe I passing through said jacket to the outer or water chamber of tank A and coiled about the chamber C, casing H, and non-conducting packing *k* within said casing about the tanks, jacket *l* and pipe I, substantially as described.

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

OTTO KUPHAL.

Witnesses:
T. F. KEHOE,
C. J. SAWYER.