No. 864,346. PATENTED AUG. 27, 1907.

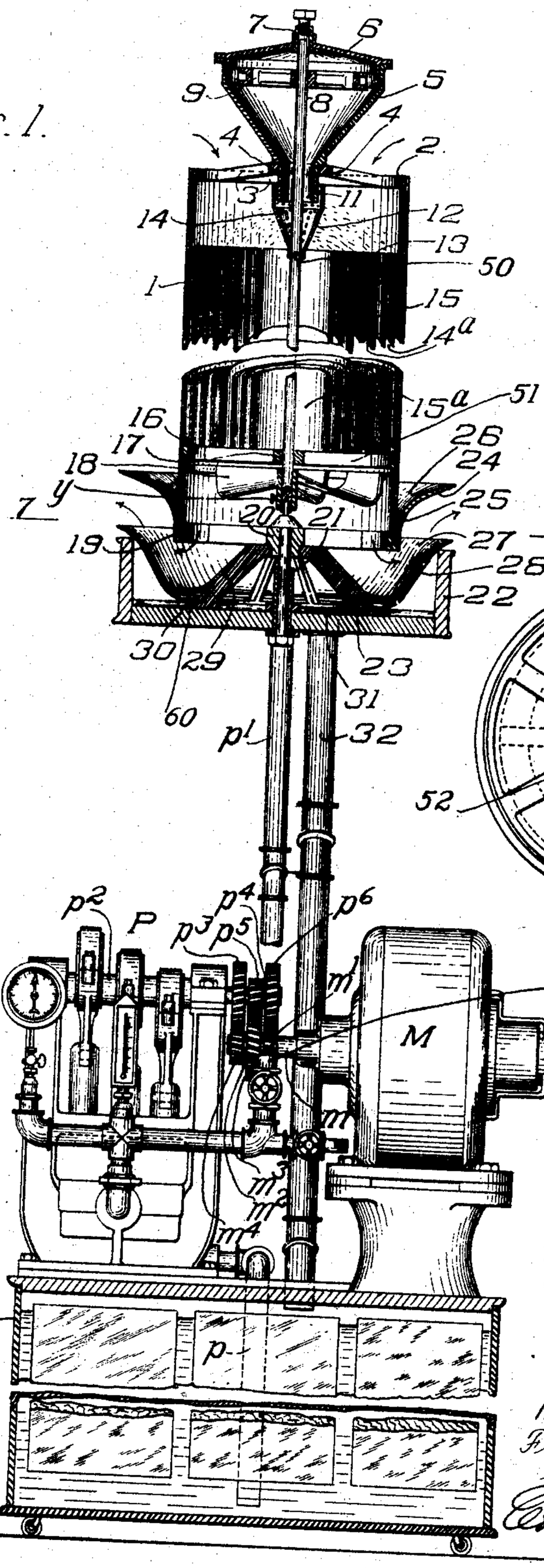
F. WHITE.

APPARATUS FOR MODIFYING AIR.

APPLICATION FILED APR. 10, 1903.

2 SHEETS—SHEET 1.

FIG. 1.



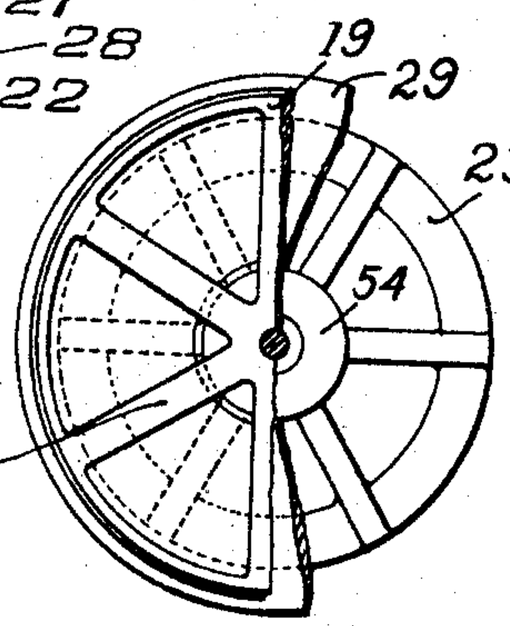
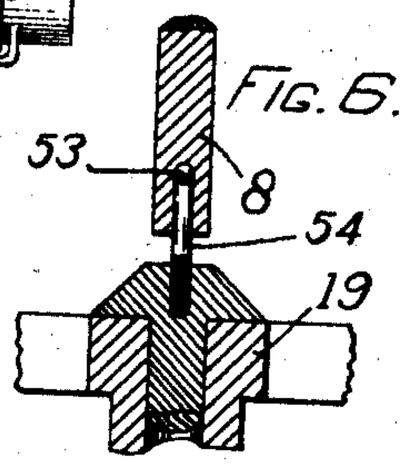


FIG. 5.

FIG. 6.



WITNESSES

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Edward L. Reed

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2 SHEETS—SHEET 2.

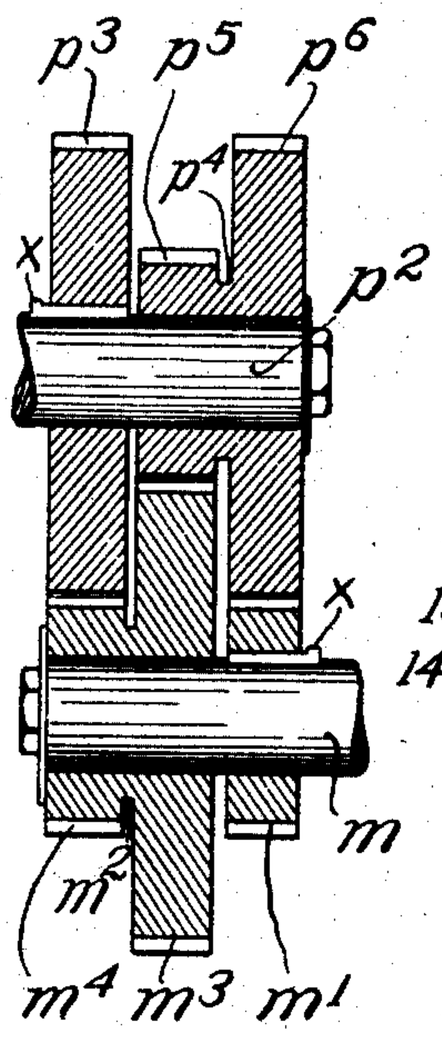

FIG. 4.

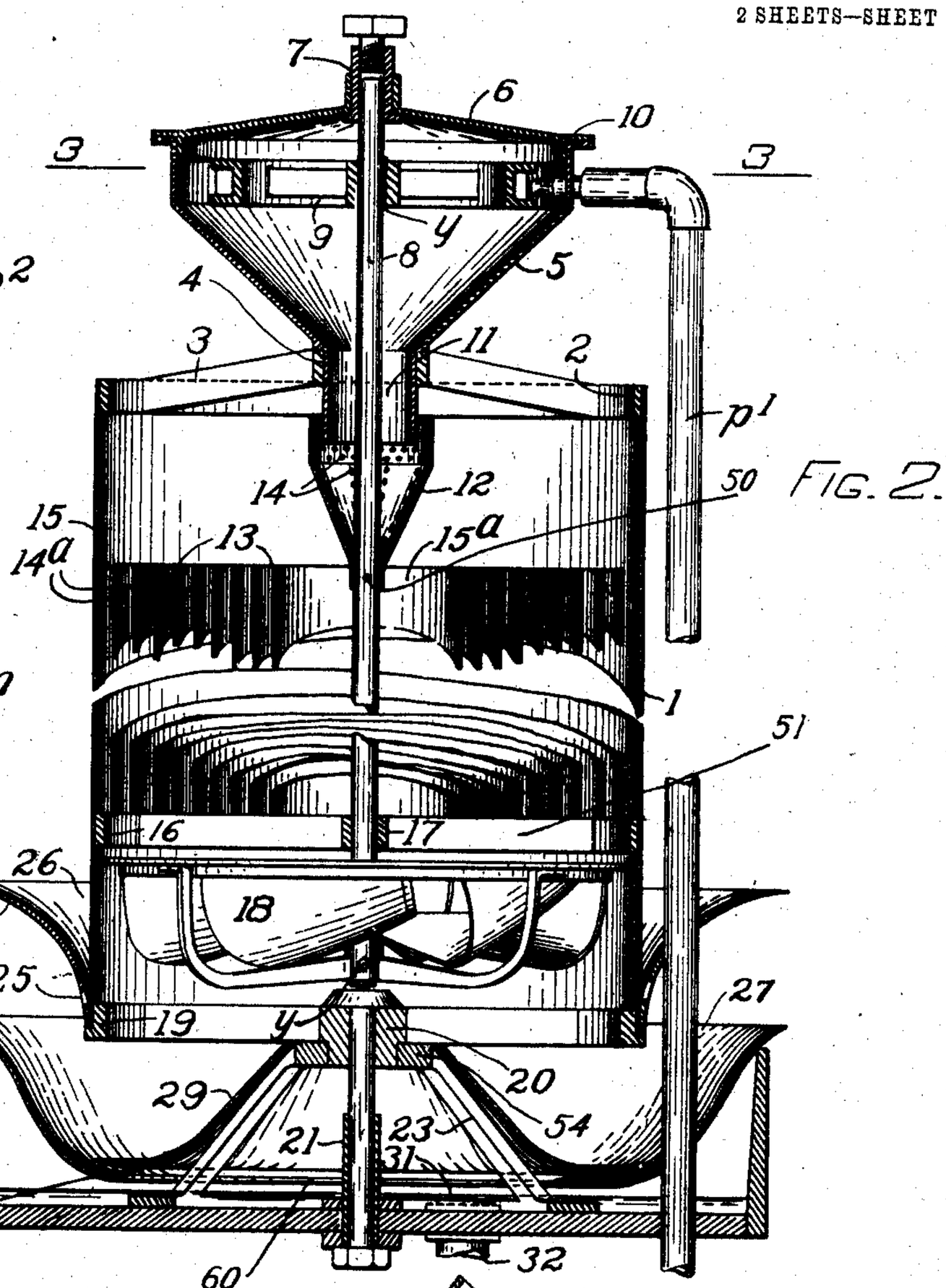

FIG. 2.

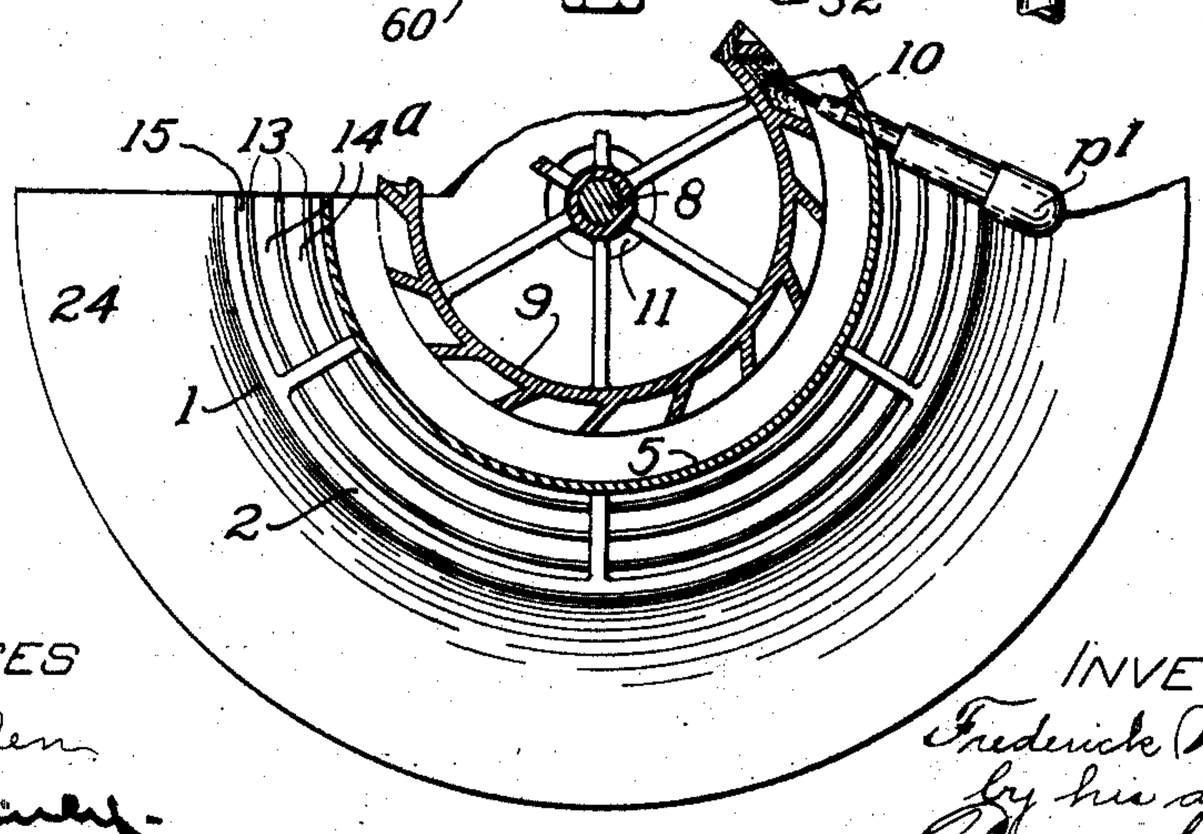

FIG. 3.

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UNITED STATES PATENT OFFICE.

FREDERICK WHITE, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO REGENERATED COLD AIR COMPANY, OF PORTLAND, MAINE, AND BOSTON, MASSACHUSETTS, A CORPORATION OF MAINE.

APPARATUS FOR MODIFYING AIR.

No. 864,346. Specification of Letters Patent. Patented Aug. 27, 1907.

Application filed April 10, 1903. Serial No. 151,967.

To all whom it may concern:

Be it known that I, FREDERICK WHITE, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Apparatus for Modifying Air, of which the following is a specification, reference being had therein to the accompanying drawing.

Figure 1 is a vertical central section of a new apparatus for treating air in position above a coöperating pump and therewith coupled motor, which are shown in side elevation on a reservoir from which a liquid medium is pumped to the air-treating apparatus, the fan within said apparatus being shown in side elevation. Fig. 2 is a central vertical section, on a larger scale than in Fig. 1, of the air-treating apparatus, the fan being shown in side elevation, and the section being at right angles to the section of Fig. 1. Fig. 3 is a portion of a view partly in section, at line 3—3 of Fig. 2, and partly in plan, looking down. Fig. 4 is a sectional detail of the reducing gear-coupling by which the motor and pump are operatively connected. Fig. 5 is a top-plan view of a portion of the skeleton-frame which supports the bottom of the casing of the air treating apparatus, and which is formed with radiating ribs and a central bearing; and of the covering for the frame, and of the frame which rises from the bottom of the water-pan and supports said skeleton-frame and apparatus. Fig. 6 is a vertical sectional detail showing one mode of forming a bearing for the main-shaft of the apparatus.

The object of this invention is to produce an apparatus for use in theaters, restaurants, hotels, offices, factories, hospitals, railway-cars, ships, etc., either to vary the temperature, or the hygrometric condition or the hygienic quality of air within the field of influence of the apparatus.

In the drawings, 1 is the outer casing; 2 a bridge-piece fixed to the upper portion of the casing and having openings between its radiating ribs 3 for admission of air into casing 1, and having a central bearing 4 in which the water-wheel casing 5 is supported. Casing 5 has a downwardly and inwardly sloping interior wall to facilitate continuous discharge of water; and is closed at its upper end by a cover 6 which has a bearing 7 for the upper end of main-shaft 8, on which, within casing 5, is fixed by a fastener or spline y a water-wheel 9 that is driven by the impact of a jet of water from nozzle 10. The lower end of casing 5 is open at 11 and discharges into a water sprinkler 12 which is fast on the main-shaft, and distributes water (gravitating from the water wheel) over the air modifying plates 13, preferably made up of a series of open-ended cylinders of varying diameters. The sprinkler is in the form of a cup, open at the top, encircling the lower, open end of casing 5, and pinned at 50 on the main-shaft; and has outlet-holes 14 through which the water is whirled over the upper ends of the cylinders 13. The water thereby distributed runs down the walls of the cylinders through the interspaces, 14^a, through the space 15 between the outermost cylinder and the casing, and through the innermost cylinder 15. The cylinders are supported, at their lower ends, on the transverse frame 16 fixed within casing 1, and formed with radiating ribs 51 from a central bearing 17 for the main-shaft which extends downwardly from the sprinkler and has, pinned on it by a fastener y', below the cylinders, an air-fan 18 which sucks air from without the apparatus through the openings between ribs 3, and draws the air between said air-modifying plates 13 and discharges it from the open lower end of casing 1, which is secured at its lower end to a bridge-piece 19 having radiating ribs 52 from a central hub 20. The lower end of shaft 8 is, preferably, chambered, and receives a loose ball bearing 53, which rests on an upwardly extending tang 54 (see Fig. 6) from the head of the bolt 21. Hub 20 of bridge-piece 19 is mounted on a suitable supporting-frame 23 connected with the water-pan 22. The sides of the water-pan extend beyond the outer casing 1 so that the falling water from the air-modifying plates is caught in the pan.

Casing 1, near its lower end, is provided with an upwardly and outwardly extending surrounding flange 24 which is best perforated at 25 so that water of condensation caught in the trough 26 may escape into the pan. The main purpose of the flange 24 is, however, to form a wall of the air-discharge space 27, the other wall thereof being formed by an auxiliary flange 28 which extends upwardly from within the water-pan and outwardly thereof. The inner or lower end of the flange has a central opening 60. For the best results, it is preferred to form support 23 in the form of an inverted skeleton cone, the outer covering 29 of which extends from the top of support 23 downwardly and outwardly, and overhanging the opening 60, leaving a space 30 between the lower edge of covering 29 and the bottom of the pan for the escape of water through the opening into the pan, whence the water flows through the escape outlet 31 and conduit 32 to the liquid medium or water reservoir 33. The main purpose of this particular construction and arrangement of the flanges 24, 28, and covering 29 is to form a good air-escape 27, through which the air drawn through the apparatus may be expelled readily back into the air outside the apparatus. It will be plain to all mechanics that the apparatus already described may be made in a great variety of forms to draw air into direct contact with water or other liquid medium on the air-modifying plates, to thereby change the air in respect of temperature or hygrometric or hygienic quality. The water, or other liquid me-

dium, gravitates within the machine. While falling, the air is forced over the liquid medium in direct contact therewith.

In practice, water is the usual liquid medium; and if the apparatus is to be used for cooling the air, then ice-water may be used. The liquid medium, whether a heating or cooling medium, may be taken from any suitable source. Here the source is the reservoir 33 into which the water escape conduit 32 leads from the water-pan. To raise the liquid medium to the water-wheel (meaning thereby any device which is operated by any liquid medium to rotate the shaft and therewith connected parts) any suitable devices may be used, as pump P driven by electric motor M, the pump P drawing through pipe p from the reservoir 33 and discharging through pipe p' to water nozzle 10.

In my apparatus, I find it desirable to keep the speed of pump driving shaft p^2 much lower than the speed of the motor shaft m. Shaft p^2 is provided with a fixed gear p^3, and with a loose gear having a common hub p^4, the gear p^5 being between the fixed gear p^3 and the other gear p^6. Motor-shaft m has a fixed gear m' which meshes with gear p^6 and is one-half the diameter of that gear. Shaft m also has a gear, on a common hub m^2 which is loose on the shaft m. Gear m^3 meshes with gear p^5 and is twice the diameter thereof. Gear m^4 meshes with gear p^3 and is one-half the diameter thereof. The gears are preferably spiral gears, as shown, to minimize noise. The three large gears p^3, p^6 and m^3 are of equal diameters, as are the three smaller gears p^5, m' and m^4. Of course the diameters may be varied, as desired. The foregoing is a very simple and practical reducing gear-coupling. Any other suitable device may be used for coupling the motor M and pump P. The fixed gears above mentioned are held in place by keys x, while the water-wheel and the fan on shaft 8 are held in place by fasteners y.

The effects produced by my new apparatus will be various, depending on the temperature of the air and its dryness or humidity, and depending also on the temperature of the liquid medium. Consequently, my apparatus may be used either to dry or to moisten the air. In all cases, carbonic acid gas, dust and other impurities in the air will be largely removed therefrom by the passage of the impure air in contact with the water or liquid medium which will absorb or modify the impurities.

The concentric cylinders are herein called "air-modifying plates", because, in every mode of use, impurities in the air will be largely absorbed by the liquid medium,—whether water, brine, or otherwise,—and the character of the air so changed that the air may be said to be modified. The liquid medium may be medicated, if desired.

The described form of every constituent part of my apparatus may be changed, if desired, without departure from my invention. In the present form of my invention, the liquid medium under pressure constitutes the force which rotates the shaft 8 and parts carried thereby, and in passing through the regenerator (of any suitable construction) cools, dries or humidifies the air, depending on relative temperatures of the air and liquid medium.

If desired, in some cases, the liquid jet nozzle 10 may be connected directly with a water main, for example, in which case the source of the liquid is exterior to and independent of the apparatus constructionally considered. The bolt 21 clamps the frame 19 to which casing 1 is secured on the frame 23 and also holds the frame in place in the water pan.

It is to be observed that air is ejected from the apparatus through the space between flanges 24 and 28, that is—through the air discharge space 27 in a horizontal direction. If the discharged air passed immediately upwardly outside of the outer casing 1, then the apparatus would constantly draw in, directly, the air discharged, and the suction of the fan would have but little effect on air at a distance from the top of the machine.

By discharging the air laterally from the machine, so that it will not form a direct, upward current around the outer casing and back into the machine immediately, the purified air discharged mingles, to a greater extent, with air in the room, and travels outwardly into the room to a greater distance, so that the effectiveness of the machine is greatly increased.

By entering the discharge end 11, of the water-wheel casing 5, within the cup-shaped distributer 12, all the water descending from the water-wheel casing is discharged directly into the cup-shaped, perforated distributer 12. The interior diameter of the upper portion of the distributer 12 is somewhat larger than the interior diameter of the thereby encircled discharge end 11 of the water-wheel casing, so that there is a slight space open to the air between the laterally opposed walls of the water-wheel casing and distributer. This permits air pressure within the distributer, and prevents the formation of a vacuum, which might otherwise be formed within the distributer, and restrict or prevent the effective flow of the water through the perforations of the distributer.

It is of practical importance to connect my apparatus with a pump which draws from a liquid-containing tank, and then forces the water into the cooling and purifying apparatus which then returns the liquid back into the tank so that the same liquid can be used over and over again; but, of course, my apparatus may be connected with a water main, or the like, if desired, and the liquid which is used to impel the water wheel be thrown away, or returned into the main.

The air-modifying cylinders, or plates, on which the liquid trickles down in film form, may be of any desired shape, and all the constructional parts of my apparatus may be changed in form without departure from my invention.

The concentric, cylindrical baffle-plates, or air-modifying plates, as I prefer to call them, are of sheet metal, whereby I am able to use a great number of them, and so secure a maximum area of surface for contact of the liquid and air; and also thus obtain a construction which does not shrink, warp, or absorb the liquid or foreign matter, and which makes it possible to use a maximum number of cylinders with inter-spaces which are always straight and unobstructed, whereby the constant and regular flow of both liquid and air are secured; and, moreover, a construction which is convenient and cheap. It is highly important to keep the inter-spaces between the cylinder unobstructed, and they should consequently be made of sheet metal, or some other non-absorbent material, for if they were made of absorptive material, they would shrink or warp, in the

latter case possibly obstructing the interspaces. Furthermore, if the cylinders were of wood, or other absorptive material, they would speedily become foul by absorbing impurities drawn in with the air, and thus reduce or prevent that purification of the air which it is one of the main objects of my invention to effect. I have found, in practice, that in the use in a saloon, of an apparatus like that illustrated in the drawings, the water tank sometimes shows the presence of nicotin, grease and flies drawn in from the outside air, and carried into the tank by the returning water. It is, therefore, obvious that for the special purposes for which my apparatus is designed, the cylinders should be made of some non-absorptive material. By the use of sheet metal, I am able to use very thin cylinders, and thus secure a very perfect control of the air by means of the fan. Relatively thick cylinders would increase the air "cut off" required of the fan, and impede that continuous, outward expulsion of air from the apparatus, which is desirable in practice by diminishing the volume of air expelled.

It is of practical importance, in order to enable the fan to maintain a constant and full current through the interspaces,—in effect, through the machine,—that the air-fan have a plurality of blades in each of its four quarters, so that the air may be kept in constant current at all points of the interspaces; and also in order to secure this result, that the blades of the fan be in close proximity to the ends of the cylinders, for whether the machine be used for cooling or for humidifying air, it is important that the air be expelled in uniform and constant quantity, and in as large volume as possible to produce an equable atmospheric condition in the room. This is of great importance in the humidification of mills, and of importance always. It is well known that air is difficult to control and direct in systems comprising air-fans, and the problem which I essay is to secure a constant, free and voluminous discharge of air which has been treated by direct contact with liquid in such wise to effect a maximum change, within the limits of the machine, in the air discharged. By placing the blades of the fan close to the ends of the cylinders, they act in their most effective manner, and being numerous in each quarter of the fan, the rotating fan is constantly moving the air in every interspace when the machine is in operation. The vertical interspaces between the cylinders are, on the whole, the best form of air and water passages known to me.

It is very important in practice that the air modifying plates, 13, should be concentric, with their ends as close as is practical to the blades of the air-fan, in order that the rotation of the fan shall not "cut off" the air currents which it sucks through the interspaces between the cylinders. When a "cut off" is produced, the fan itself, although pulling the air from the interspaces, causes back currents by forcing some quantity of the air against the sides of the blades; I have found in practice that if the air-fan is used to suck air from a plurality of air-passages, which are not formed from substantially concentric plates with interspaces between them, the fan itself produces antagonistic effects; viz:—one, the proper movement of the air is interfered with by what I call the "cut-off" action, that is,—by the fan driving some portion of the air which it moves back into the interspaces from which the air is moved,—(producing noise which is objectionable) and also very seriously interfering with the velocity of the passage of the air through the apparatus.

I cannot put too much emphasis upon the practical importance of moving the air through the apparatus with maximum velocity, for the whole practical success of this kind of apparatus depends upon continuously passing the large volume of air contained in the room through the machine with great velocity, in order to keep up the air-modifying action with continuous effectiveness. The air-modifying cylinders are imperforate so as, throughout their entire length, to separate the air into a plurality of concentric and independent currents and also to separate the fluid into a plurality of concentric and independent films. The cylinders should be about three-eighths of an inch or less apart, experience having shown that if they are much further apart the air passed through the interspaces may occasionally have a core or stratum (of air) which is of different temperature than the outer surfaces of the air-currents.

In the apparatus above described, the water gravitates through spaces between the cylinders until its exit from such spaces into the space below the lower ends of the cylinders and within outer casing 1. The pull of the air-fan on the air in said spaces aids gravity in effecting the downward flow of the water, and so increases the rapidity with which the water travels through the machine. The operation of the apparatus in this respect facilitates the passage through it of air and water (or other fluid) and thus secures a very rapid, effective operation of the machine. Too much emphasis cannot be placed on the rapidity with which water and air are passed through the machine both for air-cooling and humidifying purposes. When the water comes into the space below the cylinders, it is agitated and mixed with the air by rotation of the air-fan, being there given a swirling or rotary movement within the lower part of casing 1 on which it is thrown by centrifugal force from the fan. The air is here driven through a considerable mass of water and thoroughly washed, the impurities in the air being carried away by the water and the air cooled or moistened according to conditions of air and water. In this lower space, it is to be noted that the water is not a mere spray but a mass in agitation,—a volume of thoroughly mixed air and water,—and this is a wholly novel result. To merely spray the water into the air at this point would very greatly diminish the efficiency of the machine, and hence I consider the formation of a substantial body of mixed air and water, at some point, during the passage of both through the machine,—which mixed body is a rapidly traveling and replenishing one,— a very important feature of my invention.

In accordance with this invention, the air and liquid move through the interspaces between the cylindrical, air-modifying plates, in one and the same direction; and this direction is preferably from the upper end of the apparatus downwardly. If the air and liquid moved through the apparatus in directions one opposite to the other, the effectiveness of the apparatus would be greatly diminished if not practically prevented, and the liquid would be spattered outwardly

from the machine. To prevent outward spattering, the air-modifying plates, whatever be their form, whether cylindrical or otherwise, terminate between the upper and lower ends of the outer casing so that neither the distributer nor the fan can hurl the liquid outwardly. In other words, the distributer is some distance below the upper end of the casing and the air fan is above the lower end of the casing so that both are within the casing. The air deflector of the approximate shape of a truncated cone, that is between the fan and the bottom of the pan, also prevents, to an extent, the air set in motion by the fan from striking vertically against any liquid that there may be in the pan. This truncated cone-like air-deflector 30 and the air-deflector 29 being separated to form the passage 31 so that liquid in the pan readily flows out of the pan, coöperate not only to deflect the air upwardly and outwardly from the pan but also to prevent the air set in swirling motion by the fan from whirling the water outwardly out of the pan. The annular interspaces between the cylinders permit the fan to suck or draw the air therethrough without setting up antagonistic reverse currents; and consequently the fan operates to continuously draw the air downwardly through the interspaces without any cut-off of the downwardly-moving air-currents as already herein referred to.

What I claim is:

1. In apparatus for modifying air, the combination of an outer casing; a shaft within the casing; means for rotating said shaft by the force of a liquid jet; a sprinkler on said shaft; within the casing, a vertically mounted series of concentric, open-ended imperforate cylinders with spaces between them, and upon which the sprinkler discharges; a fan below the cylinders; a lateral air-escape from the casing; a source of liquid supply; means for conveying the liquid from said source to the means for rotating said shaft; and means for operating the means for conveying said liquid and means between the fan and the pan for preventing air set in motion by the fan from spattering liquid outwardly from the pan and for deflecting the air outwardly from the apparatus.

2. In apparatus for treating air, the combination of a liquid-distributing mechanism; an air-current separator; an air-moving fan; a liquid inlet; an air inlet; a liquid escape; an air escape; a pump; a motor; and a gear-coupling connecting the pump and motor, the air-current separator comprising a series of open-ended concentric cylinders which separate the air passing through the machine into a series of independent concentric cylindrical air currents, and also separate the liquid passing through the machine into a series of concentric independent films, the cylinders being spaced apart to form unobstructed cylindrical interspaces and means between the fan and the pan for preventing air set in motion by the fan from spattering liquid outwardly from the pan and for deflecting the air outwardly from the apparatus.

3. The combination of the outer casing, open at both ends, with a water-wheel casing; a water-wheel; a distributer; a shaft on which the water-wheel and distributer are mounted; a series of vertical concentric cylinders; a fan on the shaft; an outwardly extending flange at the lower end of said casing; a pan below the lower end of the outer casing, and projecting beyond the lower end of the casing; an upwardly-inclined flange below said flange at the lower end of said casing, said cylinders being open-ended and spaced apart to form interspaces in each of which a cylindrical current of air is in contact with a cylindrical current of liquid and means between the fan and the pan for preventing air set in motion by the fan from spattering liquid outwardly from the pan and for deflecting the air outwardly from the apparatus.

4. The combination of a vertical, outer casing, open at both ends to the air, means at its upper portion for supporting a water-wheel casing thereat; a water-wheel casing having an inlet for admission of a current to drive the water-wheel, and having a discharge port; a main shaft operatively mounted within the outer casing, and partially within the water-wheel casing; a water-wheel within its casing and fast on said shaft; a cup-shaped liquid distributer on said shaft, below the water-wheel casing; the discharge of the latter opening into the cup-shaped distributer; a series of vertically mounted cylinders below the distributer which distributes on the upper ends of and between the cylinders; a suction-fan fast on said shaft, below the bottom ends of said cylinders and shaped to draw air through the open, upper end of the outer casing, over liquid on said cylinders, and to force the air out of the lower end of the outer casing, substantially horizontally therefrom; and a pan, open at its top, and mounted at a distance below the bottom end of the outer casing, and projecting beyond the same, said cylinders being concentric and having between them interspaces in which concentric, contacting currents of air and liquid are formed and means between the fan and the pan for preventing air set in motion by the fan from spattering liquid outwardly from the pan and for deflecting the air outwardly from the apparatus.

5. The combination of a water-wheel casing having interior, downwardly and inwardly sloping sides and a central, vertical outlet section, with a shaft passing vertically and downwardly through the casing and having, within the casing, a water-wheel fixed on it; an open ended, vertical, outer casing; an open frame at its upper end in which the wheel-casing is mounted; a cup-shaped distributer on the shaft, the open upper end of the distributer inclosing the outlet section and the opposed walls of said upper end of the cup and outlet section being spaced apart to form an air-vent for the distributer; a series of vertical, concentric open-ended cylinders within said outer casing; an air-fan fast on said shaft at the under end of the cylinders; a pan below the fan; the lower end of the outer casing being removed from the pan to form an air-escape passage; and said cylinders operating to form a series of concentric films of liquid and a series of concentric currents of air, each contacting with a liquid film and means between the fan and the pan for preventing air set in motion by the fan from spattering liquid outwardly from the pan and for deflecting the air outwardly from the apparatus.

6. In air-modifying apparatus, the combination of an outer casing; an air-fan; a motor-wheel; a shaft on which the fan and wheel are each fast; and, between the fan and wheel a rotary distributer and a series of open-ended, vertical, concentric cylinders with unobstructed interspaces between them for unobstructed passage therethrough of a series of contacting films of liquid and currents of air, the cylinders dividing the air which enters the machine into a series of cylindrical, concentric and independent air currents, and the fan moving said currents without cut-off thereof and means between the fan and the pan for preventing air set in motion by the fan from spattering liquid outwardly from the pan and for deflecting the air outwardly from the apparatus.

7. In air-modifying apparatus, the combination of a casing; an air-fan therein; means for operating the fan; and means for discharging water in mass on said fan; the fan giving the air and water a whirling movement within said casing a series of concentric vertical cylinders of varying diameters; and an air-deflecting device below the fan.

8. In air-modifying apparatus, the combination of a casing; an air-fan therein; means for operating the fan; and means for discharging water in mass on said fan; the fan giving the air and water a whirling movement within said casing and throwing the water centrifugally against the casing a series of concentric vertical cylinders of varying diameters; and an air-deflecting device below the fan.

9. In air-modifying apparatus, the combination of a casing; an air-fan therein; means for operating the fan; and means for discharging water in mass on said fan; the fan giving the air and water a whirling movement within said casing and throwing the water centrifugally against the casing; a water-pan below the fan; a water-escape therefor; and an air-escape below the lower end of the

casing a series of concentric vertical cylinders of varying diameters; and an air-deflecting device below the fan.

10. In air-modifying apparatus, the combination of a casing; an air-fan therein; means above the air-fan for directing water in volume upon the fan; an air-escape below the casing; and means for catching the water, below the fan a series of concentric vertical cylinders of varying diameters; and an air-deflecting device below the fan.

11. In air-modifying apparatus, the combination of a casing; an air-fan within the same; and means for discharging a fluid in mass on said fan a series of concentric vertical cylinders of varying diameters; and an air-deflecting device below the fan.

12. In air-modifying apparatus, the combination of a casing; a cylinder within the casing; and an air-fan within the casing; the casing and cylinder being arranged with a space between them for passage of air and water; and the fan being below said space a series of concentric vertical cylinders of varying diameters; and an air-deflecting device below the fan.

13. The combination of a casing; an air-fan therein; and means for discharging water in mass into the space occupied by the fan within the casing a series of concentric vertical cylinders of varying diameters; and an air-deflecting device below the fan.

14. The combination of an outer casing; a therein-contained water distributer; a therein-contained air-fan; a series of air-modifying plates within the casing, and between the distributer and the fan; a pan; air-deflecting means between the pan and the fan; means for rotating the fan; and means for supplying a liquid to said distributer; the opposite ends of said outer casing being open and the upper end of the casing extending above the distributer and the lower end of the outer casing extending below the fan.

15. In air-modifying apparatus the combination of an outer casing with a therein-contained air-fan; means for operating the air-fan; a pan below the lower end of the casing and of larger cross-sectional area than the cross-sectional area of said casing; air-deflecting means between the fan and the pan; air modifying plates within the casing above the fan and a liquid distributer above said plates, within the casing and below the upper end thereof.

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

FREDERICK WHITE.

Witnesses:

EDWARD S. BEACH,

M. E. COVENEY.