No. 661,944. Patented Nov. 20, 1900.

E. S. BELDEN.

APPARATUS FOR REMOVING MOISTURE FROM AIR.

(Application filed Mar. 16, 1900.

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

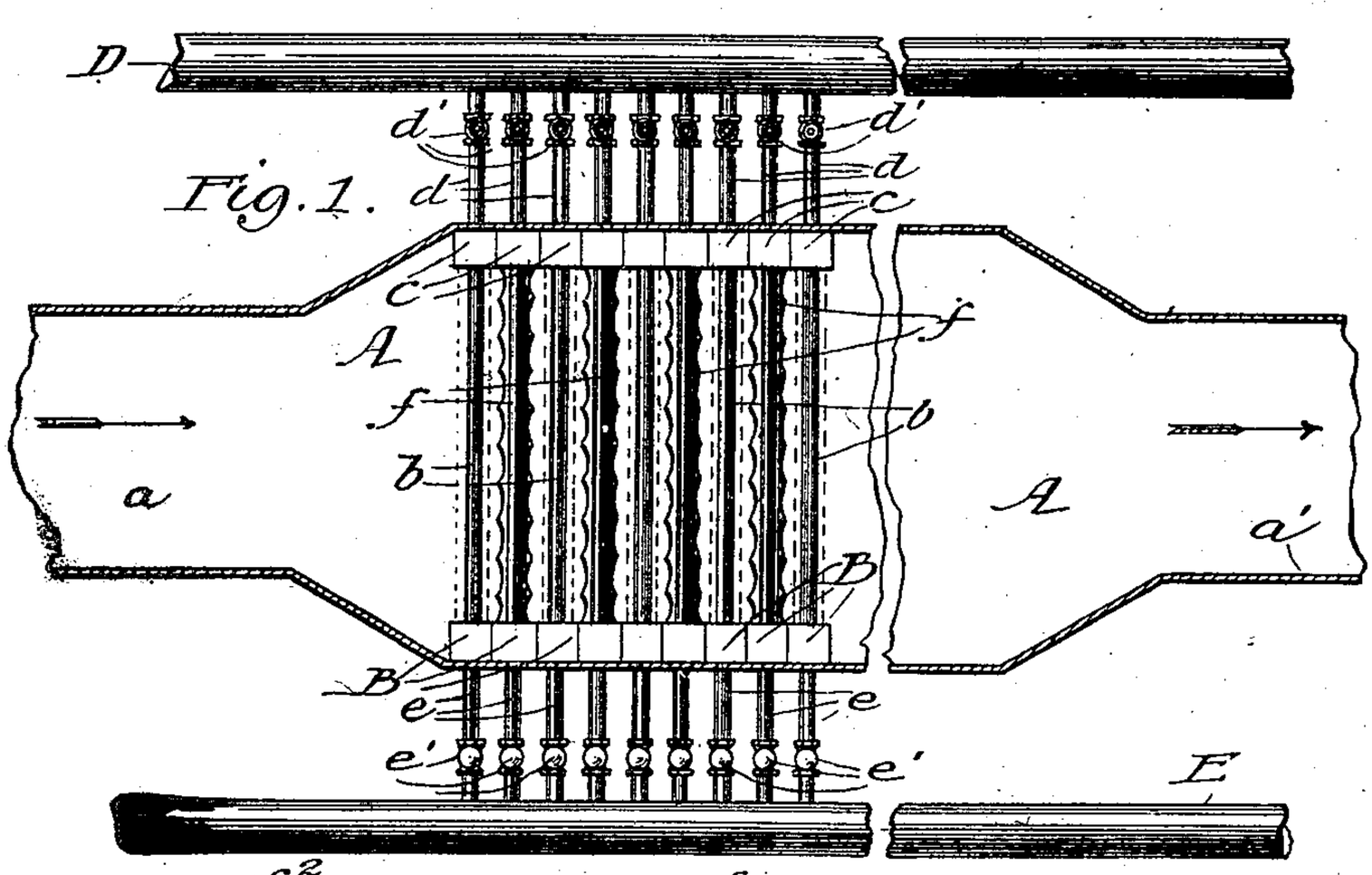

Fig. 3.

Fig. 6.

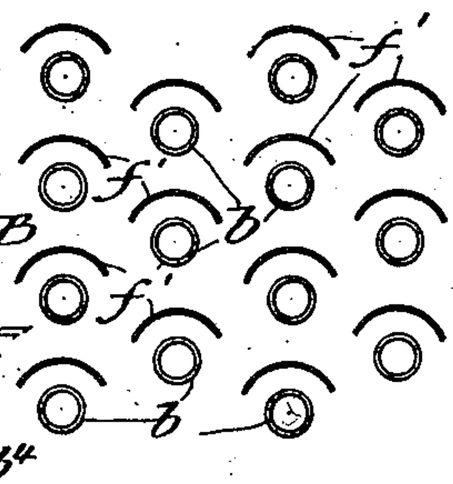

Fig. 7.

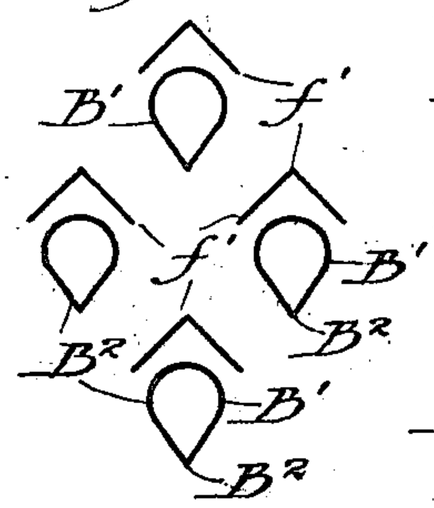

Fig. 2.

Fig. 4. Fig. 5.

Witnesses:
Harold G. Bailey
Frank S. Blanchard

Inventor:
Edgar S. Belden
By Jesse & H. M. Cox
Attys

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Fig. 8.

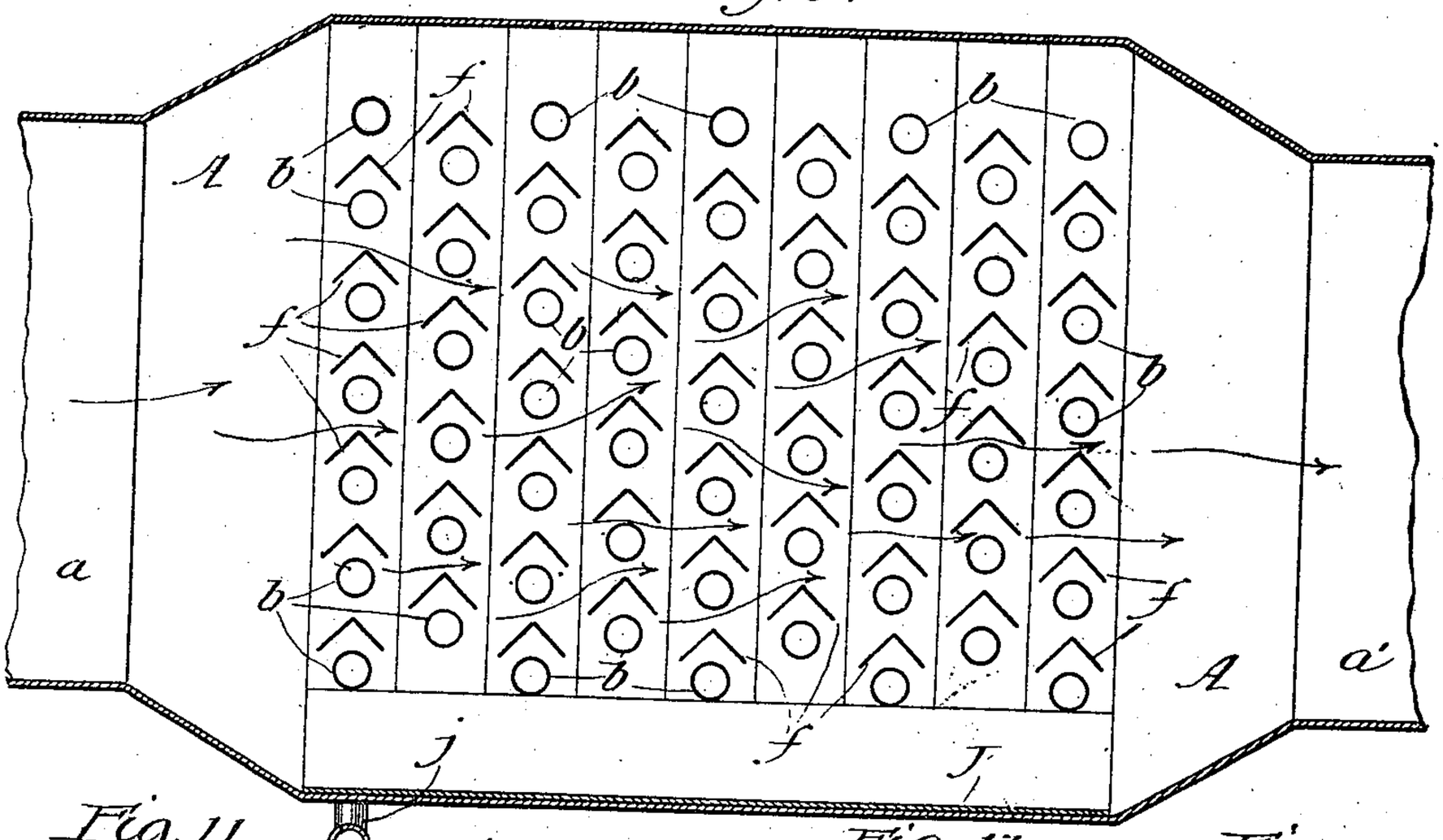


Fig. 11.

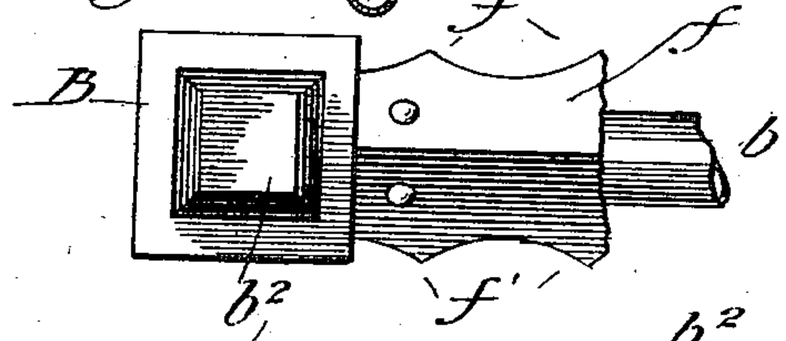


Fig. 13.

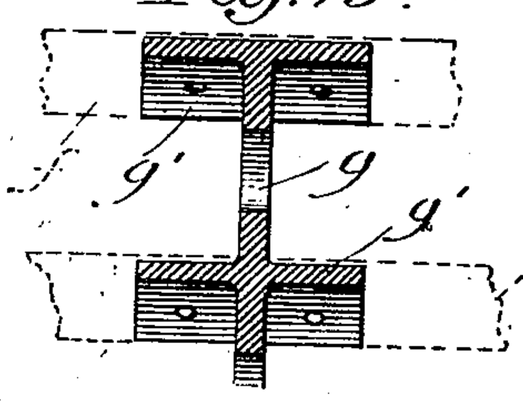


Fig. 12.

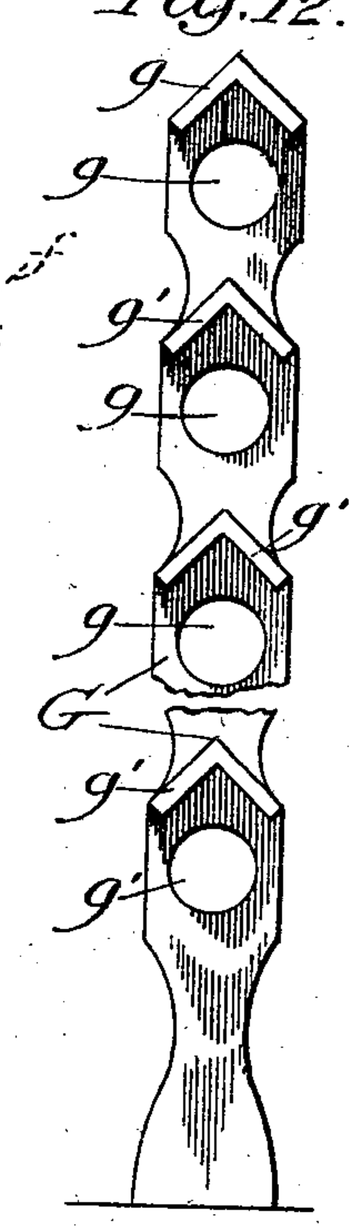


Fig. 10

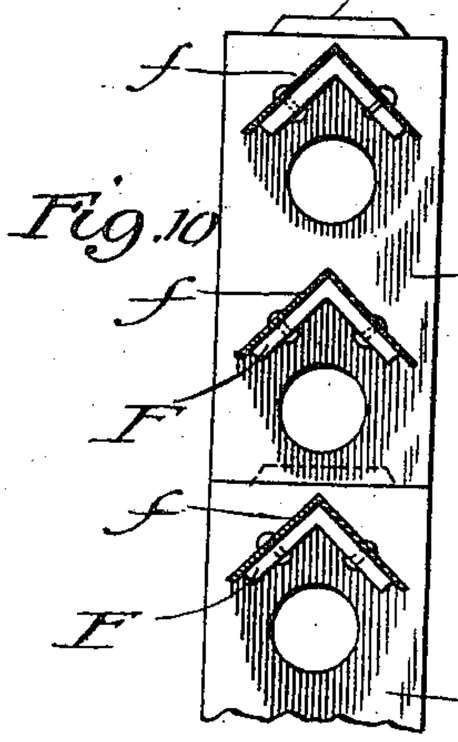
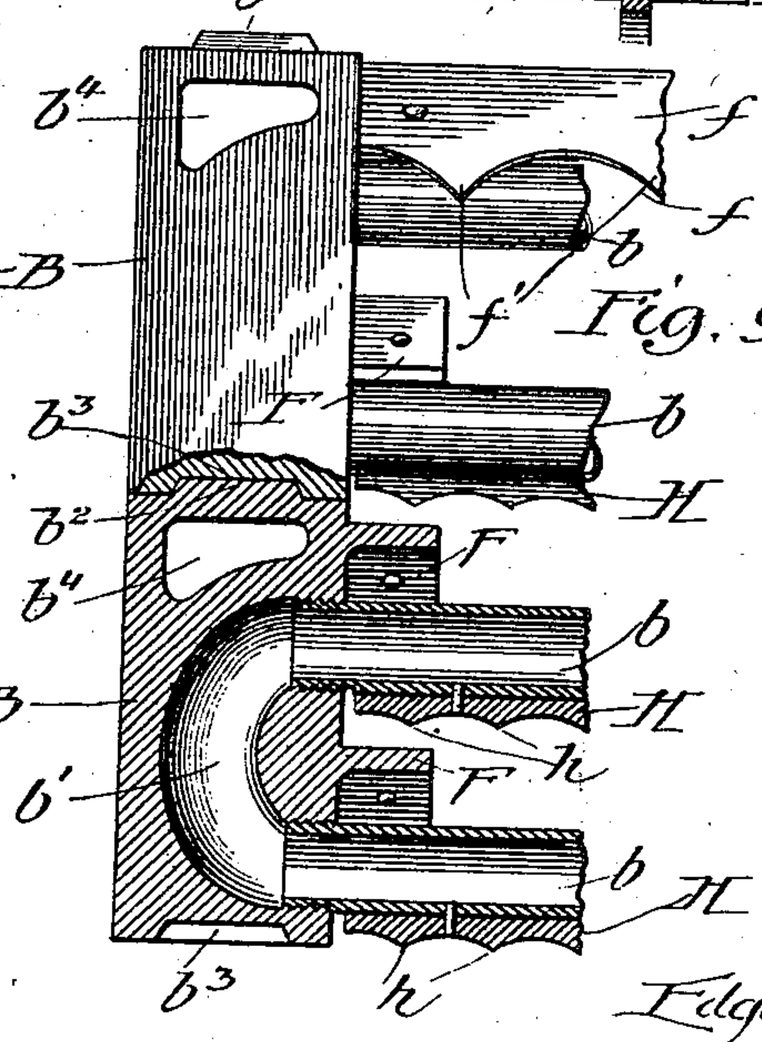


Fig. 9.



Witnesses:
Harold G. Barrett.
Frank S. Blanchard

Inventor:
Edgar S. Belden
By Jesse & H. M. Cox
Attys

UNITED STATES PATENT OFFICE.

EDGAR S. BELDEN, OF CHICAGO, ILLINOIS.

APPARATUS FOR REMOVING MOISTURE FROM AIR.

SPECIFICATION forming part of Letters Patent No. 661,944, dated November 20, 1900.

Application filed March 16, 1900. Serial No. 8,870. (No model.)

To all whom it may concern:

Be it known that I, EDGAR S. BELDEN, a citizen of the United States, residing in the city of Chicago, county of Cook, and State of Illinois, have invented a new and useful Improvement in Apparatus for Removing Moisture from Air, of which the following is a specification.

My invention relates to apparatus for removing moisture from air; and the objects of my invention are, first, to provide means for precipitating the moisture by cooling the air; second, to provide means for quickly removing the precipitated liquid, and, third, to provide the other details hereinafter set forth. I attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a plan view of the apparatus, the walls of the inclosing chamber being shown in section to reveal the parts within. Said figure shows the supply and return pipes lying outside of the chamber and the cooling-coils, headers, and hoods within said chamber. Fig. 2 is a transverse vertical section of the apparatus upon a scale somewhat larger than the scale used in Fig. 1. The hoods or roofs are removed in order to show the coils of pipe. Fig. 3 is a top view of a series of hoods, showing their relative positions one above another. Fig. 4 is a side view of a portion of a cooling-pipe, showing the drips or fins attached thereto. Fig. 5 is a transverse section of a pipe and drip or fins as shown in Fig. 4. Fig. 6 is a transverse sectional view of a group of cooling-pipes, showing an alternative form of hood. Fig. 7 is a transverse sectional view of an alternative form of cooling-pipe. Fig. 8 is a longitudinal vertical section of the apparatus, taken on the line 7 7 and looking in the direction of the arrows, Fig. 2. The arrangement of the cooling-pipes and hoods is herein shown. Fig. 9 is a detail view from the side, partly in section, of the headers which form the return-bends whereby the cooling-pipes are connected and also form the supports for said pipes and for the hoods. Fig. 10 is a detail view of the headers looking in the direction of the arrow, Fig. 8. Fig. 11 is a top view of the headers as in Figs. 9 and 10, showing also a portion of a cooling-pipe and roof in position. Fig. 12 is a view in elevation of an auxiliary standard or rack for supporting the cooling-pipes and roofs at points between the headers. Fig. 13 shows a central vertical section of the auxiliary standards as in Fig. 12.

Similar letters refer to similar parts throughout the several views.

The cooling-chamber A consists of an inclosed vessel constructed of sheet metal or other suitable material and has leading thereto the pipe *a* for supplying the air from which the moisture is to be removed. The discharge-pipe *a'* serves to convey the air away from said chamber after the moisture has been removed.

The pipes *b b*, through which the brine, ammonia, or other cooling fluid circulates, extend transversely within the chamber A and are connected at their extremities to the headers B B. Said headers consist, preferably, of cast metal and are provided with an inclosed chamber *b'*, which affords a continuous passage through which fluid may pass from one to another of said pipes. I prefer to form said chambers *b'* with a sweeping curve in the manner shown in Fig. 8 in order to avoid the deposit of sediment therein when brine is used as the cooling fluid.

The headers B are preferably constructed in the form of rectangular right prisms and are designed to rest one upon another in a vertical series, thus forming a column or support to which the pipes *b* are connected. In order to increase their security of position, each of said headers is provided with a lug b^2 at one extremity, which fits into a corresponding socket b^3 in the extremity of the header next adjacent.

The vertical series or rows of headers are so arranged at opposite sides of the chamber A that by means of the passages *b'* in said headers any specified one of the pipes *b* is connected at one extremity with the next adjacent pipe above and at the other extremity with the next adjacent pipe below. By this construction a vertical row of pipes in conjunction with the connected headers constitutes a separate coil with a continuous passage throughout its length.

For the purpose of avoiding the use of unnecessary material and at the same time retaining the desired prismatic form the head-

ers B have the cored chambers b^4 extending transversely through them. With the exception of the ones occupying the highest and lowest positions in any vertical row the headers B are "universal," or, in other words, are of such symmetry that a single pattern may be used for a coil or set of coils composed of any number of pipes. The bases C C at the bottom of the chamber A form the supports for said headers B. In each coil the uppermost one of the pipes b is connected with the exterior supply-pipe D by means of a pipe d, provided with a valve d'. The header c at the top of the row of headers B, adjacent to said supply-pipe D, is so constructed as to form a direct connection between said pipe d and the uppermost one of the pipes b. Similarly the lowest one of the pipes b in each coil is connected with the exterior return-pipe E by means of the header c' and pipe e, said pipe being provided with the valve e'.

Upon the headers B, a slight distance above each of the points of connection with the pipes b, are formed the lugs F F, which support the hoods or roofs f f. Said hoods or roofs consist, preferably, of sheet metal and are so formed as to protect those of the pipes b lying beneath from water dropping from above. It is preferable that said hoods be so constructed as to have a double slope from a point above the center of the pipes b, with a pitch of about forty-five degrees and a span somewhat greater than the diameter of said pipes b. The cross-sectional outline of the hoods may be varied, however, and an alternative form of hood f' is shown in Fig. 6 of the drawings, said hood f' being curved and convex from above. The hoods are serrated—that is, are provided at their lateral edges with a series of points or projections f^2 f^2. It is well known that the amount of water in a drop varies with the configuration of the object from which the water falls. For example, the quantity of water which will fall as a single globule or drop from a needle or other pointed object standing vertically is smaller than the amount which will fall from a horizontal plane surface. When the apparatus is in operation, said hoods become covered with water, as will hereinafter appear, and as said points f^2 are the lowest portions of said hoods the water tends to collect at said points and when thus collected falls in the form of small drops.

In order to prevent the water from dropping from one hood to another one next below, said hoods are so arranged vertically that one of said points f^2 does not lie directly above the points upon the adjacent hoods below. In other words, said points f^2 are staggered or offset with respect to a vertical line, so that a drop falling from one of said points may pass one or more of said hoods below without coming into contact therewith. By this construction and arrangement of the hoods f the water does not remain thereon any great length of time, for said water gravitates toward said points f^2, and as soon as a small quantity is there collected a drop is formed which in falling clears the pipes b and also many, if not all, of the hoods f below.

The racks or standards G form auxiliary supports to prevent the sagging of the pipes b and hoods f when the same are of great length. Said racks are provided with the apertures g, wherein said pipes b rest, and also with lugs g', to which said hoods f are attached. Said hoods are secured to said lugs g' and also to the lugs F on the headers B by riveting or in any other suitable manner.

Upon the lower portions of the pipes b are secured the drips or fins H H. (Shown in detail in Figs. 4 and 5.) Said drips conform to the lower surface of said pipes and are approximately triangular or wedge-shaped in cross-section. When viewed from the side, said drips have a serrated appearance, being provided with a series of points h h, which serve to collect the water formed on said pipes and permit the prompt fall of said water in small drops in the manner described in connection with the drip-points f^2 of the hoods f.

At the bottom of the chamber A is the pan J, into which the water from the pipes b and hoods f drops. From said pan the water is removed by way of the drain-pipe j, which is provided with the valve j'.

The operation of my apparatus is as follows: It is well understood that air at high temperature will hold in suspension more water in the form of vapor than will air at a lower temperature and also that if air saturated with moisture is cooled the surplus moisture is precipitated in the form of water. To take advantage of this principle, the pipes b are reduced to a low temperature by causing brine, ammonia, or other cooling fluid to flow from the inlet or supply pipe D into said pipes b. Said cooling fluid circulates through said pipes b and headers B and finally passes out into the return-pipe E. The flow through the individual coils of pipes is regulated by means of the valves d' and e'. Air from which the moisture is to be removed is then caused to flow from the inlet a into the cooling-chamber A, where the air comes into contact with the cold pipes b. As the air is thus cooled the moisture suspended therein is precipitated upon said pipes in the form of water and the cooled air from which said moisture has been removed passes out by way of the discharge a'. As the pipes b are arranged transversely to the direction of the flow of air and are arranged at different heights and as the hoods f also cause a deflection of the air-current, the air comes thoroughly into contact with said pipes, thereby insuring the desired decrease in temperature. This is important, for if the air is saturated the amount of water contained in the discharged air will be directly proportional to the temperature thereof. The water precipitated upon the pipes b runs down onto the fins or drips H and is collected at the points h thereon. As

soon as a body of water sufficient to make a small drop is thus collected a drop is formed and falls onto the hood *f* next below. In a similar manner the water dropping onto said hoods is collected and falls in small drops from the drip-points f^2 thereon. As said points f^2 are vertically out of line, the water falling therefrom will to a great extent miss the points upon the hoods below and will be collected at the bottom of the chamber A in the pan J, from which it may be drawn off through the drain *j*. It is thus apparent that as soon as water of precipitation is formed in the cooling-chamber A it quickly falls to the bottom pan J and does not long remain upon either the pipes *b* or hoods *f*. Herein lies an important feature of my invention, for if the temperature of the cooling-pipes *b* is below the freezing-point of water, as is frequently desirable, the water, if allowed to remain a considerable time upon said pipes or until large drops are formed, and if after falling down from one pipe the water strikes other pipes below said water is apt to be cooled below the freezing-point and be deposited upon said pipes in the form of ice or frost. Such deposit would interfere with the passage of air through the chamber A and would also be objectionable in that it would operate as insulation around said pipes and minimize the cooling effect thereof. Moreover, by quickly removing the water formed upon the pipes *b* the insulating effect of the water itself is lessened, and my device is therefore much more effective as a cooling apparatus than if the water or ice were allowed to remain upon the cooling-pipes. In addition, by removing the water from the presence of the air or other gas passing through the chamber A the danger of reabsorption of the water by the gas is diminished.

By means of the valves *d'* and *e'* any one of the vertical rows of pipes *b* may be cut out of the circuit of the cooling fluid. Therefore if by accident any one of said rows becomes coated with ice the latter may be removed by shutting the valves *d'* and *e'* communicating with said row, thus preventing the entrance of the cooling fluid and allowing the ice to be melted by contact with the air passing through the chamber A.

Although the pipes *b* are cylindrical, pipes having other cross-sections may be used. In Fig. 7 is shown an alternative form of pipe B', which has a cylindrical upper portion, but has at its lower portion a pointed or wedge-shaped cross-section. The function of the tapering lower edge B^2 of said pipe B' is similar to that of the drips or fins H, attached to the pipes *b*. Said pipes B' have a certain advantage over the circular pipes *b* in that the cooling fluid within may cool the entire surface of said pipes B', but cannot gain access to and so perfectly cool the drips or fins H upon the pipes *b*.

It is evident that many other details of my apparatus—for example, the construction of the headers B, the form of the chambers A and bottom pan J, and the arrangement of the exterior piping—may be greatly varied without departing from my invention.

Although I have referred to air as the gas from which the moisture was to be removed, it is manifest that other gases may be similarly treated with similar results.

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

1. In a gas-cooling apparatus having a plurality of cooling-pipes, stationary liquid-shedding parts separate from said pipes, but vertically adjacent thereto for preventing the liquid precipitated from said gas, by reason of the cooling thereof, from coming into contact with pipes other than those on which said liquid is first collected or precipitated.

2. In a cooling apparatus, the combination of cooling-pipes for extracting the moisture from air; and stationary plates located vertically adjacent to each of said pipes for carrying off the precipitated liquid previously existing in a gaseous form suspended in said air.

3. In an apparatus for removing moisture from air and other gases, the combination of pipes for cooling said air, and hoods for preventing the water discharged from said air by reason of the cooling thereof, from coming into contact with pipes other than the ones whereon said water is first collected.

4. In an apparatus for removing moisture from air and other gases, the combination of pipes for cooling said air, hoods for protecting said pipes from falling water, and drip-points upon said hoods.

5. In an apparatus for removing moisture from air and other gases, the combination of hoods for carrying off the water extracted from said air, and drip-points on said hoods so arranged that certain of said points lie in the same vertical plane, but lie in different planes when reference is had to vertical planes located at right angles to said first-mentioned plane.

6. In an apparatus for removing moisture from air, the combination of cooling-pipes, plates fixed adjacently to said pipes for carrying off the precipitated water falling from above, and drips or fins upon said pipes for collecting the water precipitated upon the pipes by which said drips or fins are carried.

7. In an apparatus for removing moisture from air, the combination of pipes for conveying a cooling fluid and precipitating upon their outer surfaces the moisture contained in said air, stationary plates located vertically adjacent to said pipes for carrying off the water precipitated from said air, thereby preventing said water of precipitation from coming into contact with pipes other than those upon which the moisture is precipitated, and a structure inclosing said pipes and plates, said structure constituting a cooling-chamber.

8. In an apparatus for removing moisture

from air, the combination of a cooling-chamber; air-ducts leading to and from said chamber; cooling-pipes suitably supported and connected within said chamber, said pipes serving to precipitate moisture suspended in said air; hoods over said pipes for carrying off the water of precipitation and protecting the respective pipes beneath said hoods from said water of precipitation dropping from above said hoods; and drips or fins upon said pipes.

9. In an apparatus for removing moisture from air, the combination of cooling-pipes, water-shedding hoods over said pipes, and headers affording connections for said pipes, said headers also constituting the end supports of said pipes and hoods.

10. In an apparatus for removing moisture from air, the combination of cooling-pipes, water-shedding hoods over said pipes; headers affording connections for said pipes, said headers also constituting the end supports of said pipes and hoods; and racks forming auxiliary supports for said pipes and hoods.

11. In an apparatus for removing moisture from air, the combination of a cooling-chamber; cooling-pipes and headers within said chamber, said pipes and headers constituting a series of coils; water-shedding hoods over said pipes, and means for regulating in each of said coils separately the flow of a cooling fluid.

12. In an apparatus for removing moisture from air, the combination of a cooling-chamber; air-ducts leading to and from said chamber; cooling-pipes suitably supported and connected within said chamber; hoods over said pipes, and drip-points upon said hoods so arranged as to lie vertically out of line.

13. In an apparatus for removing moisture from air, the combination of a cooling-chamber; air-ducts leading to and from said chamber; cooling-pipes within said chamber; headers connecting and supporting said pipes; hoods over said pipes; drip-points upon said hoods lying vertically out of line; drips or fins upon said pipes, and means for controlling the supply of the cooling fluid through said pipes and headers.

EDGAR S. BELDEN.

Witnesses:
ELI BRANDT,
ARTHUR M. COX.