No. 651,963 Patented June 19, 1900.

E. R. BUTLER.

PROCESS OF MANUFACTURING ICE.

(Application filed Jan. 4, 1898.)

(No Model.) 5 Sheets—Sheet 1.

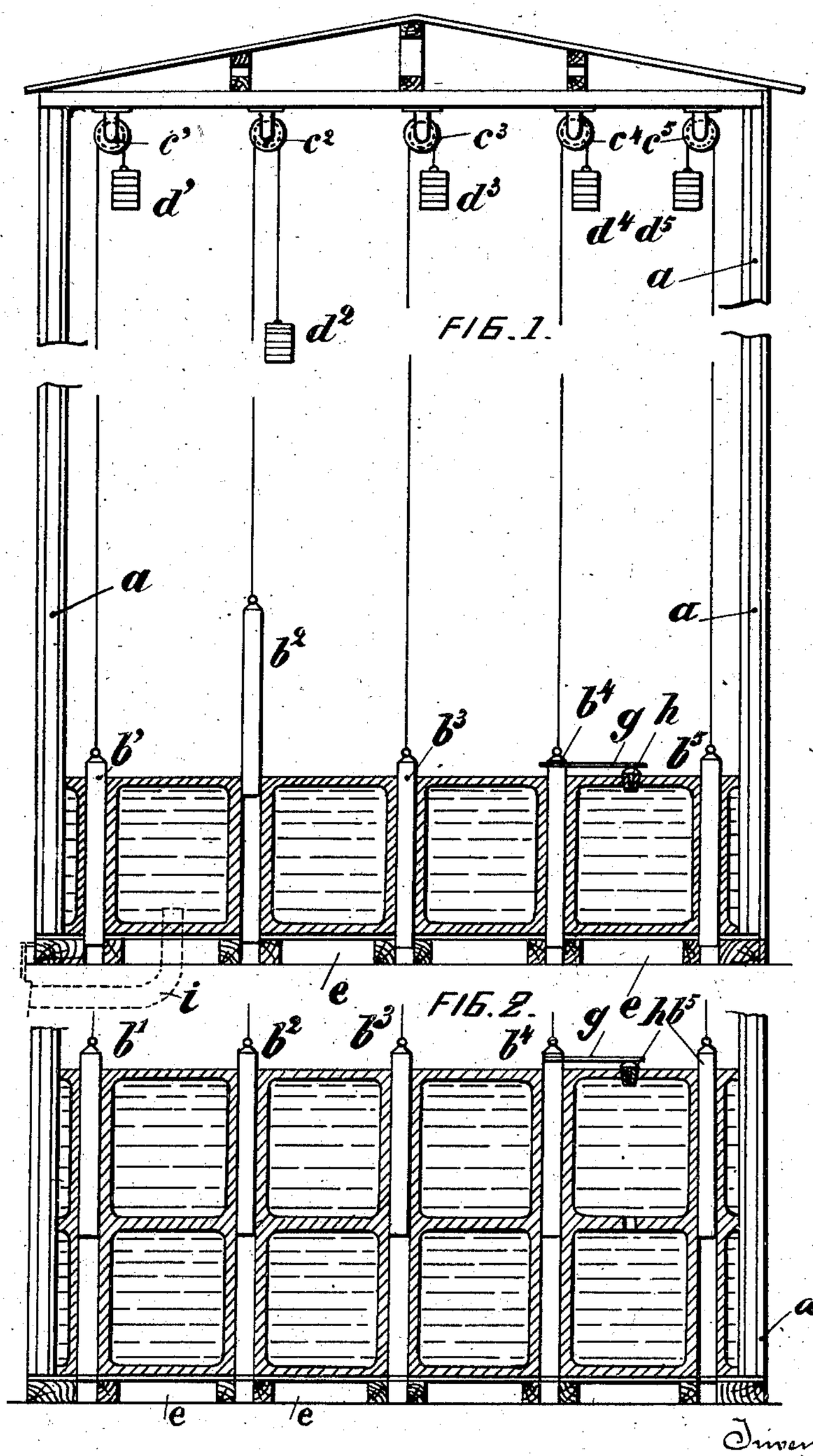


FIG. 1.

FIG. 2.

Witnesses
R. Aberli
Fred. Ellmore

Inventor
Edward Richè Butler
by Brosend Knauth
his Attorneys

No. 651,963. Patented June 19, 1900.

E. R. BUTLER.

PROCESS OF MANUFACTURING ICE.

(Application filed Jan. 4, 1898.)

(No Model.) 5 Sheets—Sheet 2.

FIG. 3.

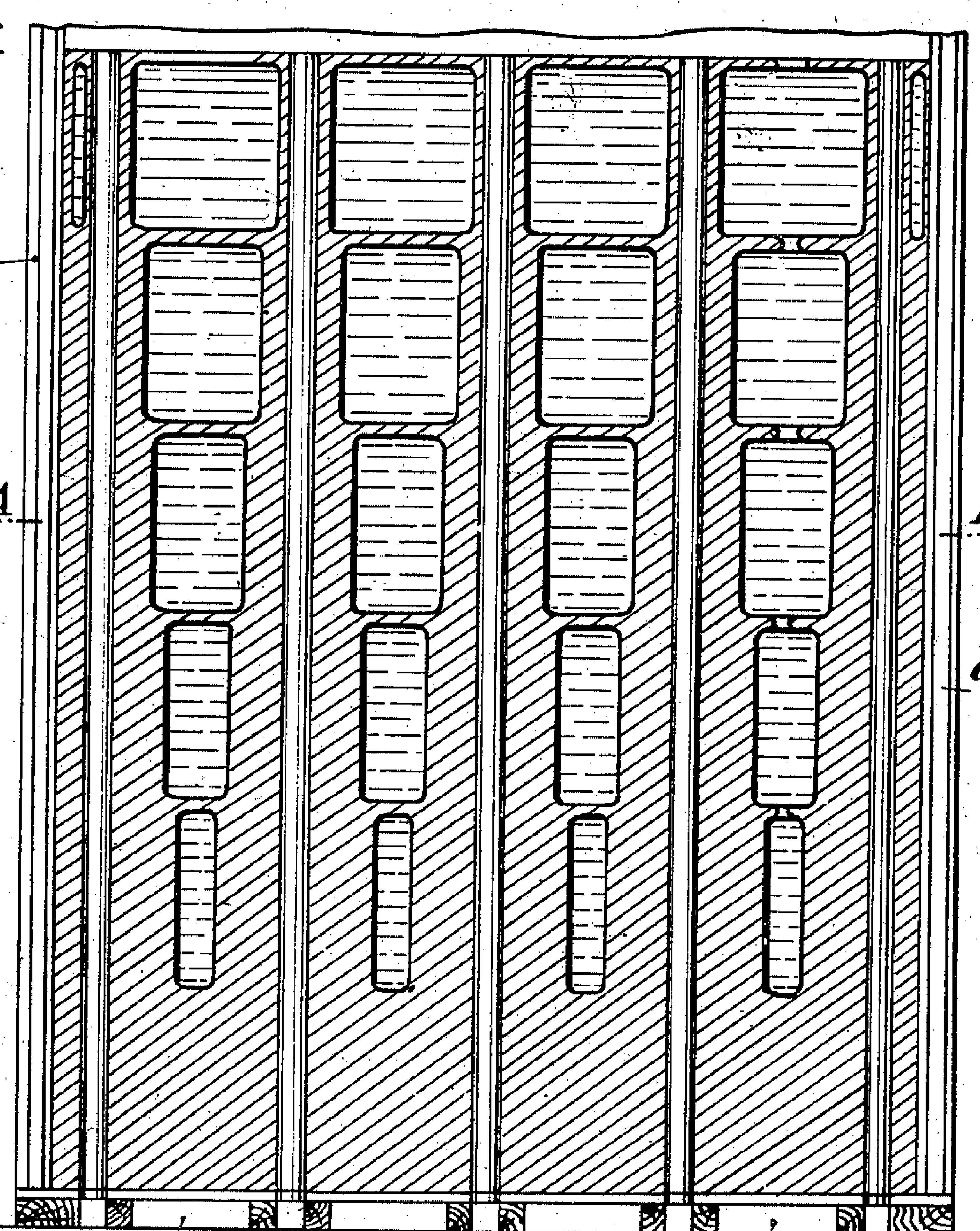
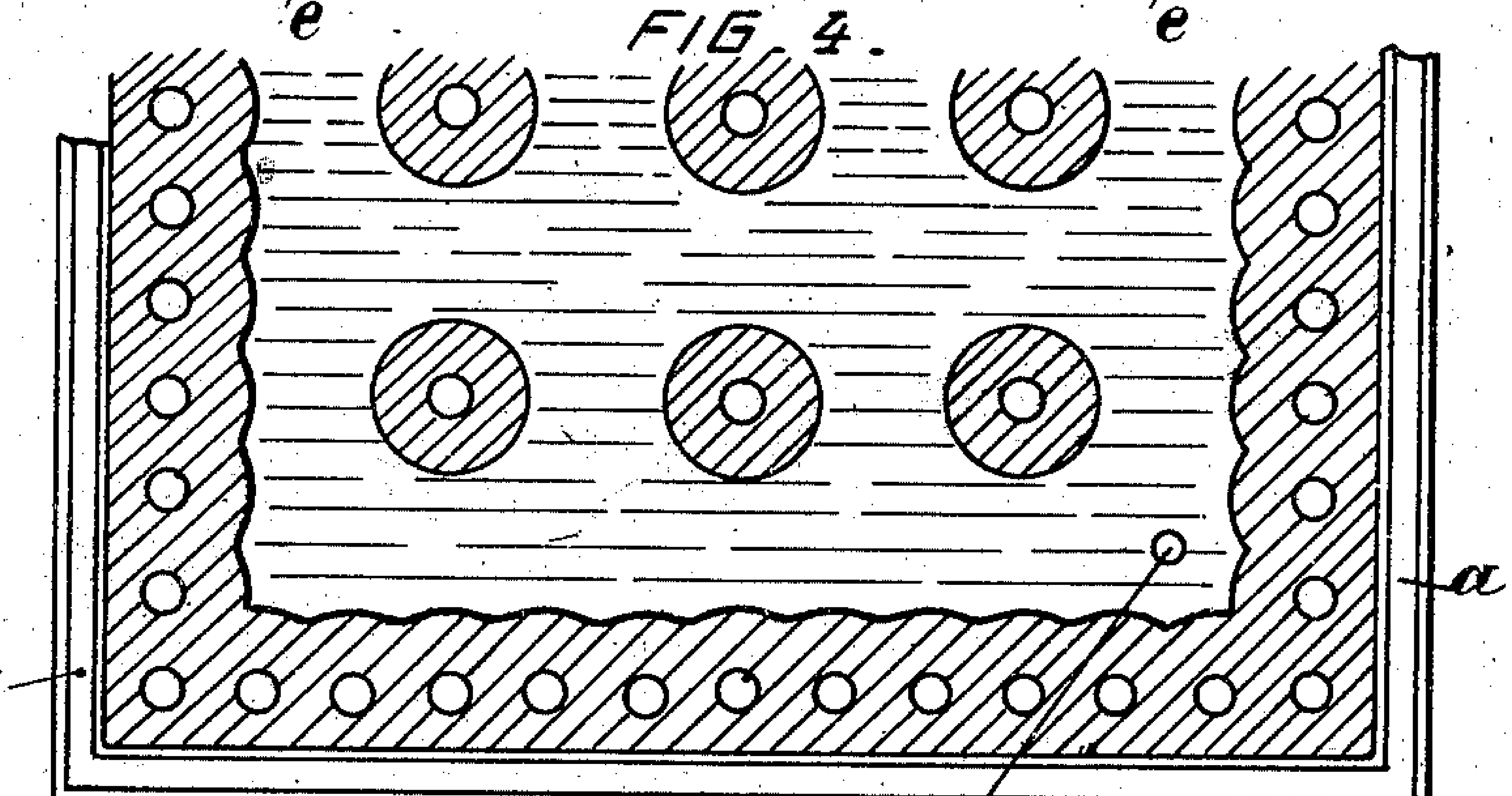


FIG. 4.



Witnesses
R. Aberli
B. C. Morse.

Inventor
Edward Richè Butler
By Messrs. Knauth,
his Attorneys

No. 651,963. Patented June 19, 1900.

E. R. BUTLER.

PROCESS OF MANUFACTURING ICE.

(Application filed Jan. 4, 1898.)

(No Model.) 5 Sheets—Sheet 3.

FIG. 5.

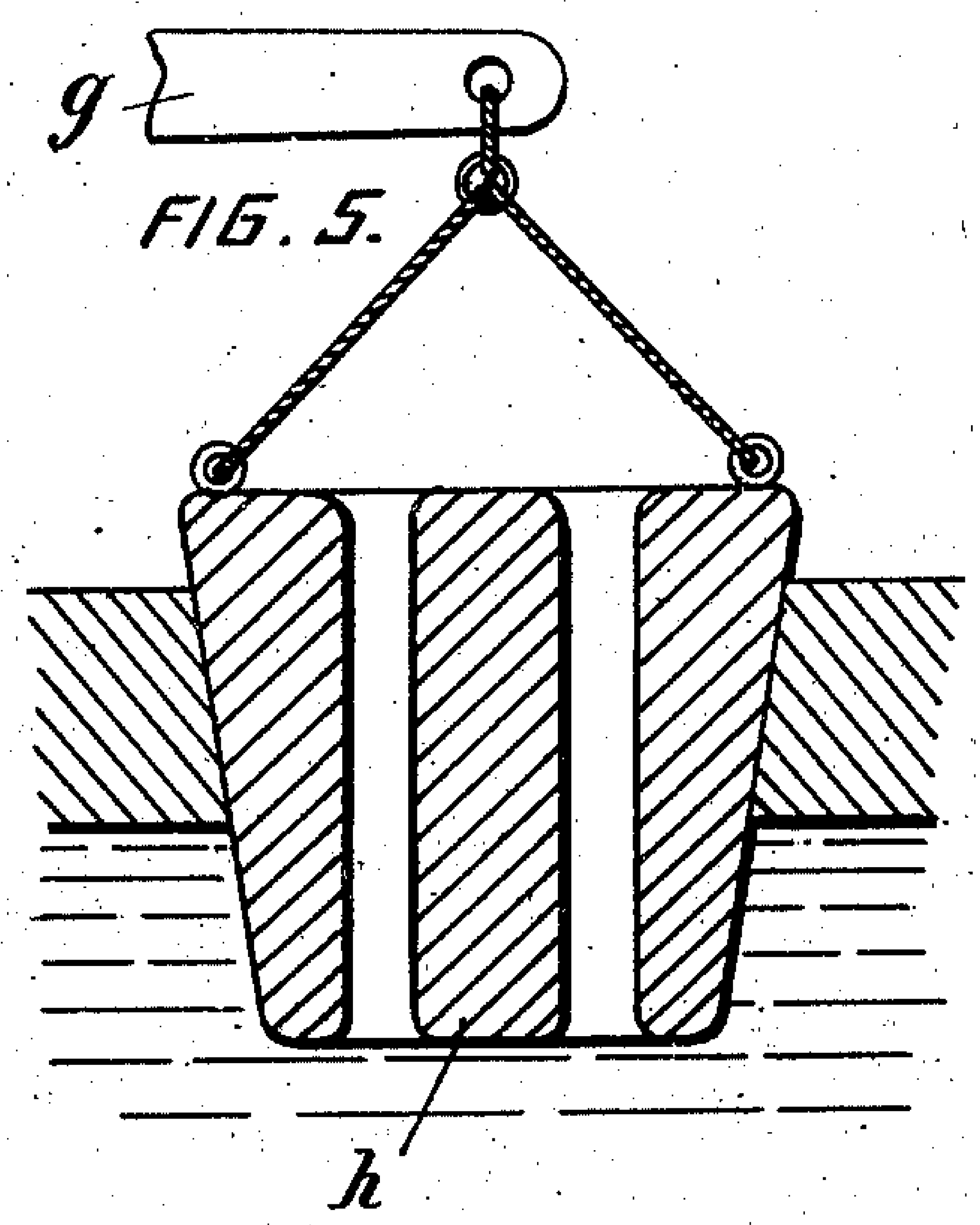
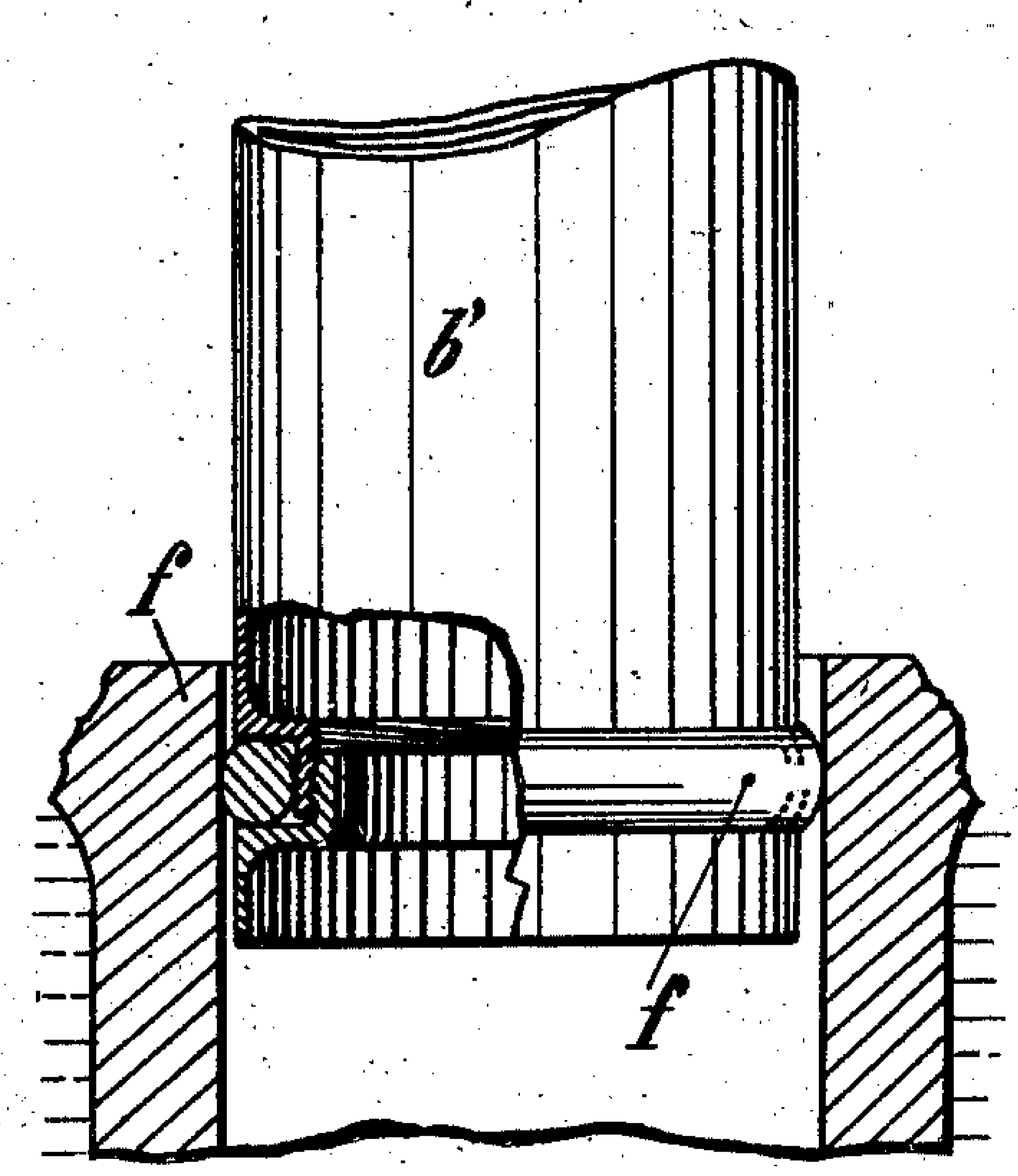


FIG. 6.



Witnesses
R. Aberli
Fred. O. Morse

Inventor
Edward Riché Butler
By Briesen & Knauth
his Attorneys

No. 651,963. Patented June 19, 1900.

E. R. BUTLER.

PROCESS OF MANUFACTURING ICE.

(Application filed Jan. 4, 1898.)

(No Model.) 5 Sheets—Sheet 4.

FIG. 7.

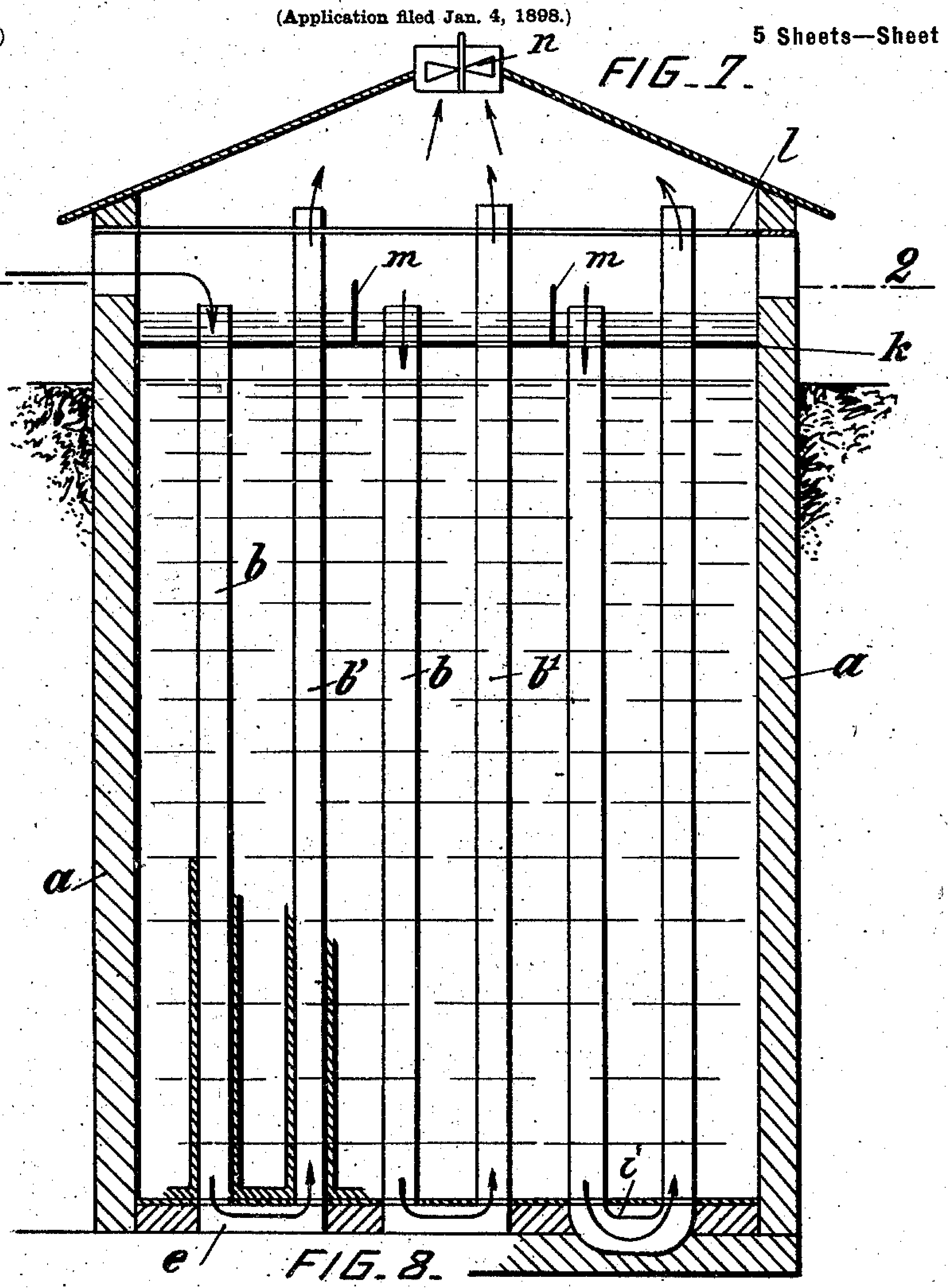
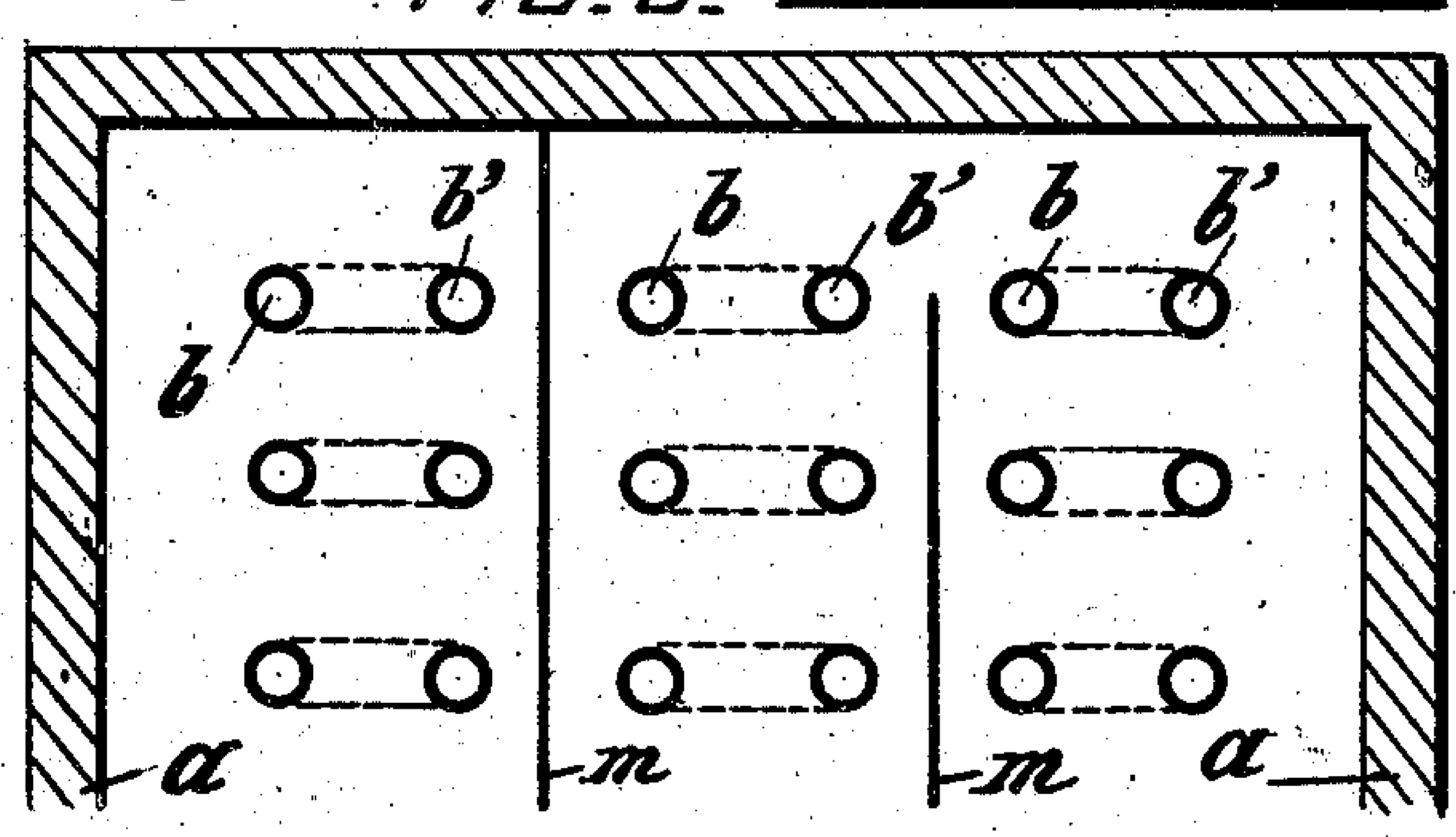


FIG. 8.



Witnesses

Inventor
Edward Riché Butler
By
his attorneys

No. 651,963. Patented June 19, 1900.

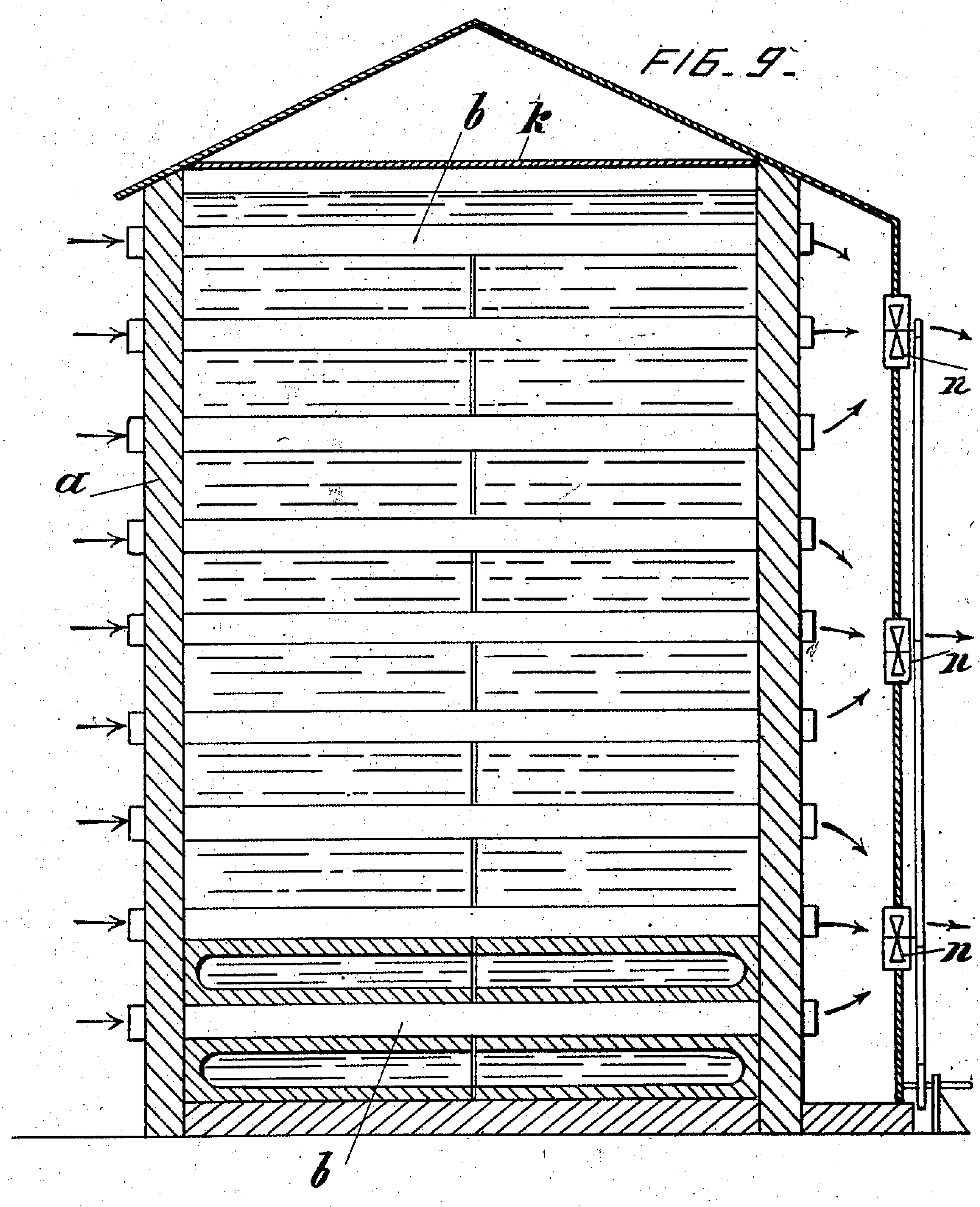
E. R. BUTLER.

PROCESS OF MANUFACTURING ICE

(Application filed Jan. 4, 1898.)

(No Model.) 5 Sheets—Sheet 5.

FIG. 9.



Witnesses
R. Aberle
Fred. C. Morse

Inventor
Edward Riché Butler
By Breeen & Knauth
his Attorneys

UNITED STATES PATENT OFFICE.

EDWARD RICHÉ BUTLER, OF PARIS, FRANCE.

PROCESS OF MANUFACTURING ICE.

SPECIFICATION forming part of Letters Patent No. 651,963, dated June 19, 1900.

Application filed January 4, 1898. Serial No. 665,522. (No specimens.)

To all whom it may concern:

Be it known that I, EDWARD RICHÉ BUTLER, engineer, of 10 Rue Louis le Grand, Paris, France, have invented or discovered a new and useful Process for the Manufacture of Ice, (for which I have obtained Letters Patent in the following countries: France, dated June 24, 1897, No. 268,174; Germany, dated December 15, 1897, No. 99,355; Austria, filed December 14, 1897, dated February 16, 1898, Vol. XLVIII, No. 1,089; Hungary, dated December 16, 1897, No. 11,966; Sweden, dated December 16, 1897, No. 1,831, not granted yet; Norway, dated December 29, 1897, No. 9,285, not granted yet; Italy, dated December 3, 1897, Vol. XCIII, No. 240; Spain, dated January 18, 1898, Vol. XXIX, fo. 393, No. 21,907, filed December 14, 1897; England, dated December 18, 1897, No. 30,022; France, additional to French patent dated June 24, 1897, No. 268,174, filed December 8, 1897; Switzerland, provisional, dated December 18, 1897, No. 15,990; Belgium, dated December 10, 1897, No. 132,455; Turkey, dated December 20, 1897, No. 362; Russia, dated December 11 and 23, 1897, No. 3,461, and Canada, filed January 10, 1898, No. 80,137, not granted yet;) and I do hereby declare the nature of the said invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement thereof.

This invention relates to a process for the manufacture of ice in blocks of any dimensions by simple and economical means without the direct aid of machinery.

The invention is illustrated in the accompanying drawings, which represent in an elementary manner the general arrangement of an installation of the freezing apparatus.

In the drawings, Figure 1 is a vertical sectional view of one form of apparatus and by which my process may be carried out. Fig. 2 is a like view of the lower portion of the same, showing another step in the process. Fig. 3 is a similar view showing the manner in which the successive layers are frozen. Fig. 4 is a horizontal sectional view of the same on the line A B of Fig. 3. Fig. 5 is an enlarged vertical sectional view of the vent-plug. Fig. 6 is an enlarged fragmentary side view, partly in section and with parts broken away, of one of the conduits or tubes, the view showing the manner in which the conduit is seated in the ice. Fig. 7 is a vertical view of another form of apparatus and which because of its simplicity may be termed the "preferred" form for carrying out my invention. Fig. 8 is a horizontal sectional view of the same, the view being taken on the line 1 2 of Fig. 7. Fig. 9 is a vertical sectional view of still another form of apparatus by which my invention may be carried out.

In Fig. 1, a is a tank or building in which a number of cold-air conduits, which may be metal tubes b' b^2 b^3 b^4 b^5, &c., are suspended by ropes or bands passing over pulleys c' to c^5 and counterbalanced by weights d' to d^5, so as to remain wherever placed, or they may be retained in the position into which they are moved by any other means.

At the commencement of the operation the lower ends of the conduits b' b^2, &c., are put in communication with a cold-air main formed in or by the double floor e, which is provided with sockets, in which the lower ends of the tubes are adapted to be seated. Packings f, Fig. 6, are provided at the lower ends of the conduits to prevent leakage of water into the cold-air main.

The tank or building a is filled with water nearly up to the tops of the conduits b' b^2, &c., and cold air is then admitted through the main or double floor e and by circulating through the conduits cause the congelation of the immediately-adjacent film of water as well as of that in contact with the bottom e, the cold air which escapes from the conduits also producing the congelation of the whole of the surface of the layer of water, whereby a hollow chamber of ice filled with water is produced, as shown in Fig. 1.

I provide special means to prevent the contained water, as it gradually continues to freeze, from bursting the superjacent film of ice formed. One form of such means consists of one or more perforated vent-plugs h, which are supported at the surface of the water, so as by dipping therein they prevent ice being formed at the points occupied by the plugs and permit the escape of the water expelled by expansion during congelation.

In Fig. 1 one of these hollow plugs *h*, Fig. 5, is shown as suspended from an arm *g*, carried by the air-conduit b^4. When the ice has acquired sufficient thickness a current of hot air is passed through the cold-air main and conduits b' b^2, &c., for the purpose of sufficiently melting the enveloping ice to permit of the conduits b' b^2, &c., being then raised to the position represented in Fig. 1 at b^2, with the packings *f* still fitting in the bores formed in the ice by the conduits. All of the conduits b' b^2, &c., having been thus raised, more water is admitted, so as to fill the tank or building *a* nearly up to the new level of the top ends of the conduits, and the plug or plugs having been readjusted to that level the water is then frozen by the cold-air current as before. The apertures left by the removal of the plugs *h* allows of the water expelled by continued congelation from the lower layer rising into the second layer.

It is preferable to arrange the plugs for the successive layers in such relative positions that the cold water from below will flow along the bottom of the layer next above and there deposit the ice crystals carried by it, as the upper layers of water are always less cold than the lower layers.

By repeating the above-described operation a number of times the congelation proceeds in successive stages, the block acquiring gradually more solidity toward the lower part first formed and upon which the cold-air current has acted for a longer period. When the block of ice has attained a sufficient height, the conduits b' b^2, &c., are entirely removed and the cold-air current again admitted for a certain time until a solid block of ice is formed, traversed by the tubular cavities vacated by the conduits b' b^2, &c., and which facilitate the splitting of the block into lumps of uniform size.

In order to render it unnecessary to make the walls of the freezing-chamber *a* strong enough to resist the pressure of the head of water, the cold-air conduits are placed close together near the sides, (as shown in Fig. 4, which is a horizontal section on line A B, Fig. 3,) in order that congelation shall be more rapid along the sides, so that the protective layer of ice thus formed, whose thickness becomes gradually increased toward the lower part, will sufficiently strengthen the walls of the structure, this wall of ice being braced by horizontal layers of ice which form upon the different layers of water.

In Figs. 7 and 8 a number of tubes *b* b' of canvas, metal, or other material of unequal length are shown as grouped within the structure *a* and connected either by the double bottom *e* or by means of a bend, as shown at *i*. The tubes *b* open through the tray *k*, which closes in the top of the freezing-chamber *a*, while the tubes b' open through the ceiling *l*. Water supplied to the tray *k* circulates between partitions *m*, Fig. 8, before flowing into the freezing-chamber through suitable apertures in tray *k* around the tubes *b* b'. By admitting cold air through the tubes *b* at same time that the water is supplied to the freezing-chamber the congelation of the water will first take place upon the external surfaces of tubes *b* b', owing to the circulation of the cold air therein, and this congelation will gradually proceed until the chamber is completely filled by a solid block of ice. A current of hot air is then passed through the cold-air pipe and tubes *b* b' for the purpose of detaching them from the ice in which they are inclosed, and the tubes are then withdrawn, leaving a solid block of ice traversed by tubular cavities, which facilitate the splitting up of the block into parts of uniform size. In some cases after having removed the tubes water may be run into the tubular cavities until by the circulation of cold air said cavities are completely closed up with ice. The tubes may be disposed horizontally, as shown in Fig. 9, the congelation of the water first commencing around the tubes, which are withdrawn on the completion of the congelation.

To obtain a rapid circulation of cold air, exhausters, such as fans *n*, suitably driven, may be disposed at suitable points of the structure.

By the process described blocks of ice of any dimensions may be produced by very simple and economical means without the aid of special machines.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is—

1. The process of manufacturing ice in a single block which consists in passing a refrigerating fluid through a series of conduits—maintained in a body of water—until the water adjacent to said conduits is congealed, in thereupon passing a heating fluid through said conduits and partly withdrawing them from the ice, then surrounding the partly-withdrawn portions of said conduits with water and again passing a refrigerating fluid through said conduits and through the passages from which they are withdrawn and so on repeating the operation until a block of ice of sufficient size is formed.

2. The process of manufacturing ice in a single block which consists in passing a refrigerating fluid through a series of conduits—maintained in a body of water—until the water adjacent to said conduits is congealed, simultaneously submitting the top and bottom of said body of water to the action of a refrigerating agent so that one or more water-containing compartments are formed by the ice, establishing a communication for the passage of water from the interior of said compartment or compartments and beneath the surface of the ice during the formation thereof, in thereupon passing a heating fluid through said conduits and partly withdraw-

ing them from the ice, then surrounding the partly-withdrawn portions of said conduits with water and again passing a refrigerating fluid through said conduits and through the passages from which they were withdrawn and so on repeating the operation until a block of ice of sufficient size is formed.

The foregoing specification of my improvements in the manufacture of artificial ice signed by me this 20th day of December, 1897.

EDWARD RICHÉ BUTLER.

Witnesses:

EDWARD P. MACLEAN,

MAURICE HENRI PIGNET.