No. 636,255. Patented Nov. 7, 1899.

E. GATES.

PROCESS OF SIMULTANEOUSLY COOLING AIR AND PURIFYING AND REGULATING ITS MOISTURE AND APPARATUS THEREFOR.

(No Model.) (Application filed July 31, 1897.) 6 Sheets—Sheet 1.

Fig. 1.

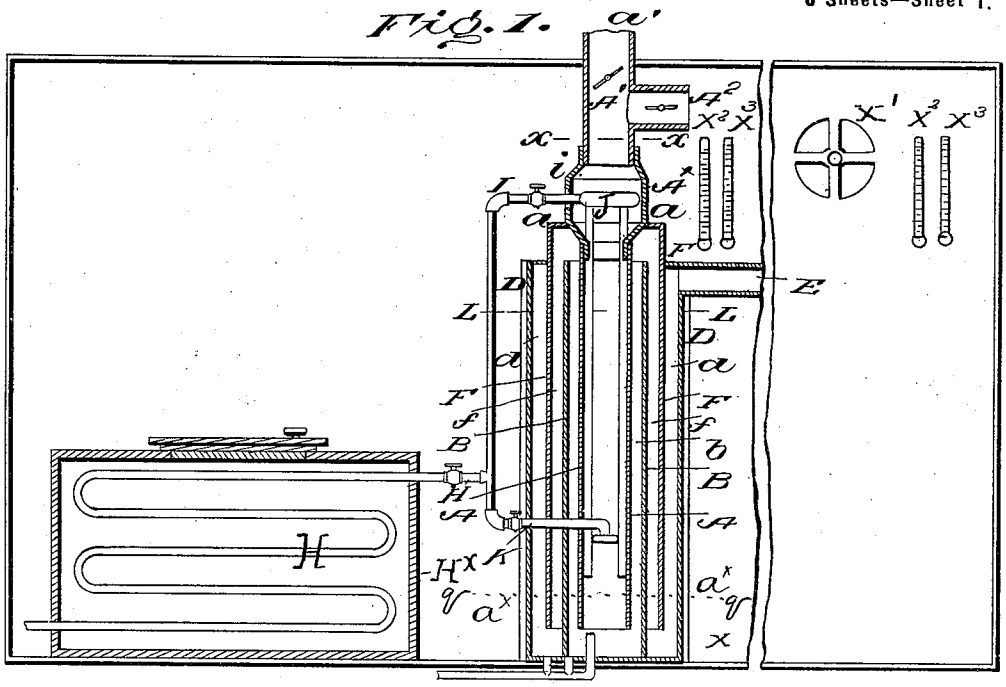


Fig. 2.

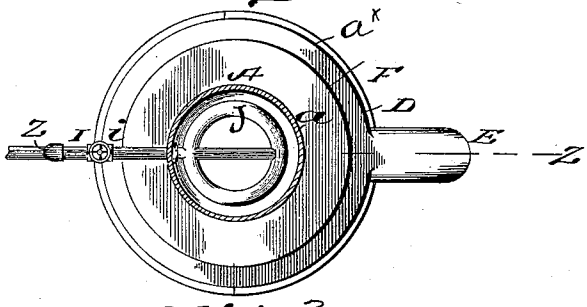


Fig. 4.

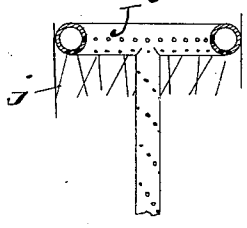


Fig. 3.

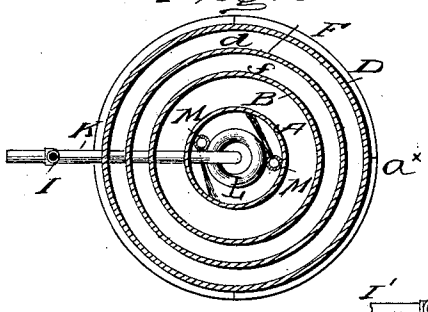


Fig. 11a.

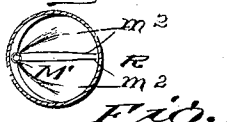


Fig. 15.

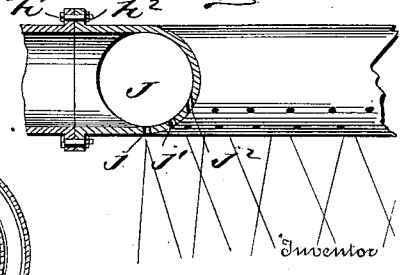
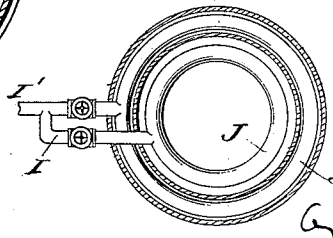


Fig. 16.



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PROCESS OF SIMULTANEOUSLY COOLING AIR AND PURIFYING AND REGULATING ITS MOISTURE AND APPARATUS THEREFOR.

(Application filed July 31, 1897.)

(No Model.) 6 Sheets—Sheet 2.

Fig. 5.

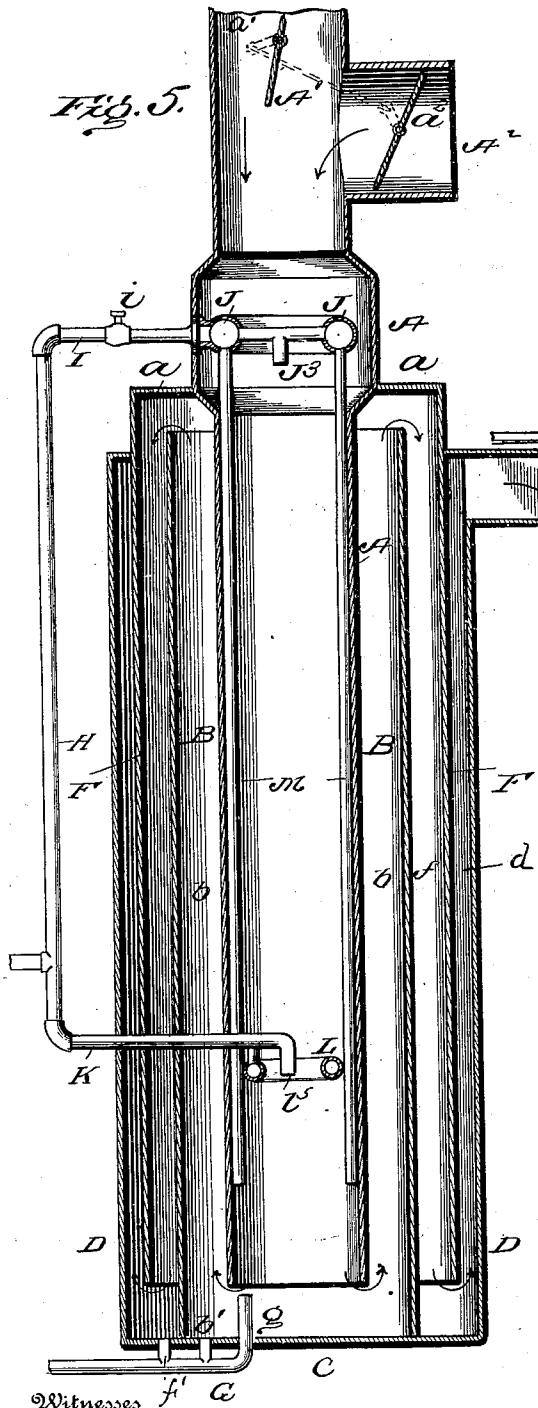
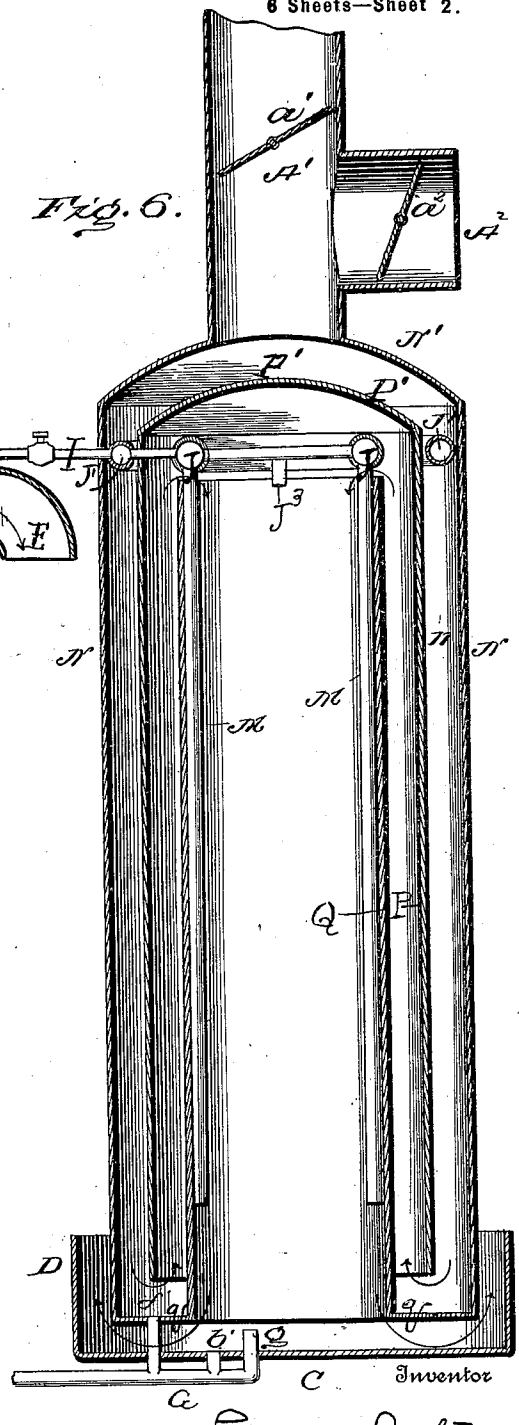


Fig. 6.



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PROCESS OF SIMULTANEOUSLY COOLING AIR AND PURIFYING AND REGULATING ITS MOISTURE AND APPARATUS THEREFOR.

(Application filed July 31, 1897.)

(No Model.) 6 Sheets—Sheet 3.

Fig. 7.

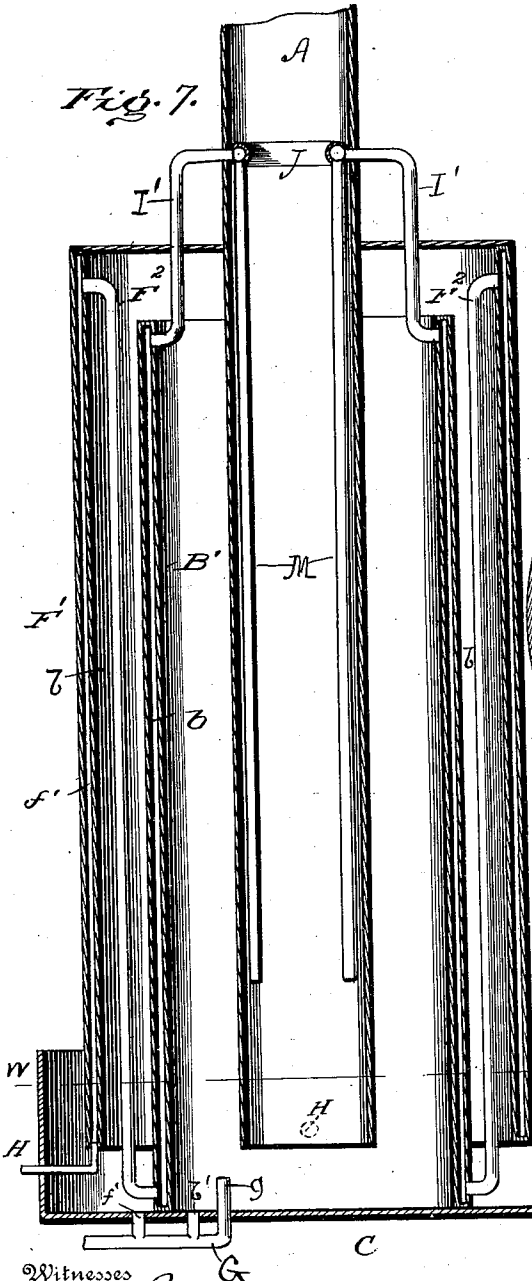
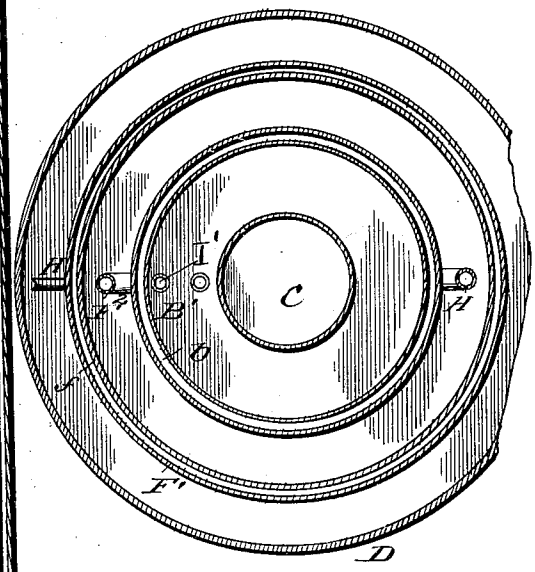


Fig. 7a.



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PROCESS OF SIMULTANEOUSLY COOLING AIR AND PURIFYING AND REGULATING ITS MOISTURE AND APPARATUS THEREFOR.

(Application filed July 31, 1897.)

(No Model.) 6 Sheets—Sheet 4.

Fig. 8.

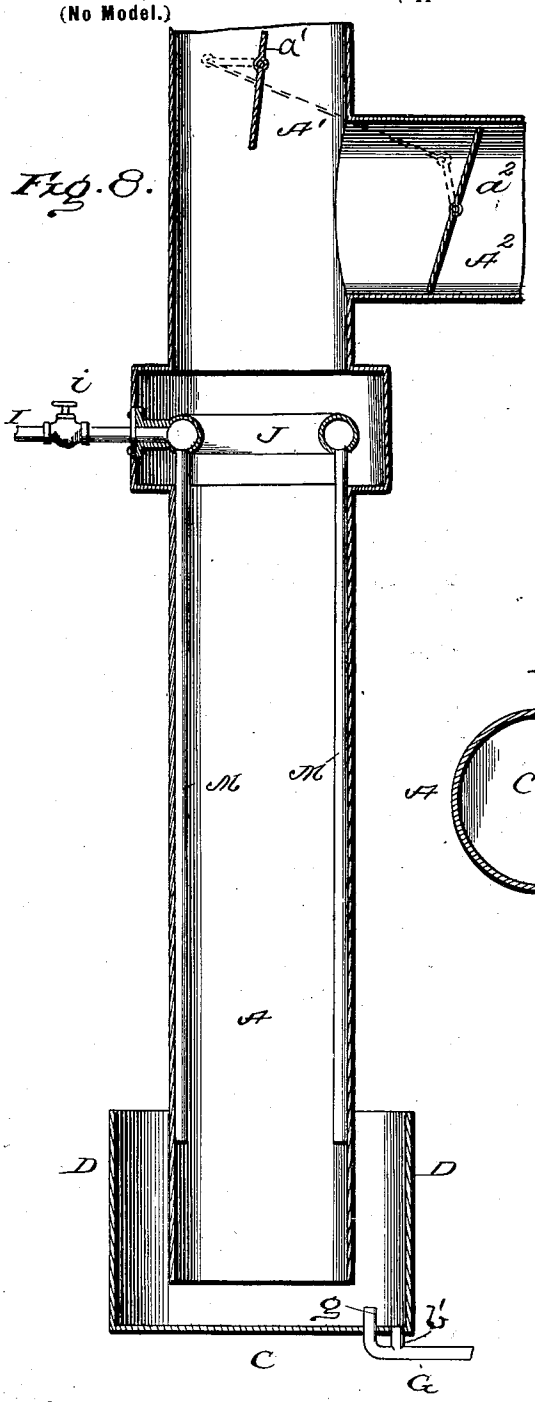


Fig. 9.

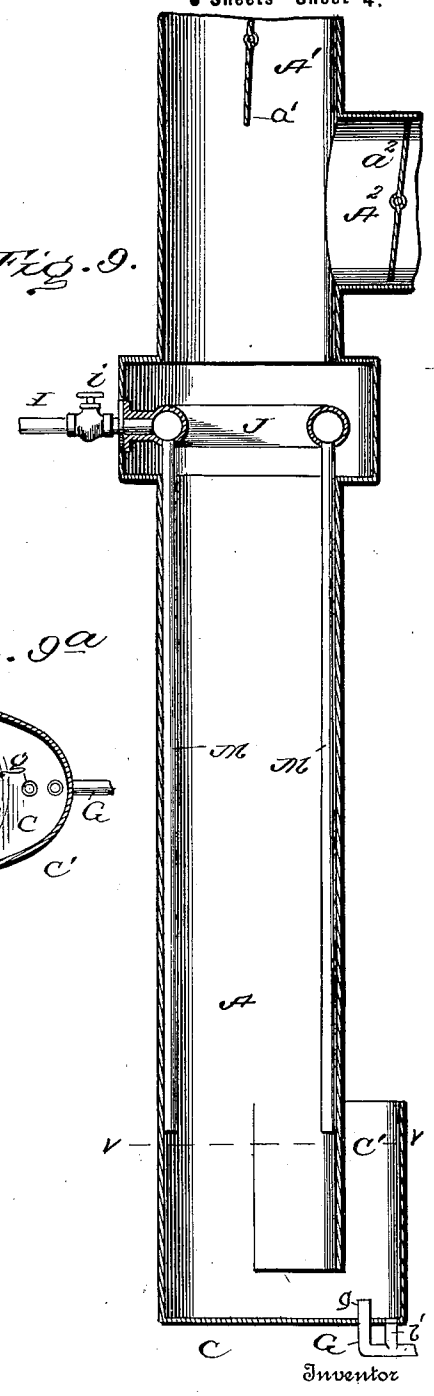
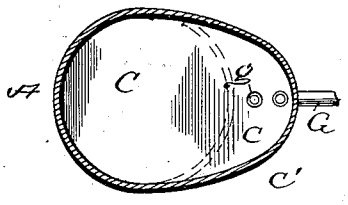


Fig. 9a



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(No Model.) 6 Sheets—Sheet 5.

Fig. 10.

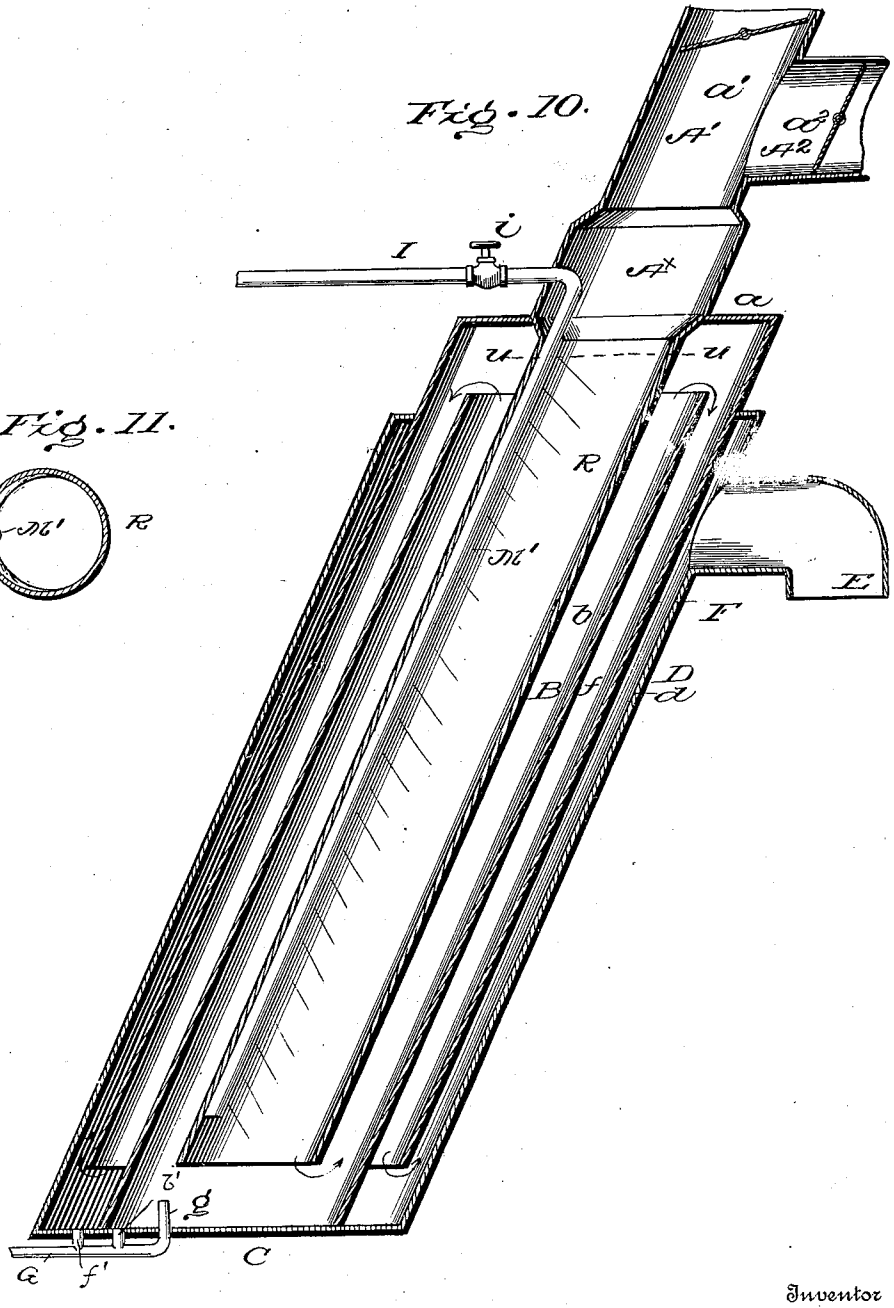

Fig. 11.

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(No Model.) (Application filed July 31, 1897.) 6 Sheets—Sheet 6.

Fig. 12.

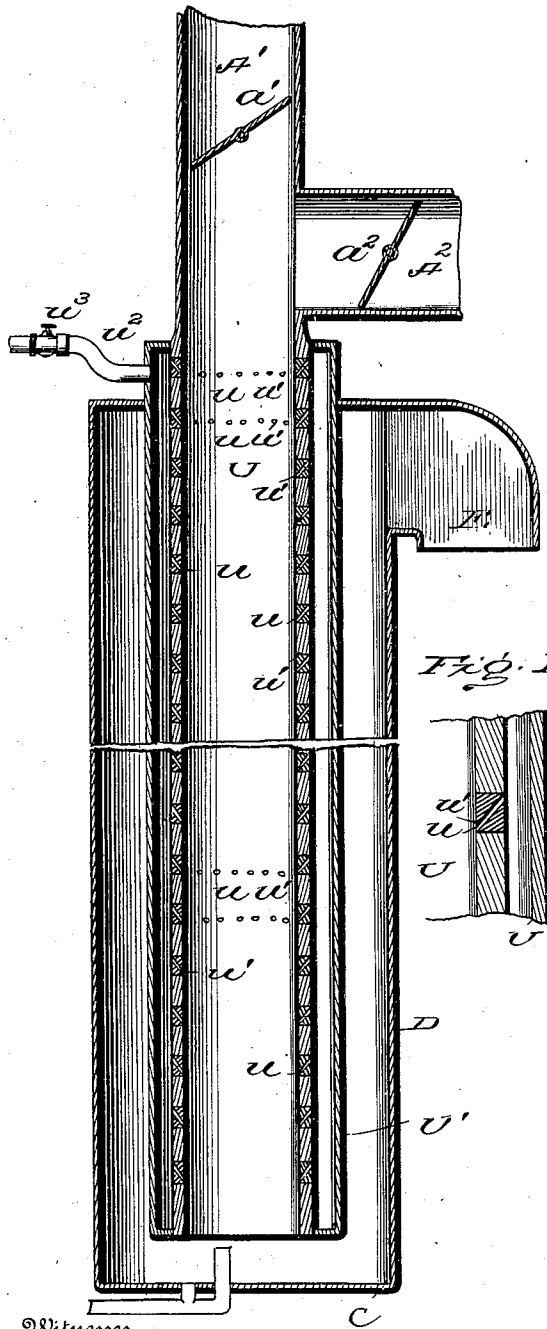
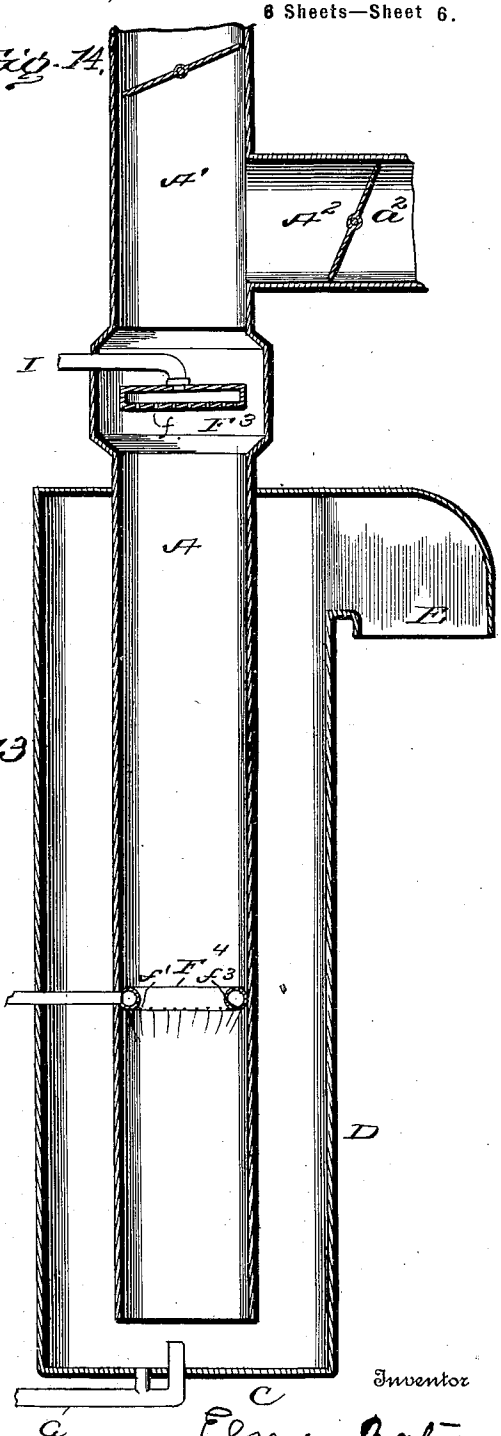


Fig. 13

Fig. 14.



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UNITED STATES PATENT OFFICE.

ELMER GATES, OF CHEVY CHASE, MARYLAND.

PROCESS OF SIMULTANEOUSLY COOLING AIR AND PURIFYING AND REGULATING ITS MOISTURE AND APPARATUS THEREFOR.

SPECIFICATION forming part of Letters Patent No. 636,255, dated November 7, 1899.

Application filed July 31, 1897. Serial No. 646,610. (No model.)

To all whom it may concern:

Be it known that I, ELMER GATES, a citizen of the United States, residing at Chevy Chase, in the county of Montgomery and State of Maryland, have invented certain new and useful Improvements in Processes of Simultaneously Cooling Air and Purifying and Regulating Its Moisture and Apparatus Therefor, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to a method for rendering the air in rooms cool, comfortable, refreshing, and healthful for respiration during the summer season and in highly-heated furnace-rooms, &c.

The methods heretofore employed for keeping rooms cool during summer have not proved convenient or satisfactory, their failure to do so being emphasized in the attempts to cool the air of sick-rooms, work-rooms, dining-rooms, and furnace-rooms during the heated part of the day. These attempts have not only failed to cool the air, but have allowed it to remain dry, warm, stagnant, and depressing. Window-screens admit dust and hot air into the rooms, and fans produce unhealthful drafts and do not cool the air, and although they keep it in circulation they do not promote ventilation. Refrigerators are objectionable because of expense for ice and of the still greater expense of purchase and maintenance of cold-producing machinery, if used, and because they do not promote ventilation or sufficient circulation of the air. Refrigerators are also objectionable because they condense the moisture out of the air, rendering it dry and unhealthful; but a refrigerator is also quite impracticable for ordinary domestic uses because very large refrigerating-surfaces would be needed to cool air fast enough for the purposes of hygienic ventilation. Keeping the windows closed and darkened renders the air unhealthful because of the absence of sunlight, and the method does not keep the room cool if it is properly ventilated or if people occupy it. No device is at present obtainable which makes it as inexpensive and convenient to quickly cool the air in any or all the rooms of a house as, by means of a stove, we can warm them.

There are no devices which, while they cool the air also free it from dust, foul gases, and other impurities and at the same time guarantee a certain and sure supply of fresh air. Neither have we any cooling devices which without a special and complicated system of hygrometers, moisture-producers, and moisture condensers automatically regulate the humidity of the air.

It is the object of my invention to avoid the aforementioned defects in the present methods of cooling a room, and to supply a new and efficient apparatus—a cooling-stove—which will as readily and quickly cool the air in a room in summer as a heating-stove will warm the same room in winter.

It is also the object of my invention not merely to cool the air, but at the same time to automatically bring a regulated quantity of air into the room and to force a corresponding volume of breathed and warmed air out of the room, thus producing sanitary and sanatory ventilation.

A further object is the freeing of the air from dust, odors, and gaseous impurities, and to automatically regulate the amount of moisture, so that it may be neither too much nor too little for health, and so that it may have a refreshing feeling and an invigorating effect.

Still another object of the invention is the production of thorough ventilation without drafts of air; and, lastly, it has been my object to produce a device which is simple, automatic, and inexpensive, so that like an ordinary stove it may readily be placed in any room, be ornamental, occupy but little space, and be easily managed without special instruction.

The invention is of value to the sick when the weather is hot, because, as is well known, the death-rate is greatly increased by an oppressive temperature, and is also of value to working people in crowded establishments, not alone to their health, but to the employer, who thereby gets more labor performed in the same time; but the greatest value is in the home, where a cooled room secures comfort and rest during the day and recuperative sleep at night.

Figure 1 is a vertical section of an apart-

ment containing a machine or stove built in accordance with my invention. Fig. 2 is a horizontal section, enlarged, taken on line *x x*, Fig. 1. Fig. 3 is a horizontal section, also enlarged, taken on line *y y*, Fig. 1, looking downward. Fig. 4 is a detail still more enlarged and illustrating the movements of the water in its travel through the upright part of the machine. Fig. 5 is a vertical section on line *z z*, Fig. 2. Fig. 6 is a vertical section of a modification. Fig. 7 is a vertical section of another modification. Fig. 7ª is a horizontal section on line *w w* of Fig. 7. Fig. 8 is a vertical section of a simplified modification of my invention. Fig. 9 is a similar section of a more simplified modification. Fig. 9ª is a transverse section on line *v v* of Fig. 9. Fig. 10 is a vertical section of another modification, in which all the cylinders are disposed in an inclined position. Fig. 11 is a detached section of the inner cylinder on the horizontal line *u u*. Fig. 11ª is a transverse section of the inner cylinder of Fig. 10. Fig. 12 is a vertical section of another modification, in which I propose to employ a tube or cylinder of relatively small diameter in proportion to its length. Fig. 13 is an enlarged section of said inner tube. Fig. 14 shows another modification. Fig. 15 is a detail, enlarged, of a portion of the discharger. Fig. 16 is a plan view showing two dischargers.

Referring particularly to Figs. 1 to 5, X X indicate the floor and inclosing walls of a room or apartment within which is located one form of my apparatus or cooling-stove.

A is a cylinder or shell, made, preferably, of copper, galvanized iron, or other not easily corroded or cast metal and circular in cross-section. This cylinder has or may have combined therewith a laterally-enlarged section $A^{\times}$ near its upper end, as is indicated in the drawings, above which is a continuation or extension A′, which is designed to communicate with the air outside of the building and is preferably provided with some sort of a damper, as at *a′*, there being also another similar inlet pipe or tube A^2, communicating directly with the air inside of the room or apartment and disposed near its ceiling, so as to admit air from the upper part of the room. a^2 is a damper within this inlet-pipe, the dampers being connected by cranks and links, so that they act reciprocally—one opening as the other closes. Preferably I make the enlarged section $A^{\times}$ removable—as, for instance, by connecting it with the sections above and below by overlapping tubular joints, as indicated in Fig. 1.

The cylinder A has its lower open end a short distance above the lower end of a shell or cylinder B, which is of larger diameter and is open at its upper end, but is closed at its lower end by a base-plate or head C, of greater diameter than the cylinder B, with a third cylinder or shell D rising therefrom and preferably closed at its upper end except an outlet-pipe E, which may be short, as in Fig. 5, or of greater length, as in Fig. 1, its open end discharging downward.

F is another shell or cylinder disposed in the annular space between shells B and D, with its lower end open, its upper end being united with the inner cylinder A by means an annular collar or flange *a*.

It will be seen that there are three concentric annular chambers *b d f*, through which air can be moved in a sort of zigzag path, as indicated by the arrows, the air-current entering at the upper end of the cylinder A, at the bottom of which its direction of travel is reversed, and passing into the apartment through the outlet-pipe E.

G is a drain-pipe, the upper end *g* terminating a short distance above the base-plate C, with short pipes *b′ f′* communicating directly with the chambers *b f*. The presence of a series of small drain-pipes insures that under all ordinary conditions there will be no escape of air through pipe G, but there will be a satisfactory drainage, with varying quantities of water flowing through the apparatus, the horizontal section of the said pipe being kept practically full of water at all times. The object of this combination of drain-pipes is to secure a better discharge of water from the apparatus under all the varying conditions of use. Of course suitable bracing or spacing connections or ties may be employed between the concentric cylinders to assist in maintaining them in proper relation to each other.

H is a water-pipe connected to some suitable water-supply which will afford sufficient pressure, preferably to the street-mains of the ordinary waterworks system, where such is accessible. In the illustration shown in Figs. 1 and 5 this water-pipe is disposed vertically, with a horizontal extension I and a stop-cock *i* to deliver water within the upper end of the cylinder through a discharger or annular sprayer J, the construction and operation of which are as follows: Preferably the discharger or annular sprayer is located in the expanded or enlarged part of the cylinder and is in the form of a hollow ring of somewhat less diameter than the cylinder at that point, with a series of perforations or discharge-openings in its lower half. In order to attain the best results, I prefer that the wall of the discharger or annular sprayer, at least that part through which the openings are made, shall be of such thickness that each of these small openings shall constitute practically a short tube of such length as to efficiently determine the direction taken by the fine stream of water passing through it, the stream being so small that it will break up into droplets. As is more plainly indicated in Fig. 4, the outer row *j* or two rows of these perforations incline in such direction that the streams of water issuing from them are discharged against the inner wall of the cylinder A downwardly and tangentially in

such way that the water moves over the said inner surface or wall in a spiral path and in a thin sheet, other perforations j' j^2 having such a pitch or inclination that the droplets travel in a somewhat spiral or circular path for some distance after leaving the discharger, the result being that the water is broken up into a great multitude of rapidly downwardly moving droplets which so nearly fill the space inclosed by the cylinder as to carry with them a downward-moving air-current drawn in at the top of the cylinder and discharged at the lower end.

Still referring more particularly to Fig. 5, the air-current travels down the cylinder A and around its lower open end, thence up through the annular chamber *b*, around the upper end of the cylinder F, down through the chamber *f*, around the lower end of that cylinder, up through the annular chamber *d*, and thence out through the outlet-pipe E. As indicated in Fig. 1, said outlet-pipe is or may be extended toward the center of the room and discharged downward toward and upon a bed, a table, or other piece of furniture and upon a person or persons thereat.

It will be readily understood that the frictional engagement or contact of the downward tangentially-moving droplets will produce a vortex-like movement of the air column within the cylinder A and that several functions are incident thereto. For instance, an increased volume of air will be drawn in at the top of said tube and discharged through the outlet-pipe. By reason of centrifugal action dust particles and other deleterious matter will be separated from the air-current, caught by the thin sheet of water which is moving in a downward spiral path around the inner surface of said cylinder, and discharged at the bottom into the water, and finally passing out through the waste-pipe G. More or less of the heavier particles of matter not driven against the spirally-moving sheet of water will acquire such momentum while moving downward through the cylinder that instead of following the air-current in its reversed path upward through chamber *b* will continue downward into the water which is flowing over the upper surface of the base-plate or head C, and thence out through the waste-pipe. Thus the air which is finally delivered into the room will be practically freed from such character of impurities and also from other fine particles of matter which will be caught by the descending droplets, and thus carried out through the waste-pipe.

It is important in an apparatus of this character that there should be practically no obstruction in the path traversed by the air-current in its way through the machine, particularly of a sort which would tend to interfere with the ready formation of a vortex-like movement, for these two reasons more especially—first, because it has been found such formation of column facilitates the movement of the greatest amount of air through an appropriately-shaped trunk or other sort of conduit with the expenditure of motive power, and, second, because that character of moving column is the most effective in purifying the air through the operation of centrifugal action, and economy as regards these results is especially desirable in a machine in which the work is being done by water from the fact that undue or needless consumption of water will under many circumstances absolutely prevent their being used in many places where their operation would be very serviceable.

Now in my invention I have provided against the above-indicated interferences with the air-currents as follows: First, as illustrated in Figs. 1, 3, 6, 8, 9, 10, and 16, I have combined with the open upper end of the cylinder A an enlarged section, enlarged in horizontal diameter, in which is located the discharger or sprayer, which is itself disposed a short distance above the upper end of said cylinder, thus permitting air to flow in not only through a central opening having a diameter almost as great as that of the cylinder, but also through an annular throat-like space between the sprayer and the entire upper end of the cylinder, the upper bounding wall or surface of which is curved and inclined downward and inward toward the center of the cylinder, and is therefore adapted to facilitate the proper movement of the air to form a vortex within said cylinder. Again, I employ dampers or valves, consisting of disks pivoted centrally within the inlet-sections A' A^2, which when only partially open admit air around nearly their entire peripheries, a mode of operation which further facilitates the formation of the desired vortex. When beginning to open, they admit air over two opposite edges. In Fig. 14 the same arrangement of valves or dampers is shown, with absolutely nothing within the cylinder to obstruct the movements of the air-current, and from an examination of the drawings it will be seen that substantially the same condition exists in all the air-passages, so far as relates to their being unobstructed.

Two other features of construction which I have adopted contribute materially to the formation of the vortex, as follows: One is the combination, with said cylinder, of an annular sprayer or discharger, whereby the air is caused to enter and pass through a central opening within said sprayer, the second feature being the combination, with the above-recited parts, of a vertical tubular trunk disposed above that central opening and in line therewith, and thereby adapted to commence the formation of a vortex in the air-current prior to its passage through the central opening of the sprayer, having found that by the use of such a combination of instrumentalities the actual formation of the vortex will be commenced some distance above the sprayer and a much more effective utilization of the entire length of cylinder A for the purpose designed than could possibly be attained in

any prior construction, a matter of great practical importance in view of the fact that the height of the apparatus is limited by the height of the apartment within which the invention is to be worked in each case.

Again, by reason of the downward-moving water being divided into droplets, it exposes a very large surface to the air through which or with which it is moving, and it will rapidly cool the air; and this whether the air be drawn through the inlet-pipe or extension A′ in whole or in part; or whether it be drawn through the inlet-pipe A^2 from the room or apartment in whole or in part, it being evident that by proper use of the dampers a' a^2 or other equivalent regulating devices the proportion of air which is drawn from the room and discharged again into the room, or is drawn from outside of the room and discharged into the room may be regulated to correspond with the varying conditions of each particular case, dependent in great measure upon the size of the room, the number of its occupants, the difference in temperature between the water which is being used and the temperature at which it is desired to maintain the air within the room, the temperature of the air outside of the room, the hygrometric condition of the air within the room and that outside compared with the relative humidity desired within the room, and other exigencies which may arise, as will be readily understood without further explanation. So, also, means may be employed for reducing the temperature of the water before it is delivered through pipes I K or either of them. A simple convenient way of doing this will be to surround a zigzag section of the pipe H by a box $H^{\times}$, Fig. 1, and put therein some suitable refrigerating material.

In addition to the relatively small openings or perforations j j' j^2 I propose to combine therewith a central discharge consisting of a series of small openings or perforations which are or may be in the form of an ordinary sprinkling-nozzle or sprayer, as is indicated at j^3, (see, for instance, Figs. 5 and 6,) the drops from which fall in nearly vertical lines, so as to move downward a sort of core or central column of air, which may have at its upper section a slightly centrifugal or vortex-like movement, the character and general direction of these air-currents depending in some measure, however, upon the height of the cylinder, its diameter, and the water-pressure employed, together with the relative sizes of the air-inlets, which latter are regulated by means of either or both of the dampers a' a^2.

I am aware that in the class of apparatus known as "spark-extinguishers" used in the smoke-stacks of locomotives or other engines it has been proposed to employ a series of tubes radiating from a central hollow head and inclined upward, the device to be located at or near the base of the stack for the purpose of imparting a spiral motion to the steam and gases which are being driven upward through said stack with great violence by the expansion of the steam as it escapes under great pressure from the cylinder or cylinders of the engine, the object of said device being to impart a rotary or whirling motion to the draft, which will operate to extinguish the sparks before they reach the atmosphere and will permit some of the heavier incandescent particles to drop back through the outgoing whirling current of steam and fall into the smoke-box after they have been extinguished by being driven against the inner surface of the smoke-stack. In such spark-extinguishers there was no attempt made, so far as I am aware, to do either of the three things which constitute the useful features in the operation of my invention, as follows: the modification of the temperature of the outgoing current in which the vortex had been produced, the modification of the hygrometric condition of said current, and the removal from said current of impurities, partly by driving them downward with the current in such manner that they will continue their downward movement after the direction of travel of the current has been reversed instead of going out of the apparatus with the current.

In automatically regulating the hygrometric condition of the air within the apartment I utilize the well-known fact that the question whether or not and the extent to which air yields its moisture to or takes moisture from water with which it is brought into contact depends upon, among other things, the temperature of the air compared to that of the water, the relative humidity of the air, the relative extent of exposed water-surface, and the rate of travel or flow of the air in contact with such exposed water-surface. Now, by reason of the water being divided into droplets and its exposed surface being thereby greatly increased relative to the bulk of water, by the movement, including the rotatory motion of the droplets and their rapid movement through the downwardly-moving air-current within the cylinder, I am able to rapidly and automatically vary the hygrometric condition of the air of the inclosed apartment within such limits as shall produce the best sanitary and sanitory conditions. After such limits of hygrometric conditions in both directions shall have been ascertained and determined upon by any means they can be maintained with substantial uniformity by regulating the water-supply and varying such supply, together with, where greater accuracy is desired, the temperature of the water, together with the temperature of the room, by means of the dampers above referred to, also under some circumstances regulating the outlet of air from the room.

In Fig. 1 I have indicated at X′ a ventilator, which may be of any well-known or approved sort, properly located, and I propose to employ one or more thermometers X^2 and hygrometers X^3, inspection of which will enable the attendant to determine the atmos-

pheric conditions within the apartment and make the various adjustments above indicated, so as to maintain the proper sanitary and sanatory conditions, as may be found desirable.

It is well known that owing to the fact that the street-mains are buried at about the same depth the water issues therefrom at a nearly uniform temperature throughout the entire service and rises and falls very slowly with the changes of the seasons, and of course the temperature of the refrigerating material can be so controlled that the temperature of the water passing through the water-pipe therein can be regulated. Now by a little experimenting and regulating of the valves and the dampers, meantime watching the fluctuations of the thermometers and hygrometers, they can be so regulated that when once properly set the desired atmospheric conditions within the room will be automatically maintained for a quite long period of time.

While under many conditions satisfactory results may be attained through the employment of only the devices above described, yet under some conditions, particularly where the height of the cylinder A is such as to make it desirable, I propose to combine therewith a series of supplemental devices which are practically duplicates of those indicated by $J\,j\,j^2\,j^3$ and which are indicated at $L\,l\,l'\,l^2\,l^3$, differing, however, from the upper corresponding series in that, among other things, the hollow ring must be small enough to be disposed inside of the vertical water-pipes M M, to be described, and in having no communication therewith. The conditions which exist within cylinder A at the point where the second or supplemental annular discharger or sprayer should be located are materially different from those which exist at the upper end of said cylinder, so far as relates to the water, the air, and the impurities, in the following respects, among others: First, the thin sheet or film of water has in great measure or wholly lost its spiral motion by reason of friction and is moving directly downward; second, another portion of the water which left the sprayer in tangentially downward-directed streams has become fine rapidly-rotating droplets, which, in moving directly downward or nearly so, present a greatly-increased surface to the air-current, and would be therefore liable to be carried out of the apparatus, particularly with some of the modified forms to be hereinafter described, and, third, these minute droplets have been "loaded," so to speak, with impurities which they have abstracted from the air-current since they left the sprayer in streams. Likewise the downward-moving air-current is in a materially different condition from what it was a short distance below the top of the cylinder in that, among other things, while its downward velocity has increased its vortex-like motion has decreased, this change having been produced in part by the friction of the air against the film of air at the inner surface of the cylinder and in part by the effect of the downward-moving droplets of water above referred to. So, also, the condition of the impurities of the air-current is different at the point of the lower sprayer from what it was at the upper end of the cylinder in that, among other things, some of both the lighter and the heavier particles have been driven into the film of water and are in condition to be carried out through pipe G. Some are moving downward with the droplets of water and if unmolested will be carried out of the apparatus with the reversed air-current; but the action of the second sprayer in producing a vortex in the air-current operates differently from the vortex at the upper part of the cylinder in effecting a purification of the air, because, among other things, many of such particles are now being carried by the droplets, and, secondly, because the greatly-increased surface of the droplets, as compared with the surface of the streams, enables the vortex to operate much more efficiently in forcing such impurities into the downward-moving water film, whence they will go out through the waste-pipe. These pipes M M, preferably two of them, are closed at their lower ends, but open at their upper ends into the hollow ring J, from which they are in this instance suspended, and they are provided with a series of downward-inclined openings *m m*, which are adapted to deliver small streams of water tangentially upon the inner wall of cylinder A (see particularly Fig. 3) and in the direction of the spirally-moving thin sheet of water flowing over such surface in such manner that the rapidly-moving droplets will insure that the spiral direction of the flow of that sheet of water shall be continued, preferably to the lower end of the cylinder, which will assist in maintaining the air vortex even though the cylinder be of such height that otherwise the travel of the lower part of the sheet or film of water would be on lines practically vertical by reason of the frictional contact of the water with the cylinder. Thus these pipes M constitute supplemental devices for maintaining the desired flow of water and may be used as auxiliaries to the discharger J under any conditions which may exist. The presence of these vertical pipes in close proximity to the inner wall of cylinder A produces eddies immediately behind them, (having reference to the direction of travel of the air,) into which eddies the particles of impurities move, collect, and are caught by the water and carried by it down into the waste-pipe G, such collection of objectionable matter, including noxious vapors and odors, being made more effective by the fact of the difference in direction, speed, and character of movement within the eddies.

To facilitate connecting the water-pipe I with the discharger J, I propose to use a flanged joint $i'\,i^2$, (shown in Figs. 8, 9, and 15,)

the openings through which are of such size as to facilitate removing from the discharger any material which may accumulate therein, particularly such as would tend to obstruct the discharge-openings, and of course a similar coupling may be used with the pipe K of such construction preferably that the connection and separation may be effected without disturbing the position of the water-supply pipe.

I do not wish to be limited to using pipes M M, one or more of them, of such length as to extend down to the supplemental discharger L when that device is used, and I propose when needed to provide one or both of those pipes M with a series of downward-inclined openings which will discharge water toward the center of the cylinder A.

In order to attain the most satisfactory results under all conditions, I combine with the cylinder A, which is open at its lower end, a larger cylinder B, a still larger one F, open at its lower end, and an outer cylinder D, as I have above described, the air passing in a zigzag path through the concentric series of inclosed air-chambers; but one or all of these last-referred-to chambers may be omitted, particularly the outer one, D, although I prefer to have the outer one extend upward from the base-plate C such distance to, say, the point indicated by the dotted line q q, thus constituting a tank or receptacle to collect water and discharge it from the apparatus through the pipe G.

In the modification shown in Fig. 6 the relationship between some of the parts of the structure is reversed, as follows: While the number of concentric cylinders and inclosed air-chambers is the same as in the preceding figures, all except the outer one, D, and its discharging-outlet are inverted as regards their open ends and their connection with the air-inlets A′ A^2—that is to say, the cylinder N, which is next inside the outer cylinder D, has its upper end connected directly with the inlets by means of a collar or annulus N′, and the next inside cylinder P is closed at its upper end by a head or cap P′, thus forming a duct or passage-way n', through which air enters the outer concentric chamber n of the apparatus. Then the inner cylinder Q has its lower end connected with cylinder N by a collar or annulus q, there being a concentric air-chamber p, so that the air in its zigzag path through the apparatus is compelled to follow a different route from that which it travels in the prior figure, although in this essential particular the air-current moves in a downward vortex-like column inside the inner cylinder and is moved in that manner by the operation of water discharged through some series of openings j j' j^2 j^3, and preferably one or more perforated vertical pipes M M, which are substantially like the corresponding parts of the other figures and need not therefore be described in detail. In this form of my invention I propose to employ also a supplemental discharger J′; but instead of disposing it within the lower part of cylinder Q, I prefer to locate it in the upper part of the air-chamber n and supply it with water from water-pipe I, which is or thus may be made common to both dischargers; but by preference it has a separate and independent water-pipe $L^{\times}$, with stop-cock $i^{\times}$, so that if from any cause it shall be found desirable to use either of the dischargers separately the apparatus can be operated in that way, a convenient way of doing which is illustrated in Fig. 5—that is to say, the water-pipe may have two branches L L′, with a stop-cock in each, as is diagrammatically indicated in Fig. 20. One decided advantage which is incident to this form of my invention is due to the fact that the droplets from discharger J′ travel the entire height of the two cylinders between which they move and therefore exert their influence upon the downward-moving air-column for a greater length of time, and therefore more effectively in some respects than the water from the supplemental discharger in the preceding figures does. Of course there is no central "core" in the air-chamber n, such as there is within the cylinder A, and owing to the narrowness in horizontal section of the space between cylinders N and P the tangential downward-moving droplets will operate effectively in imparting to the air-current a corresponding movement, so that the air vortex within cylinder Q will commence the work of separating fine impurities from the air-current at a much higher point than it will in the machine of the previous figures.

In Figs. 7 and 7^a I have shown another modification, in which the walls of the cylinders B′ F′ are double and are closed at top and bottom, thus forming a series of concentric water-chambers b' f', disposed between the air-chambers b f and not communicating therewith. In this apparatus the water-pipe H instead of communicating directly with the dischargers opens into the lower end of the water-chamber f' of cylinder F′ and after traveling upward through that water-chamber is conducted by one or more pipes F^2, preferably two diametrically opposite pipes, to the lower end of water-chamber b', from the upper end of which air-chamber it passes through one or more water-pipes I′ to the discharger J, constructed like those heretofore described, and vertical pipes M M. From an examination of the drawings it will be readily understood that when the apparatus is in operation the temperature of the water rises gradually from the time it enters water-chamber f' until it reaches the water-receptacle C by reason of absorbing heat from the traveling air-current. Another difference in mode of operation and result between this form of my invention and the prior ones is this: In this last-described apparatus the air after passing around the lower open end of cylinder C travels over and in contact with a series of sur-

faces of increasing coldness and upon which by reason of their reduced temperature moisture carried by the air is constantly being deposited, so that the air is much drier when it leaves the apparatus than it will be when leaving either of the other forms of my invention with a given temperature of water-supply and a given temperature of air which is being acted upon or treated, for which reason this form of my invention possesses some advantages as regards the regulation of the hygrometric conditions of air within an apartment over either of the previously-described forms, because, among other things, it is possible by reducing the temperature of the water within the air-chambers to materially increase the amount which will be abstracted from the air moving over and in contact with the metallic surfaces of those relatively cold-water chambers, and thus deliver into the apartment air which is very much drier than the air would be if it were delivered directly from the cylinder C or even followed the zigzag path through the various air-chambers without being subjected to the action of the increasingly cold surfaces above indicated.

In Fig. 8 I have shown a simplified modification, in which the cylinders B D F are omitted, except so much of the outer one, D, as is required to form the sides of the water-receptacle, thus delivering the air which has been treated at the lower part of the room.

In Fig. 9 the construction of the apparatus has been further cheapened by omitting the greater portion of the cylindrical wall or sides D of the water-receptacle, continuing the cylinder A down to the base-plate C throughout the greater part of its circumference, and providing a sort of upturned lip or flange C′ adjacent to the cut-away lower end of said cylinder for the delivery of the reversed air-current and the collection and discharge of the water.

Although I have used the word "vertical" as describing or indicating the position of the cylinders and water-pipes M M, I do not wish to be limited to placing them in exactly such position, because under many conditions satisfactory results can be obtained with the above-referred-to parts of the apparatus disposed at an angle of many degrees from the vertical. In fact, in Fig. 10 I have illustrated a modification in which R is a cylinder inclined in position, its angle to the vertical depending upon some conditions which will be hereinafter explained. M′ is a water-pipe disposed in close proximity to the uppermost inner surface of the cylinder, closed at its lower end and provided upon opposite sides with a series of perforations, substantially such as those in the water-pipes M, as heretofore explained, except that instead of discharging water from one side only of the pipe it discharges water in opposite directions, preferably tangentially downward toward the bottom of the cylinder, in such a way that there is a spirally downward moving two-part thin film of water flowing in opposite directions around the inner surface of the cylinder, uniting at a line extending lengthwise of the cylinder upon its lower surface and emptying into the water-receptacle. In addition to such holes m' m' I propose to provide another series m^2 m^2 through the under surface of the pipe under some circumstances, (see particularly Figs. 5 and 6;) but without this second or supplemental series air entering at the upper end of the cylinder becomes cool by contact with the water adjacent to the pipe M′ and descends, giving place to warmer air, which in turn becomes cooled by the contact of the water, so that there flows out from the lower end of the cylinder a continuous current of air which has been cooled, purified, and has had its hygrometric condition changed during its travels through the cylinder. Surrounding this cylinder R is a concentric one, B, with an annular air-space *b*, the lower end of the cylinder B being closed by the base-plate C, thus compelling the air-current to follow the path indicated by the arrows at the upper open end of said cylinder. Outside of this there is a larger cylinder F, open at its lower end and closed at its upper end by a collar or annulus *a*, extending inward to the inner cylinder A. D is a still larger concentric cylinder, closed at its lower end by the base-plate C and at its upper end by a flange or collar connecting it with the cylinder F, with an annular air-chamber *d*, so that the air travels in a zigzag path (indicated by the arrows) to the outlet E.

In the modifications of my invention which I have illustrated in this case there is a novel mode of operation common to them all—that is to say, the moving of the air-current through the apparatus is produced in large part by the pulling action of rapidly-moving small bodies of water—the construction and arrangement of the various appliances for discharging the water within the cylinders being such that, following the general line of movement of the air-currents, the small bodies of water, streams, droplets, or spirally-moving films move much more rapidly than does the adjacent air, one result thereof being that the velocity of the air-current and the degree of its rarefaction are increased during its travel through the cylinder or tube, one advantage of which is the increase in the facility with which the separation from the air of various impurities and their collection by the water is effected, in part by the centrifugal action of the air-current, in part by the increase in the downward motion of the particles of the impurities by reason of which they continue their movement down into the water at the bottom of tube A instead of going up with the air-current, and in part by said impurities being engaged by the water, which travels faster

than they do, and thus picks them up, as it were.

In Fig. 12 I have shown a somewhat simplified form of my invention, in which I employ a tube U of relatively small diameter in proportion to its length and having a series of inclined perforations in its sides. A convenient way of making these perforations is to provide the tube with a series of quite large openings and fill these openings with other metal of some sort and then drill or punch the perforations through such metal plugs or inserts. One method which I have employed successfully is to fill the larger openings of the tube with lead and then punch the apertures with a fine-pointed punch which is tapering either throughout its entire working length or at its point, the result being that the lead or other soft metal is compacted around the openings, which will be found desirable both because such condensation of metal at that point increases its durability and also presses it firmly against its seat in the pipe.

In Fig. 13 I have shown an enlarged section of a portion of the pipe to illustrate this part of my invention. The perforations u are indicated as pointing directly toward the center of the tube, while those at u' not only incline downward and inward, but are tangential to the bore of the tube, so as to produce a vortex in the downward-moving air column. U′ is a tube or casing surrounding tube U, with an inward-projecting flange or rim at the top and a similar one at the bottom, thus forming an annular water-chamber, with a feed-pipe u^2 and a stop-cock u^3. The perforations extend or may extend from top to bottom of the tube, so that the downward-moving air column has its speed accelerated from top to bottom, and when tangential perforations are employed, either separately or in connection with the radial ones, the speed of rotation of the vortex is also increased at the lower part of the tube. C D represent a water-reservoir, with a waste-pipe G, as in the prior constructions, and it is obvious that by extending the cylinder D up the side of the tube U′ for some distance the air after leaving the lower end of tube U will be brought into contact with the outer surface of said cylinder U′, which is cooled by the current of water within, the temperature of which is lower than that of the jets or spray of water which the air-current has just left, so that under many conditions, which can be regulated at the will of the operator, the air can be dried and its hygrometric condition kept within such a range of relative humidity as will insure its sanatory condition in each particular case.

Under some circumstances I propose to arrange the apertures through the wall of the tube U in groups—that is to say, two or more rows of such apertures extending around the tube at the upper part of the water-chamber and one or more similar series at points below—at, for instance, the places indicated by parallel rows of dotted lines Fig. 12, dependent upon the length of the tube or its diameter, or both.

In Fig. 14 I have shown another modification, in which I employ a cylinder A, substantially like that shown in Fig. 1, with an enlarged section, preferably made removable—as, for instance, in Fig. 1—and in which I mount a water-discharger F^3, the lower face of which is preferably flat and formed with a series of vertical holes of such diameter that the water-jets issuing therefrom will descend some distance in the form of continuous unbroken streams instead of breaking up into droplets. Then at a point such distance below discharger F^3 that the streams from that last-mentioned discharger have not broken up into droplets I place another discharger F^4, having the same kind of vertical apertures, and so on down toward the bottom of the cylinder A. I prefer to make the discharger F^4 and those below it in the form of a hollow ring to provide for the passage of the streams from the discharger above down through the center of the cylinder without producing an objectionable splashing of the water in its downward movement. In fact, under some conditions I propose to form those practically vertical apertures f' f^3 upon slightly-converging lines to facilitate the delivery of the streams of water from each of them down through the centrally-open discharger or dischargers below, and while I have indicated the upper one, F^3, as having a flat under surface or disk-like plate it is obvious that it may be ring-like in form, although I usually make the enlargement in horizontal section of the cylinder at that point such that the presence of either form of discharger will not materially obstruct or interfere with the inflow of air to the upper end proper of the cylinder A, the same being true, of course, of the enlargement shown in the prior figures.

While I have explained the best mode now known to me for carrying my invention into effect, I do not wish to be limited to the details of construction shown and described, because many modifications thereof will readily suggest themselves to any one skilled in the art without departing from the spirit of my improvement or going outside of its scope.

What I claim is—

1. In an air-cooling apparatus, the combination of a vertical cylinder, a sprayer at the upper end of said cylinder to produce a downward-moving air-current through said cylinder, a tubular air-trunk above the sprayer forming a practically unobstructed air-inlet, a water-receptacle at the lower end of the vertical cylinder, an annular upturned wall of the water-receptacle forming an air-outlet adapted to reverse the direction of travel of

the air-current, an opening and damper adapted to admit air from an inclosed apartment to the air-inlet above the sprayer, and an opening and damper adapted to admit air from outside said apartment to the air-inlet above the sprayer substantially as set forth.

2. In an air-cooling apparatus, the combination of a vertical cylinder, a vertically-enlarged section at the upper end thereof, an annular sprayer for discharging jets of water downward into the upper end of the cylinder to produce a vortex-like downward-moving current of air through the cylinder, a water-receptacle at the lower end of the cylinder, an annular upturned wall of the receptacle forming an air-outlet adapted to reverse the direction of travel of the air-current, and means for regulating the inflow of air through the annular sprayer at the upper end of the vertical cylinder, substantially as set forth.

3. In an air-cooling apparatus, the combination of a vertical cylinder, means for discharging jets of water downward into the upper end of the cylinder to produce a sheet of water moving down upon the inner surface of the cylinder and to produce a vortex-like downward-moving current of air through the cylinder adapted to drive impurities into the sheet of water, a water-receptacle at the lower end of the cylinder to receive such impurities and discharge them from the apparatus the receptacle having an upturned wall forming an air-outlet adapted to reverse the direction of travel of the air-current, and an air-inlet at the upper end of the cylinder, substantially as set forth.

4. In an air-cooling apparatus, the combination of a vertical cylinder, means for discharging jets of water downward into an open space in the upper end of the cylinder and produce a vortex-like downward-moving current of air through the cylinder, and supplemental devices within and below the upper end of the cylinder for increasing the speed and the vortex-like movement of the air-current, substantially as set forth.

5. In an air-cooling apparatus, the combination of an inner vertical cylinder, an air-inlet, means for discharging jets of water tangentially downward into the upper end of the cylinder, to produce a downward-moving current of air through the cylinder, and an outer cylinder which reverses the direction of travel of the air-current at the lower end of the inner cylinder, and an air-outlet, substantially as set forth.

6. In an air-cooling apparatus, the combination of a vertical cylinder, an air-inlet, means for discharging jets of water downward into the upper end of the cylinder to produce a downward-moving current of air, means for discharging a vertical series of jets of water tangentially against the inner wall of the cylinder below the first-mentioned jets to produce a vortex in the air-current, and an air-outlet, substantially as set forth.

7. In an air-cooling apparatus, the combination of a vertical cylinder, means for discharging jets of water downward into the upper end of the cylinder and produce a downward vortex-like air-current through the cylinder, an air-inlet adapted to conduct air from an inclosed apartment to the upper end of the cylinder, an air-inlet adapted to conduct to the cylinder air from the atmosphere outside of the apartment, an air-conduit disposed between the air-inlets and the upper end of the cylinder, and dampers or valves adapted to regulate the movement of air through the air-inlets simultaneously or alternately, substantially as set forth.

8. In an air-cooling apparatus, the combination of a vertical cylinder, a concentric cylinder to reverse the direction of travel of an air-current, and means for discharging a vertical series of jets of water tangentially downward against the inner wall of said vertical cylinder to produce a vortex-like air-current moving downward in the said vertical cylinder, substantially as set forth.

9. In an air-cooling apparatus, the combination of a vertical cylinder, an annular sprayer at the upper end of the cylinder to produce a downward-moving vortex-like air-current through the cylinder, a cylindrical air-inlet above the sprayer, a centrally-pivoted damper within the air-inlet adapted when opened to permit air to pass around its edges and thence to opposite sides of the space within the annular sprayer to facilitate the formation of a vortex-like air-current, substantially as set forth.

10. In an air-cooling apparatus, the combination with a vertical cylinder, of means for discharging small jets of water into a practically unobstructed space at the upper end of the cylinder, and an annular sprayer for discharging another series of tangential and vertical jets of water into an otherwise unobstructed space below the first-named series, substantially as set forth.

11. The herein-described process or method of treating air, which consists, essentially, in subjecting it to the pulling and rarefying action of rapidly-moving small bodies of water while both the air and the water are moving in the same direction through a tube or cylinder, whereby the air is both cooled and purified; and subsequently separating from the air the water and the impurities which have been collected in the water, substantially as set forth.

12. The herein-described process or method of treating air and impurities mingled therewith which consists, essentially, in moving the air downward through a tube or cylinder, simultaneously subjecting the air to the action of small bodies of water which are moving spirally downward within the tube or cyl-

inder with the air, and also to the action of a downward-moving water-film which is traversing the inner surface of the cylinder, whereby the air is cooled and the impurities are separated therefrom and are mixed with the water-film; and subsequently moving the air over water and in a reversed upward direction of travel, depositing in the water impurities which have been separated from the water, substantially as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

ELMER GATES.

Witnesses:
H. H. DOUBLEDAY,
WM. H. DELACY.