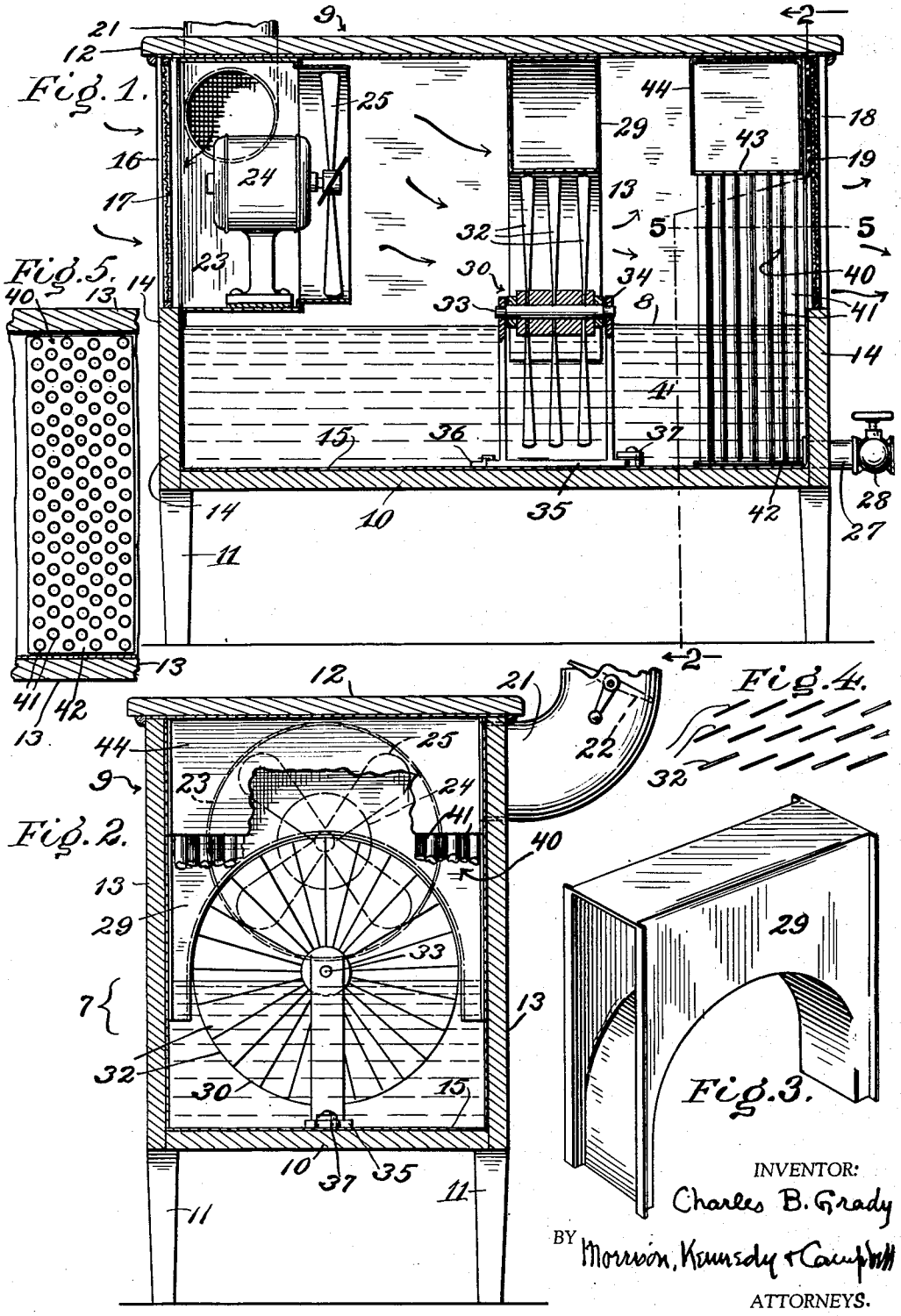
Dec. 1, 1936. C. B. GRADY 2,062,412

GAS TREATING APPARATUS

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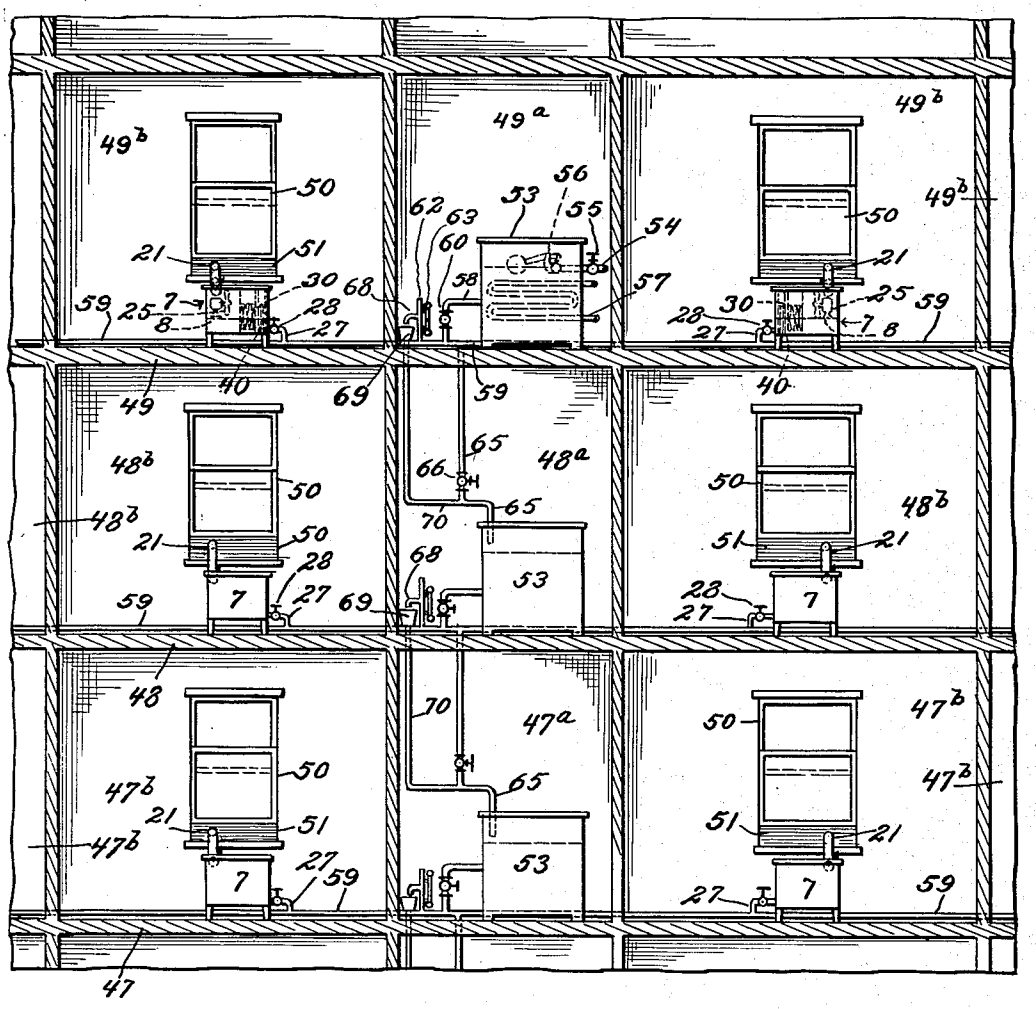
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Fig. 6.



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Patented Dec. 1, 1936 2,062,412

UNITED STATES PATENT OFFICE

2,062,412

GAS TREATING APPARATUS

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Application February 27, 1934, Serial No. 713,086

3 Claims. (Cl. 261—92)

This invention is a novel gas treating apparatus; having reference to the treatment of air or other gas by water or other liquid, and in referring hereinafter to air and water, it is intended to include operations involving other gases and other liquids. The present invention is adapted to a considerable range of utility; although the disclosure herein illustrated as an example of the invention is designed especially for the treatment or conditioning of air, for example for household, office or industrial uses.

The general object of the invention is to afford an air treating apparatus of substantial efficiency and convenience of operation and control, adapted to effectuate one or more of the following functions, to regulate the humidity of the air, to clean and purify the air by removing solid and soluble contents, and to alter the temperature of the air. A further object is to provide an apparatus which will be simple and inexpensive of manufacture, reliable in use, and easy to clean and renew when necessary.

Prior examples of gas treating apparatus and method are illustrated in my copending applications Serial No. 630,175, filed August 24, 1932, and Serial 652,251, filed January 18, 1933, since issued as U. S. Patents 2,004,108 dated June 11, 1935, and 2,013,270, dated September 3, 1935, respectively, each showing a compact and low cost individual gas treating apparatus or unit adapted to be located in a room or other enclosure to be regulated thereby. An additional object of the present invention is to afford a gas treating apparatus or unit of improved construction and operation as compared with said prior applications.

Other and further objects and advantages of the present invention will be explained in the hereinafter following description of an illustrative embodiment thereof or will be manifest to those conversant with the subject. To the attainment of the objects and advantages referred to the present invention consists in the novel gas treating apparatus, and the novel features of operation, combination and construction herein illustrated or described.

In the accompanying drawings Figure 1 is a central longitudinal section view of a gas treating apparatus embodying this invention.

Fig. 2 is a transverse vertical section view taken on the broken section line 2—2 of Fig. 1.

Fig. 3 is a perspective view of the arched baffle constituting one of the elements of the apparatus shown in Figs. 1 and 2.

Fig. 4 is a diagrammatic development view of the blades or vanes of the rotary element shown in Figs. 1 and 2.

Fig. 5 is a partial horizontal section taken on the section line 5—5 of Fig. 1.

Fig. 6 is a diagrammatic sectional elevation view of a building or dwelling embodying the general apparatus or system of this invention, including a number of the air treating units distributed in various rooms, and the means for servicing and controlling the system.

In the following specification there will first be described the improved unit or individual apparatus provided in or adjacent to each room for conditioning its atmosphere, and then a complete system or general apparatus including means for servicing all of the units comprised in the system and controlling the operation thereof, and finally the preferred method of operation and control of the system and the various units thereof.

The improved individual unit 7 hereof is shown in Figs. 1 to 5 and it will be seen to comprise in common with said prior applications an enclosure containing a water vessel over which the circulating stream of air is driven by a fan or otherwise and means for causing extensive contact between the body of water and the stream of air, the unit delivering into the room and preferably receiving air partly from the room and partly from an outside source under damper control.

The water line 8 indicates the depth of water within the lower part or vessel of the enclosure 9. The enclosure is shown composed of a bottom wall 10 elevated from the floor by legs 11, a top wall 12 which may constitute a removable cover, side walls 13 and end walls 14, preferably extending upwardly only slightly beyond the intended depth of the contained water in the vessel. The vessel is shown as having a lining 15, for example of copper. At the inlet end of the apparatus, above the end wall 14 is an air inlet aperture 16 in which may be mounted a mesh screen 17; and at the other end is shown an air outlet aperture 18 with a similar mesh screen 19. By this inlet and outlet the room air may be recirculated. Preferably there is also included a second or lateral air inlet pipe which may extend from an outdoor point into the enclosure, near the inlet end, with a damper 22 to restrict the proportion of outside air, as may be desired.

Mounted within the enclosure adjacent the air inlet is a walled chamber 23, the first part of which may be of square section, the latter part cylindrical. Within the square section is mount-

ed a fan motor 24 and from this is driven a rotary fan 25 located in or adjacent to the cylindrical portion of the chamber, thus constituting the means for driving air through the enclosure, over the water in the vessel, and thence to the outlet.

Near the lower part of the enclosure and water vessel is shown a water connection or pipe 27 extending through the end wall 14 and lining 15 and adapted both for supplying water to and draining water from the vessel, as will be further described, said connection being shown with a valve 28 for closing or opening the connection.

Mounted within the enclosure 9, between the fan 25 and the outlet 18 is shown arranged an element 30 for promoting contact between the water and air stream, of the character of a rotary member, partially submerged, as in said prior applications. To accommodate this element there is provided, within the enclosure, a baffle member 29, preferably hollow, shown separately in Fig. 3, having substantial longitudinal thickness to constitute an arch enclosing a longitudinal passage within which the upper part of the rotary element turns. The baffle 29 may be mounted permanently in place as shown, and it operates to compel the entire air stream to pass through the passage or arch below the baffle, and thereby to cooperate fully with the rotary disk or wheel element 30 therein.

The rotary wheel or disk 30 may consist of metallic disks 32, three being shown, each of which may be slitted and bent or otherwise formed in a manner to constitute blades or vanes, the several disks being arranged transversely to the air flow and mounted on a common shaft or axle 32 which is set longitudinally near the water level in bearings 34 provided on a removable frame or carriage 35. By this arrangement, as the disks are driven or rotate, each portion thereof is first submerged and wetted and then rotated out of the water vessel to enter the advancing air stream, the blades of the several disks being relatively staggered, as shown in Fig. 4, so that the air passage through the arch of the baffle is effectively occupied by the wetted blades, which thus react with the air to control its humidity and alter its temperature, while dust and other solid matters and acids and other soluble matters tend to deposit upon or be captured or absorbed by the water on the faces of the blades.

As in said prior applications the rotary element or wheel 30 comprising the bladed disks may be driven or maintained in slow rotation by the action of the air stream upon the inclined blades or vanes of the element. Thus each blade after performing its functions in the air stream is passed again through the water and so has its cleanness, wetness and temperature restored for its succeeding passage through and actions in the air stream. The rotary wheel element is readily removable for cleaning by shifting it longitudinally from beneath the arch and thence lifting it out of the enclosure, and when replaced a fixed stop 36 on the enclosure bottom insures correct locating of this element, a button 37 securing it there.

There is herein disclosed an additional air treating element 40, preferably located beyond the rotary disk element 30 and between it and the outlet 18, although in some cases the non-rotary element 40 may be usefully employed without the disk element 30. The non-rotary or fixed element 40 is shown as comprising a plurality or bank of semi-submerged members of high thermal conductivity, preferably in the form of upstanding rods or tubes, as of copper. Said upright members or rods are shown in staggered relation so that the air stream passing between them is constantly diverted, thus promoting contact. The several rods are attached to a bottom plate 42 and a top plate 43, the entirety thus constituting a preferably rigid frame, above which may be a baffle or closing wall 44. The frame including the upright rods may readily be removed for cleaning the same by merely lifting the frame bodily out of the enclosure, it having sufficient weight to rest by gravity on the enclosure bottom when in place.

This simple treating element affords the following advantageous operations. By reason of the high conductivity of the metal the rods, tubes or other members take up the temperature of the water and this temperature condition travels upwardly to the portions of the rods above the water, these portions thus modifying or lowering the temperature of the air stream before its exit from the enclosure. For dehumidifying, as will be described, the cooling of the air stream by means of cool water is thus effectively prompted. Due to the partial location of the upstanding rods or members within the outgoing air stream, they tend to accumulate a substantial amount of moisture condensed from the outgoing air. The rods are thus maintained in wetted condition and tend to capture and remove from the air stream solid and soluble matters. The solid and dissolved materials progressively accumulating in the vessel water are periodically drawn off with the water and the latter renewed.

Referring next to the general apparatus or system illustrated in Fig. 6, this shows a dwelling, office or other building in which are a number of successive floors 47, 48, 49 etc., with an interior control room or closet 47^a, 48^a, or 49^a at each floor and at each floor also a series of individual rooms 47^b, 48^b or 49^b. In each such room is shown a window 50 having set under the under sash a window board 51 with an opening receiving the outer end of the damper-controlled lateral air inlet 21 already mentioned. Adjacent the window in each room is shown one of the air treating or conditioning units 7, which may be similar to that shown in Figs. 1 to 5 or like the disclosures in my said prior patents or of other construction having the same general character.

At the upper floor 49 the water level 8 is indicated in the conditioning units, and as already described each unit has a water connection 27 consisting of a pipe controlled by a valve 28. For servicing the several conditioning units at each of the several floors the following control apparatus is shown. In each control closet 47^a, 48^a etc. is a water supply tank 53 receiving water through a supply pipe 54 controlled by a shut-off valve 55 and an interior float valve 56 preventing overflow.

For purposes to be described the supply water in the tank 53 is to be distributed to the respective units 7 either in a warm or a cool condition. The temperature of the water in the supply tank may be varied or maintained in any desired manner, there being indicated a coil 57 immersed in the water of the tank, adapted to receive refrigerated brine or other medium for cooling the water or steam or other medium for heating it. City water may often be cool enough without refrigeration.

The water supply tank 53 is shown as having an outlet pipe 58 leading to a horizontal distrib-

uting pipe 59 which has extensions conducting the water to all of the rooms on one floor. The water connection pipes 21 of the several units are shown connected directly with the distributing pipe 59. For the purpose of controlled admission of water from the supply tank to the distributing pipe there is shown a valve 60 in the outlet pipe 58. While such valve might be operated automatically to maintain the desired water level 8 in the several units, it may advantageously be manually controlled. To facilitate control by an attendant there is shown a pipe or riser 62 upstanding from the distributing pipe in the control room, this riser having a gage glass 63 on which the water depth can be observed, with an index or mark at the proper point to bring the water in all of the units to the desired level.

As will be further described, this invention involves not merely the supplying of water to the units, at desired temperatures, but draining the water periodically from the units, for the purpose of changing the water, cleansing the units, etc. To facilitate this operation there is shown a downtake or pipe 65 descending from the distributing pipe 59 and delivering into the tank 53 at the next floor beneath, with a valve 66 in said downtake, normally closed, but adapted to be opened for draining purposes while the distributing valve 60 is closed. The valve 66 is shown near the lower end of pipe 65 but it might in fact be above the floor, so as to be accessible from the same control room with the corresponding valve 60. If desired also each supply tank 53 may have an overflow delivering into the supply tank of the next lower floor, the final one delivering to waste; and each tank may have a drain valve for removing sludge.

To insure that the water level 8 in the conditioning units does not rise substantially above the predetermined level there is shown an overflow outlet or spout 68, located for convenience at the riser 62, this spout being set at the desired water level 8 so that in case of rise of level for any cause the excess water will overflow from the spout. To handle such overflow water there is shown a trough or receptacle 69 below the spout, with a pipe 70 leading downwardly therefrom and delivering into the pipe 65 or the supply tank at the next floor beneath.

In installations where the building has only a few floors or where there are only a few rooms per floor, the heating or cooling coils may be omitted for the tanks 53 on the floor or floors below the top floor and hot or cold water be delivered from the upper tank to the lower tanks.

The method of operation and servicing of this invention may be substantially as follows. The conditioning unit provided for each room effects the washing and cleaning of the air thereof as already described, and the further description relates especially to the operation of controlling of the humidity of the air. The effect of this operation on the temperature of the air is appreciable; and other or independent heating or cooling means may be employed in conjunction herewith. It may be assumed that each room, or the windows thereof, are maintained substantially closed.

The control of humidity is effected in the first place by the servicing of the units by warm or cool water, while air is circulated or recirculated in contact with such water, and in the second place by the operation or stoppage of the fan 25, or if desired its speed regulation, and the operation of the contact producing means or wheel, in this case actuated by the air flow from the fan, and in the third place by opening or closing damper 22 more or less to regulate the admission of outside air. The control may be manual, by an attendant for one or more floors, or may be automatically conducted along the same line of operation; but differential treatment of the several rooms may be allowed for, for example by a double system of wiring for the fans, giving both individual and central control of action.

Referring first to humidifying operations by this invention, for example as performed in winter time when the air is dry, warm water is to be supplied to the conditioning units at each floor. To this end the coil 57 in each tank 53 may be supplied with steam to bring the supply water to the desired temperature, or somewhat higher to allow for temperature loss in distribution. For humidifying operations the rod element 40 may be unnecessary, and the wheel element 30 may be sufficient to produce the necessary reactions between the circulating air and the warm water. As the invention is to be used principally to regulate humidity each room may be provided, as before stated, with an independent means or radiator to regulate its temperature.

The humidifying control may best be described by taking an example. The series of rooms controlled at each floor of the building may for example have an initial air temperature of about 68° F. by the dry bulb thermometer and a wet bulb temperature of 47°, the difference 21° indicating the humidity of 15%. This is far below the comfort zone, as the humidity should be between 30% and 50% in winter time. Under these conditions, say at 8:30 a. m., in an office building, after draining all of the water vessels of the conditioning units, they may all be refilled with warm water at about 150° from the steam-heated supply tank 53; and thereupon the fan may be started. The humidity will be found to rise quite rapidly to the comfort zone; for example by 9 a. m. the humidity may reach about 40%, the water in the meanwhile cooling down to about 80°; and by 12:30 p. m. the water may drop to about 65°, with a humidity of 33%. Shortly thereafter, say about 12:40 p. m., when the humidity has dropped somewhat below 33% the attendant in charge may stop the fans, all controlled by circuits from the control room, and may thereupon drain the water out of the units by the valve 66, and thereupon refill the units with water, this time for example at 120°, the deficiency of humidity not being so great as at the commencement of the day. Upon now restarting the fans the conditions will again rapidly change so that for example at about 1:10 p. m. the water may have cooled to about 75° and the humidity risen to about 40%, and at 4:30 p. m. the temperature may have dropped to 65° and the humidity lowered to 30%.

By this manner of control the humidity has been brought quickly to and maintained within the comfort zone throughout the working day, and with minimum attention and expense. Manifestly the described afternoon control could be further repeated and the humidity maintained indefinitely in the comfort zone. The principle of control in one aspect may be described as maintaining a substantially large average difference between the temperature of the water in the vessel and the wet bulb temperature of the air, this difference insuring the described reactions for maintaining the desired humidity. The

periodic resupply of warm water is methodically performed so that before the humidity departs below the comfort zone the action is repeated by the fresh warm water and the renewed humidifying operation.

During the described operations the warmth of the water tends to raise the dry bulb temperature of the air by an amount depending on the difference between the air and water temperatures and the percentage of outside air admitted, the water losing temperature as the air becomes warmer. To avoid producing excessive dry bulb temperatures these conditions may be taken into account in managing the other temperature control; for example if a thermostat is used for steam radiators it may be set somewhat lower than usual to allow for the inevitable warming up accompanying the humidifying action.

In summer the comfort zone may be considered as between 30% and 70% humidity, while an oppressive day may present an initial dry bulb temperature of 90°, wet bulb temperature of 86° and humidity of 86%. In such case the principle of control will be as already recited and the treating water will be maintained at temperatures showing on the average a substantially large difference from the wet bulb temperature. In the case stated, the conditioning units may be serviced with refrigerated water, for example at about 35° or brine as low as 28°, far below the wet bulb temperature, and the units will be operated as before, in this case causing the humidity quickly to drop into the comfort zone, below 70%, where it will be variably maintained. The chilling action of the water and of the water cooled contact elements upon the air stream causes precipitation of moisture within the unit, the air thus being discharged into the room at a reduced percentage of humidity, while the water gradually warms up.

It may well be that dehumidification in the described manner can be effectively brought about by the unit **40** comprising upstanding semi-submerged members or rods, without the need of the rotary wheel member **30**, but the combination of the two is very effective and affords better air washing than the rod element alone. As the humidity, during the day, tends to increase, the conditions may be restored periodically at suitable intervals by draining the units, refilling them with freshly chilled water, and restarting the circulating fan, thus keeping the humidity down within the comfort zone. These operations tend to lower the dry bulb temperature of the room air, and regulation of air temperature may be supplementally secured by independent warming or cooling means.

The method thus set forth, for maintaining within the comfort percentage or zone the humidity of air in a number of rooms, may be summarized as treating the air by water of a temperature substantially different from (higher or lower than) the wet bulb temperature of the rooms to correct the humidity, and methodically or periodically renewing the required temperature of the water, preferably by replacing it by a fresh supply at the required temperature, or perhaps by applying local heating or cooling at each unit as set forth in said prior application, to renew or maintain the required temperature. As illustrated, the method hereof is carried out by means of separate conditioning units in the several rooms, each having a water vessel and air circulating means, the water being supplied from a central point at the required temperature, and distributed to the units to cooperate in correcting (elevating or depressing) the humidity, during which operation the water in the units approaches the wet bulb temperature, thus losing its effectiveness; but maintaining the humidity-correcting action by methodically, as at suitable intervals, resupplying the units with water at the required temperature, preferably by draining and refilling, although the resupply might be progressive and the fresh water displace the stale.

The rate or frequency of water renewal to the vessels, especially for dehumidification on an extremely humid day, may have to be far greater than heretofore indicated; for example, the vessels may be replenished several times per hour instead of 2 or 3 times per day, and where this is the case it is intended to provide an automatic control of simple character to minimize manual operations. Thus a time switch may be connected through circuits and motors to operate the valves, etc. to drain and then refill the vessels, say every 15 minutes, and restart the fan after each refilling; or a humidostat may be used to regulate the rate or frequency of water supply; or there may be a double control, or control including a thermostat in the vessel water.

Referring again to the described water distribution arrangement comprising the pipe **59** by which the tank **53** can supply water to the unit **7** and by which said units may be drained, it may be that in certain installations and for certain individuals it would be desirable to provide additional individual supply pipes leading from the supply tank **53** to each of the units **7**, controlled not from the control room but at each unit; in which case the individual may employ the valve **28** and pipe **59** to drain his unit, thereupon refilling it through the additional supply pipe. If desirable the control of the humidity may be facilitated in each room where an individual unit is located, for example, by control buttons on or near a desk in the room and suitable electric connections therefrom to the valves by which the unit is drained and resupplied.

If an individual in any given room desires to obtain either a lower or higher percentage of humidity than would be supplied by the system as described he may secure this result merely by the individual control of the valve **28**, opening and closing it according to the modification required.

The usual method of humidifying and dehumidifying the air in a number of rooms in a building is by means of a central air conditioning apparatus in which the air is treated and from which the conditioned air is circulated to certain rooms, being then returned to the central point for reconditioning. This requires expensive air ducts of large size, which are entirely dispensed with by the present invention, where not the air but only the warm or cool water is required to be distributed or delivered from the central point to the units in the respective rooms, and by small pipes easily accommodated.

There have thus been described a novel gas treating apparatus and a novel method of control attaining the objects and embodying the principles of the present invention; but since many matters of operation, combination and construction may be variously modified without departing from the principles of the invention it is not intended to limit the invention to such matters except to the extent set forth in the appended claims.

What I claim is:

1. Apparatus for conditioning air or other

gases comprising an enclosure having a removable cover and containing a vessel for water or other liquid and containing an air passage between the water and cover and with means to maintain air circulation through such passage, in combination with a semi-submerged rotary element for causing contact between the air stream and water, and a longitudinally thick hollow arched baffle within the enclosure below said cover and shaped to surround closely the exposed portion of the rotary element, thereby to compel the air stream to travel through the space occupied by the rotary element.

2. Apparatus for conditioning air or other gases comprising an enclosure having a removable cover and containing a vessel for water or other liquid and containing an air passage between the water and cover and with means to maintain air circulation through such passage, in combination with a semi-submerged rotary element for causing contact between the air stream and water, and a longitudinally thick hollow arched baffle within the enclosure below said cover and shaped to surround closely the exposed portion of the rotary element, thereby to compel the air stream to travel through the space occupied by the rotary element, said rotary element being mounted on a submerged removable frame, shiftable relatively to said baffle and liftable from said enclosure.

3. Apparatus for conditioning air or gas comprising an enclosure containing a vessel for a body of water or liquid and an air passage thereover, and means to maintain circulation of air therethrough, and within said enclosure two air treating devices in tandem, one device comprising a semi-submerged and continuously wet slowly rotating element occupying the air stream and causing extensive contact between the air stream and water, said air passage being substantially semicircular adjacent to said rotating element and said element substantially filling the cross section of such passage, and the other device comprising a bank of upstanding metallic members having their lower ends substantially submerged in the water in said vessel and their upper ends occupying said air passage; whereby for humidifying operation the first mentioned device transmits both heat and moisture from the relatively warm water to the air stream, while the dry second mentioned device transmits to the air stream supplemental heat but no moisture, while for dehumidifying operation both devices transmit both heat and moisture from the air stream to the body of water.

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