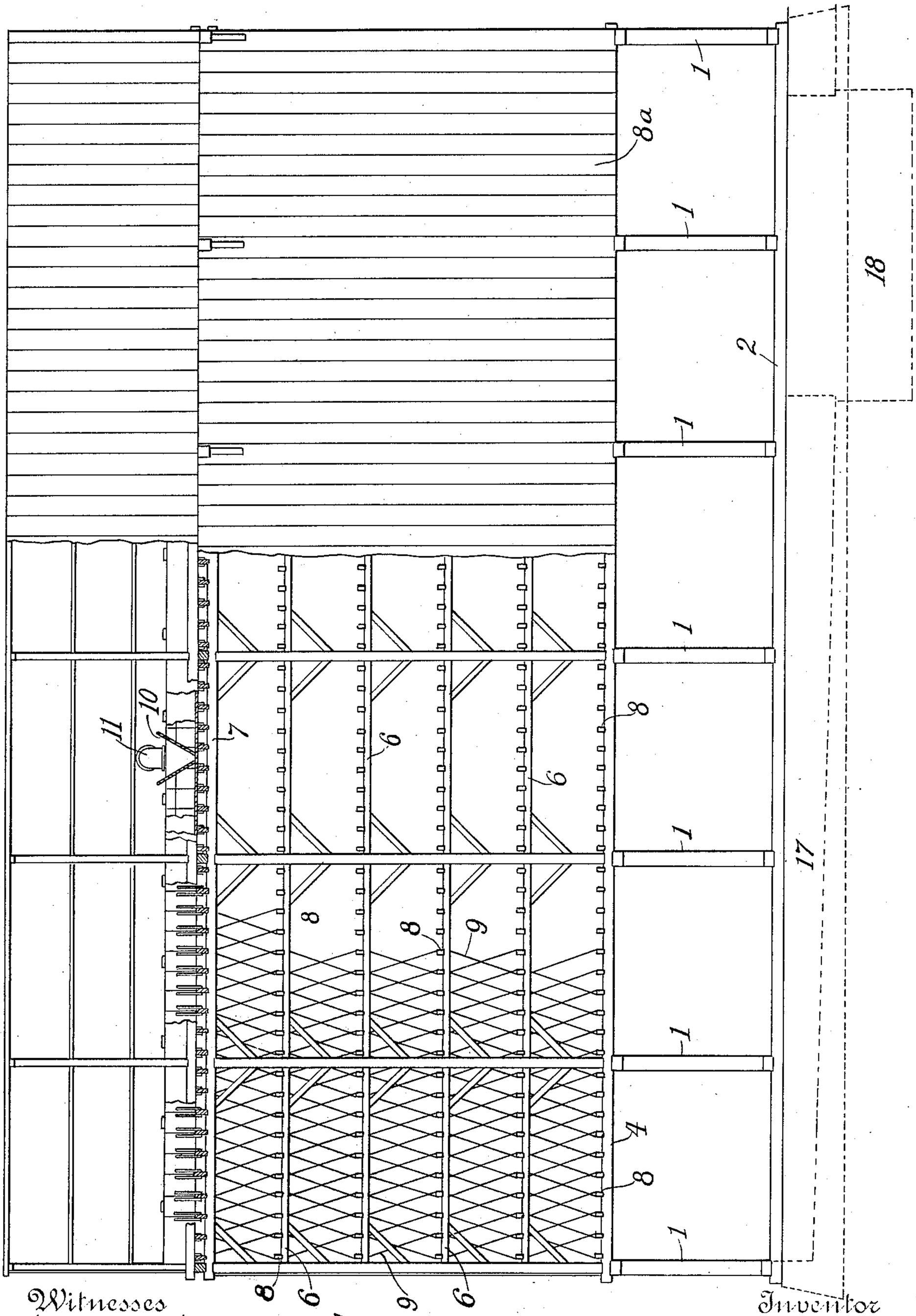
No. 844,336. PATENTED FEB. 19, 1907.

H. L. DOHERTY.

APPARATUS FOR COOLING LIQUIDS.

APPLICATION FILED DEC. 13, 1904.

3 SHEETS—SHEET 1.



Witnesses
Raphael Netter
S. S. Dunham

Fig. 1

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3 SHEETS—SHEET 2.

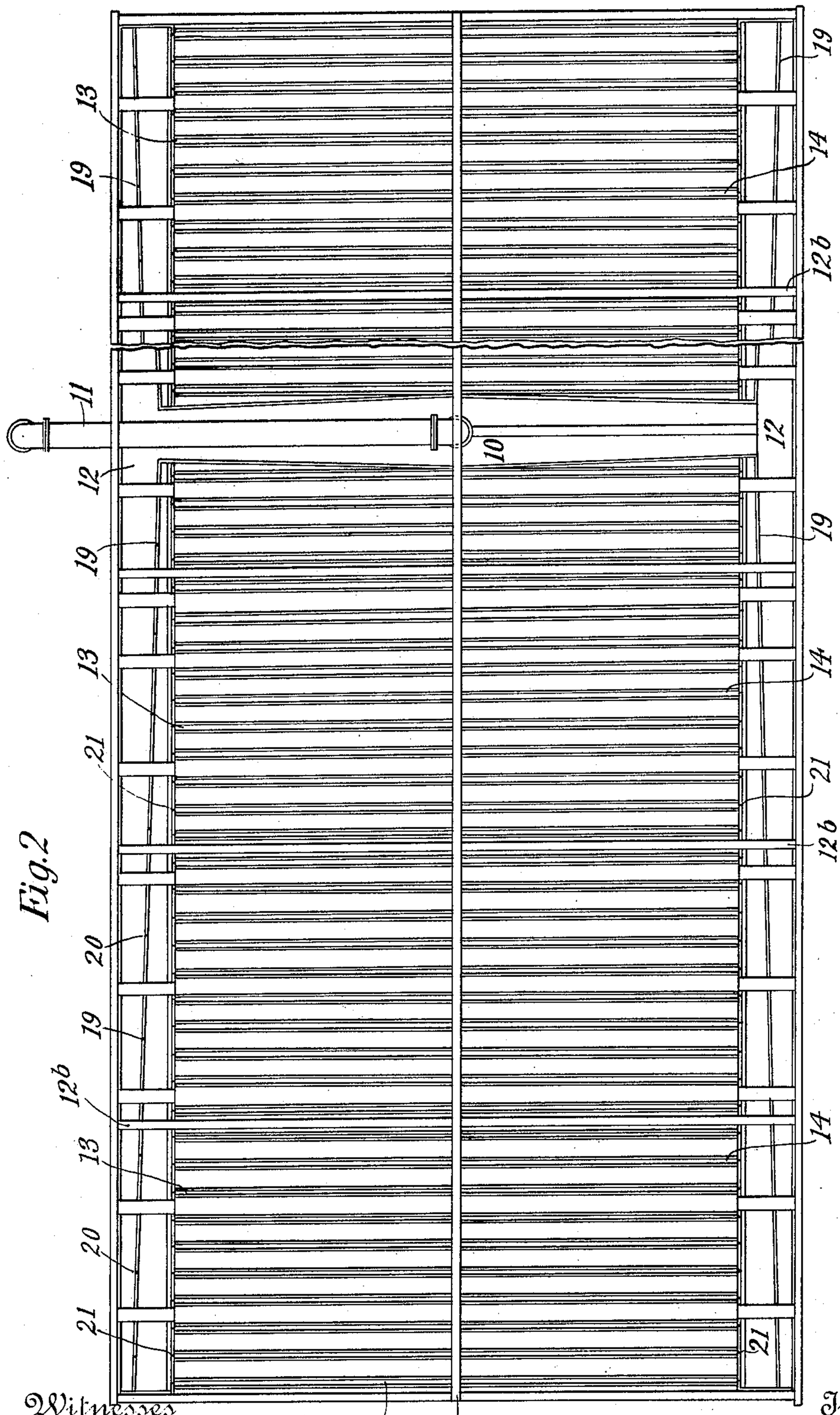

Fig. 2

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3 SHEETS—SHEET 3.

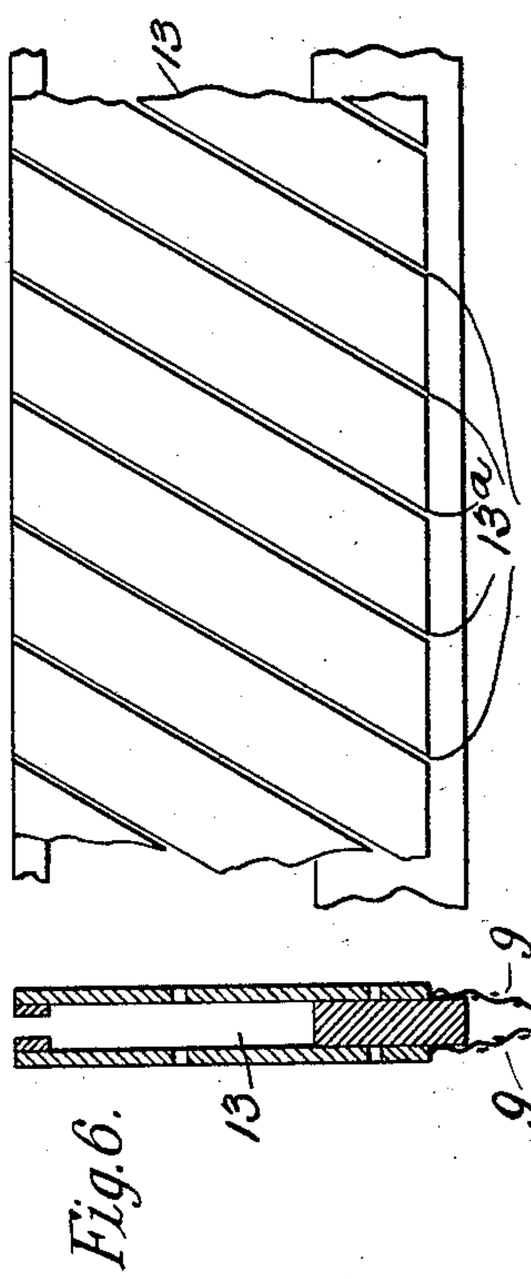

Fig. 7.

Fig. 6.

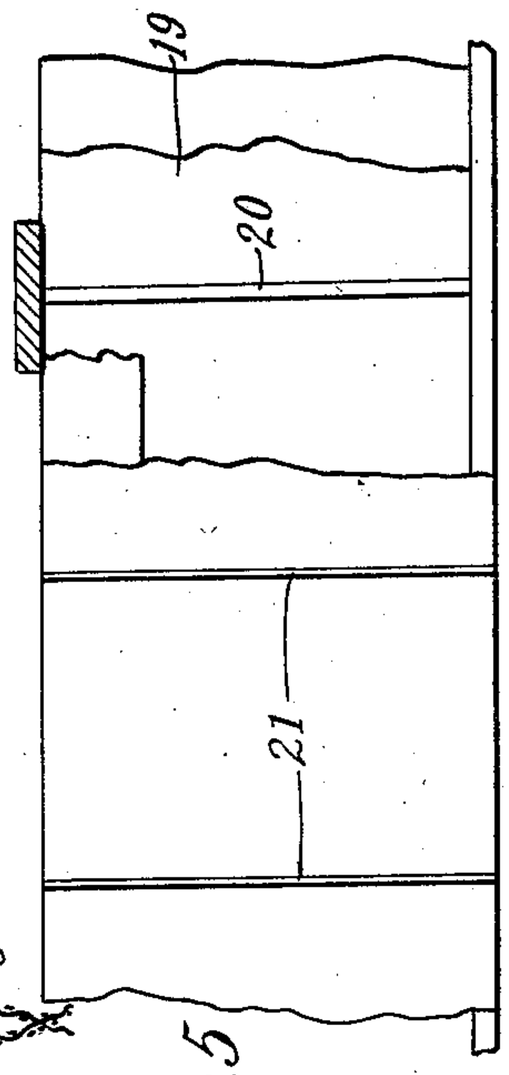

Fig. 5.

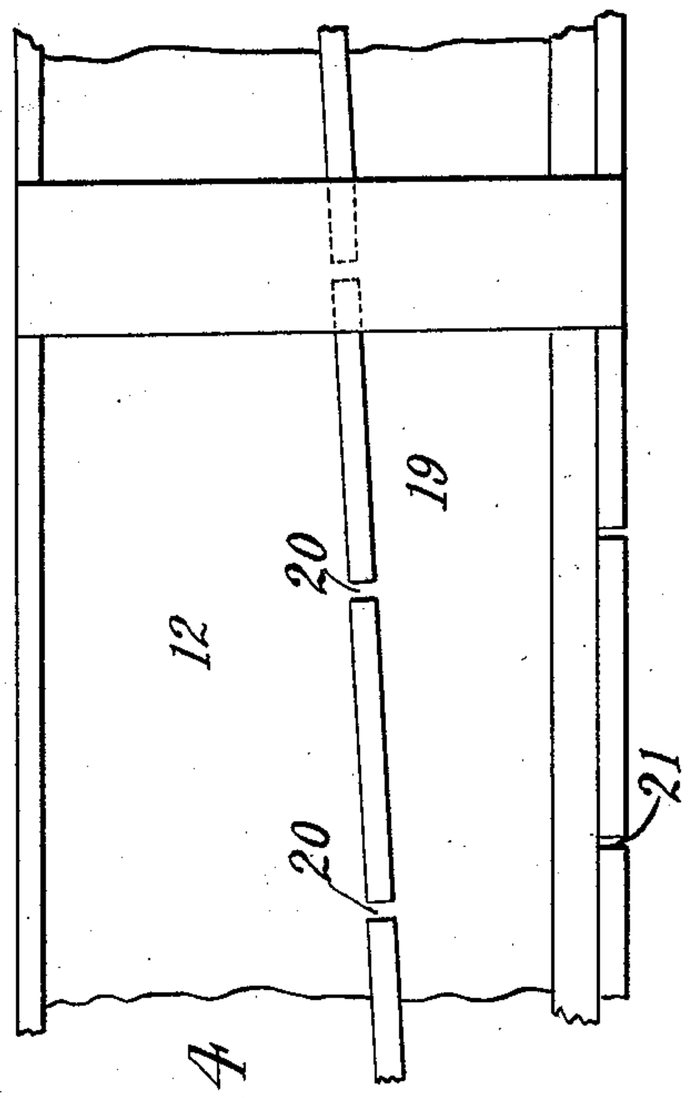

Fig. 4.

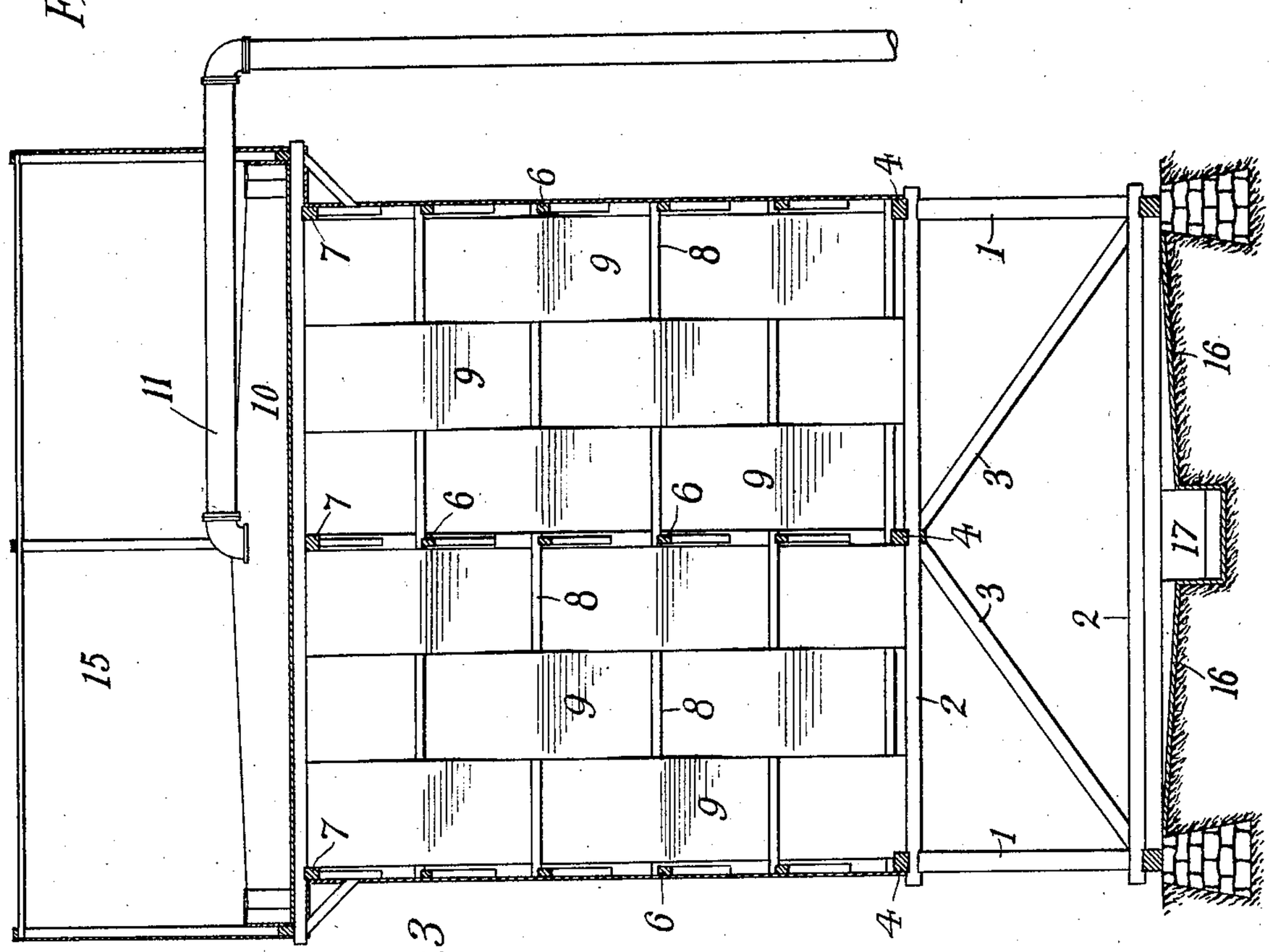

Fig. 3.

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR COOLING LIQUIDS.

No. 844,336. Specification of Letters Patent. Patented Feb. 19, 1907.

Application filed December 13, 1904. Serial No. 236,700.

To all whom it may concern:

Be it known that I, HENRY L. DOHERTY, a citizen of the United States, residing at Madison, in the county of Dane and State of Wisconsin, have invented certain new and useful Improvements in Apparatus for Cooling Liquids, of which the following is a specification, reference being had to the drawings accompanying and forming part of the same.

My invention, subject of the present application, relates to apparatus for cooling liquid of the type in which the liquid is distributed over a large area or surface and exposed to the atmosphere, whereby the heat lost by evaporation and radiation from the liquid will be rapid and the temperature reduced to a degree at least as low and in some instances even lower than that of the surrounding air.

Among the objects which I seek to attain by my invention several of the more important may be mentioned as follows: first, to provide an apparatus of the kind referred to which shall distribute the water or other liquid to be cooled over a very large radiating-surface; second, to effect such distribution evenly and make the quantity of liquid exposed per unit area of radiating-surface uniform throughout the apparatus; third, to provide a constant, uniform, and rapid circulation of air through the apparatus without the use of artificial-draft devices; fourth, to produce such an apparatus which shall possess a very high efficiency and yet be inexpensive both as to materials and as to labor in constructing it.

In carrying out my invention I employ a "tower," constructed in any desired manner suitable for the purpose—as, for example, one of the well-known "mill" type of structure. The tower contains a number of "floors," as many as may be necessary, composed of a large number of stringers, preferably arranged in series in consecutive parallel planes. Over these stringers are stretched sheets or strips of fabric or other material. On the topmost floor is a system of distributing-conduits, from which the liquid to be cooled is delivered upon the aforesaid sheets or strips with substantially perfect uniformity throughout the apparatus, so that all parts of the structure will be utilized to the best advantage. Spreading over the strips or sheets the liquid is exposed over a large area, and the loss of heat due to radiation and evaporation is therefore rapid. The apparatus being provided with suitable egress and ingress openings at top and bottom, the air therein, warmed by absorption of heat from the liquid, will rise, and passing out at the top will permit cooler air to enter below, which in turn will be warmed and caused to pass out of the apparatus. The circulation thus produced will continue as long as the supply of warm liquid upon the exposure-sheets is kept up. As the liquid spreads over the sheets it finally reaches the lower ends of the same, by which time it should have been reduced to at least the temperature of the outside atmosphere or lower. From the exposure-strips it falls into a suitable drain located below the same, from which it may be collected for utilization.

For further explanation of the invention reference may now be made to the accompanying drawings, which show the preferred embodiment.

Figure 1 is a side elevation with part of the wall broken away to show the interior arrangement of the apparatus. Fig. 2 is a plan view of the same, showing the arrangement of the conduits for distributing the liquid to the exposure-sheets. Fig. 3 is a transverse central section of Fig. 1. Fig. 4 is a detail plan view of one of the supply-conduits, showing the arrangement for delivering liquid at a substantially constant head to the discharge-conduits. Fig. 5 is a detail elevation of the same with one side partly broken away. Fig. 6 is a detail cross-section of one of the discharge-conduits, showing exposure-strips connected thereto. Fig. 7 is a detail side elevation of the same with the exposure-strips omitted.

The structure consists, broadly, of any suitable framework having a number of stringers arranged in tiers or floors. As the precise construction of the preferred form is important, from an economical standpoint, at least, it may be described somewhat in detail. The sides of the supporting-frame are composed of uprights 1, connected in pairs by transverse sills 2 and diagonal braces 3 3, the whole forming a series of cross-trusses of the desired strength and rigidity. The cross-trusses are connected by longitudinal sills 4 4.

Upon the supporting-frame just described

rests the structure which carries the cooling devices proper. In the preferred embodiment of the invention it consists of two side and one central series of uprights 5, carrying longitudinal string-pieces 6 and upper sills 7. Transversely across the string-pieces and also the sills 4 are stringers 8, arranged in vertical series, as shown in Fig. 1. The whole of the tower above the supporting-frame is inclosed by suitable walls, as shown at 8ª, Fig. 1.

Interwoven vertically through the stringers are strips or sheets 9 of porous material, as shown in Figs. 1 and 3, constituting the exposure-surface upon which the water is distributed. It will be understood that the tower is substantially filled with these strips of material, though only a portion thereof is shown in Fig. 1.

For the purpose of delivering the liquid upon the exposure or radiation sheets I employ a system of conduits, which is preferably constructed as follows:

Located transversely across the structure and resting on the upper sills 7 is a V-shaped trough 10, into which the liquid to be distributed is discharged, as from a pipe 11, terminating at about the center of the trough, as shown in Figs. 1, 2, and 3. At the ends of the trough and in communication therewith are longitudinal distributing-conduits 12 12, and extending inwardly from the latter are lateral conduits 13, registering with the stringers 8 and resting upon the upper sills 7. The lateral conduits are provided with discharge-openings in their side walls, through which the water to be cooled issues upon the depending strips 9. The distributing system may be protected by a casing 15 entirely open at the top, so as to offer no impediment to the flow of air from the tower, and may be strengthened by longitudinal and transverse connecting strips or braces, (indicated by 12ª and 12ᵇ, respectively.) The casing 15 constitutes, in effect, a continuation of the walls of the tower and serves to increase the natural draft.

From the foregoing the operation of the apparatus will be readily understood. The liquid discharged into the central trough is delivered to the longitudinal conduits 12, from whence it passes to the lateral conduits 13. From the latter it flows out upon the exposure-sheets 9. Spreading over the latter, both by gravity and capillary attraction, it parts with its heat by evaporation and radiation into the air in the tower, which air, being thus warmed, rises and passes out through the open top of the structure. The partial vacuum thus produced causes cooler air to enter through the open bottom to be in turn heated and discharged. A portion of the water in the sheets 9 will of course evaporate and pass out as vapor with the warm air; but the remainder will descend to the bottom of the apparatus and drip off the cooling-strips upon the collecting-surface 16, from whence it runs into the drain 17 and is finally collected in the sump 18.

My invention also embraces a number of structural details which have been found to be of value. These I shall now proceed to describe.

It is desirable of course that the liquid to be cooled be uniformly distributed over the cooling-surface. Otherwise, as would be the case if one part of the same were thoroughly saturated while another part contained a smaller amount of moisture, the apparatus as a whole would not operate with the desired efficiency. To insure such uniform distribution, so that the saturation of all the cooling-sheets may be kept at the maximum, if desired, I have devised the following system of distributing conduits or channels:

As before stated, the central trough 10 discharges into longitudinal conduits or sluices 12 12. The latter are of the same depth throughout, but are divided by diagonal partitions 19, extending from the trough 10 and gradually approaching the outer walls of their conduits, as shown more clearly in Fig. 2. As shown in Figs. 4 and 5, the partitions 19 are provided at intervals with vertical slits 20, through which the two divisions of the sluice are in communication. The operation of the sluices will now be clear. As the water flows through the outer division of a sluice it escapes into the inner division through the slits 20, and its volume is thereby diminished. At the same time, however, the cross-section of the outer division is constantly growing less on account of the approach of the diagonal partition 19 to the outer wall. Consequently the level or "head" of water in the outer division is the same throughout its length, and as the inner division is receiving water at uniform pressure from the same-sized openings located at regular intervals the head in that division is also uniform. In the inner walls of the inner divisions are slits 21, Figs, 2, 4, and 5, through which the liquid flows into the lateral conduits 13. The walls of the latter are also slitted, as shown in Figs. 6 and 7, permitting the water to be discharged upon the cooling sheets or strips 9, which, it will be remembered, are directly under the lateral conduits 13. The strips may, in fact, be secured to the projecting bottoms of the lateral conduits, as shown in Fig. 6, so that the liquid will be discharged directly upon the strips. Since the head of water delivered to the transverse channels 13 is the same in all, the flow therethrough is also uniform in all. These passages might also be made with decreasing cross-section, as by causing the walls thereof to approach each other toward the center, so as to make the head of liquid therein uniform throughout the length of each; but a simpler and for most purposes a satisfactory method

is shown in Figs. 6 and 7. The walls of each of the transverse or lateral conduits are parallel, but the outlet-slits 13ª therein are inclined upwardly away from the middle of the conduit, toward the sluices from which the liquid is received. By inclining the slits the liquid is more evenly distributed upon the strips than would be the case if vertical slits were used. In the latter case the liquid would be discharged in separate streams some distance apart from each other, whereas in the former arrangement the delivery is in its effect more like a continuous sheet of liquid, as would be the case if the water were discharged through a longitudinal slot in the side wall of the lateral conduits or were allowed to overflow the side walls.

By the distributing system above described the distribution of liquid on the exposure-surface is made substantially uniform throughout the tower. The quantity of water to be cooled is in most cases varying, and the demand on a cooling-tower is that it takes care of the entire amount of water that must be cooled irrespective of its relation to the quantity at which the apparatus, theoretically at least, is most efficient. In my apparatus, regardless of the amount of water that passes through the tower, the liquid supplied is distributed equally to all parts of the same, so that the operation of the tower is at all times maintained at substantially the highest efficiency of which it is capable under the given circumstances. Though I prefer to use the distributing system just described, it will be understood that other means for distributing the liquid may be employed, if desired, without unduly sacrificing the advantages flowing from other features of the invention.

The material which I prefer to use for the exposure or radiation surface is a woven fabric of organic material, such as burlap or canvas. Heretofore metal fabric, as wire-gauze or other inorganic materials, have usually been used and so far as the broad scope of my invention is concerned may also be used therein; but I have found that burlap or some other organic fabric gives much better results. I believe this to be due in part to the fact that it is more porous, and therefore holds a greater quuantity of liquid, causing it to flow more slowly through the apparatus. Consequently a comparatively small apparatus using such material for the exposure-surface will expose the liquid to the air as long as a much larger apparatus in which wire-gauze is used for that purpose. The organic fabric also has innumerable fine threads or filaments projecting from its surface and into the interstices of its mesh, which by capillary attraction becomes covered with liquid. The liquid is thus finely divided and its exposed surface greatly increased. The capillarity of the fabric also causes the liquid to distribute itself over the same, so that if the supply is concentrated at one point the liquid nevertheless spreads to all parts of the fabric and is prevented from flowing along paths of least resistance, a tendency which in most towers is very marked. Such material deteriorates somewhat more rapidly than wire-gauze; but it is cheap and may be replaced when necessary at a comparatively slight expense.

The weaving of the exposure-strips alternately "over and under" the stringers, whereby the strips are disposed in zigzag lines, is also important, as it gives a baffling effect, causing the air rising through the tower to be divided into a number of currents of sinuous form. A given volume of air is thus distributed over a greater area—that is, it is made to have a larger absorption-surface. The sinuous paths of the currents also cause all parts of the currents to come in contact with more or less of the exposure or radiating surface on which the liquid to be cooled is distributed before they finally escape at the top of the tower. A greater proportion of the total heat-absorbing capacity of a given volume of air is thus utilized. This feature is also capable of use to advantage in other apparatus.

It will be noted that the exposure sheets or strips are arranged edge to edge across the frame in one direction and side by side across the frame in another direction, thereby forming rows or series in two directions across the apparatus.

As above stated, the form or construction of the specific embodiment of my invention which I have shown herein is also important, as it is simple, light, and strong and may be constructed at low cost of labor and materials. The framework and walls may be of wood or metal, and in either case common commercial shapes may be used. It is to be understood, however, that the invention is not confined to the precise structure mentioned, as the latter is merely the preferred form, but may be embodied in other forms to suit different circumstances.

What I claim is—

1. In a cooling apparatus, the combination of a frame, a plurality of radiation sheets or strips suspended vertically therein in zigzag lines in staggered relation to one another, and means for discharging liquid upon the said sheets or strips, as set forth.

2. In a cooling apparatus, the combination of a frame, a plurality of exposure strips or sheets suspended vertically therein, arranged edge to edge in one direction across the frame and side by side in another direction across the frame, forming rows or series across the apparatus, and a plurality of spaced stringers extending across the frame and engaging alternate strips, whereby the latter are given a sinuous form, as set forth.

3. In a cooling apparatus, the combination

of a frame, an exposure-surface therein, and means for discharging liquid upon the said surface, comprising a plurality of conduits discharging upon said surface, and one or more sluices discharging into the conduits, said sluices being adapted to maintain a substantially uniform head of liquid throughout their extent; as set forth.

4. In a cooling apparatus, the combination of a frame, an exposure-surface therein, a plurality of transverse conduits discharging liquid upon said surface, a pair of longitudinal sluices discharging into the conduits at the ends thereof, a transverse trough discharging into the sluices, and means for maintaining a substantially uniform head of liquid in the sluices, as set forth.

5. In a cooling apparatus, a distributing-sluice of unvarying depth and varying cross-section whereby a substantially uniform head of liquid will be maintained throughout its length, as set forth.

6. In a cooling apparatus, a distributing-sluice of unvarying depth, having parallel side walls, and a diagonal partition therein having ports for delivering liquid from one division of the sluice to the other, as set forth.

7. In a cooling apparatus, the combination of a distributing-sluice of unvarying depth and varying cross-section, whereby a substantially uniform head of liquid will be maintained throughout its length, a plurality of conduits extending laterally from the sluice, having discharge-apertures, and a plurality of exposure sheets or strips depending from the conduits to receive liquid therefrom, as set forth.

8. In a cooling apparatus, the combination of a distributing-sluice of unvarying depth, having parallel side walls and a diagonal aperture therein having ports for delivering liquid from one division of the sluice to the other, a plurality of conduits extending laterally from the sluice and having apertures for the discharge of liquid, and a plurality of exposure sheets or strips depending from the conduits to receive liquid therefrom, as set forth.

9. In a cooling apparatus, the combination of an open supporting-frame consisting of a plurality of trusses; a superstructure composed of vertical side members, a plurality of horizontal string-pieces carried thereby, a plurality of stringers carried by the string-pieces, and a wall surrounding the superstructure; a plurality of sheets or strips of organic fabric disposed vertically on the stringers; a distributing system for discharging liquid upon the said sheets or strips at their upper ends and at substantially the same rate upon all; a casing surrounding the distributing system; and means below the superstructure for collecting the cooled liquid; as set forth.

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