Dec. 4, 1934. W. L. FLEISHER 1,983,023

METHOD AND APPARATUS FOR VENTILATION

Filed Jan. 14, 1932 4 Sheets-Sheet 1

Fig. 1

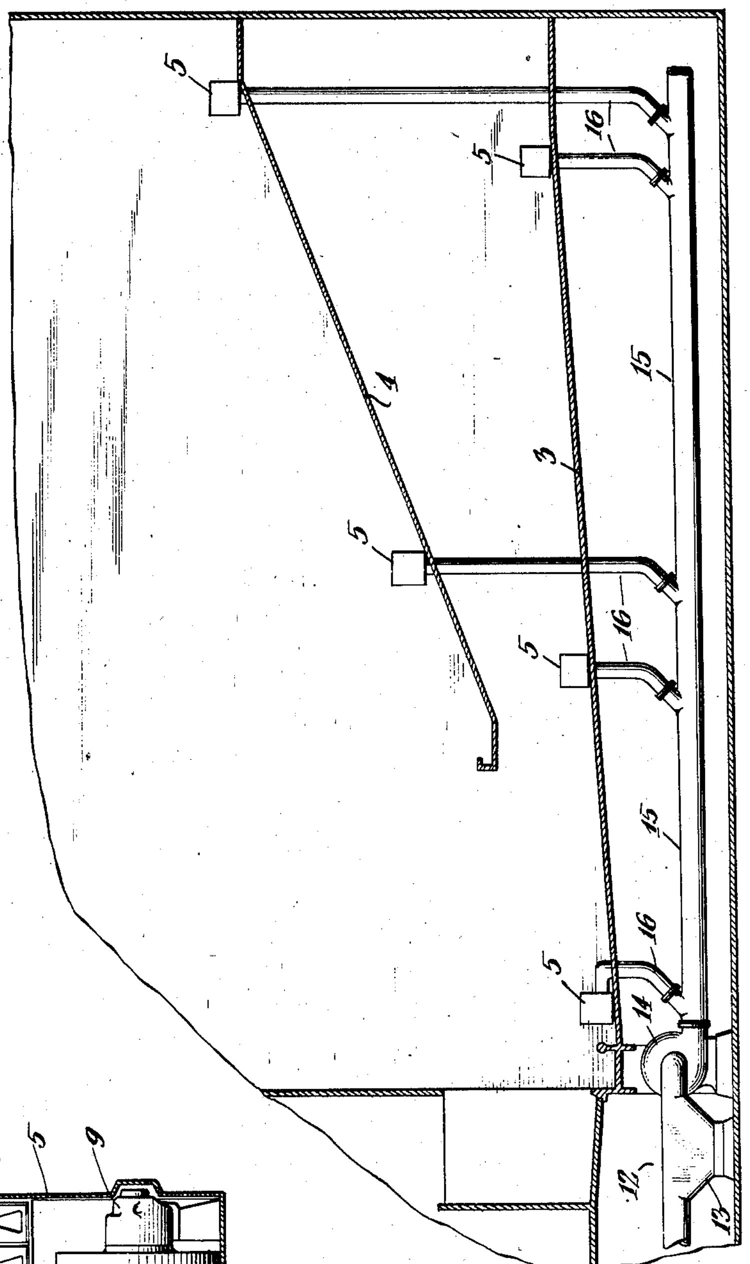
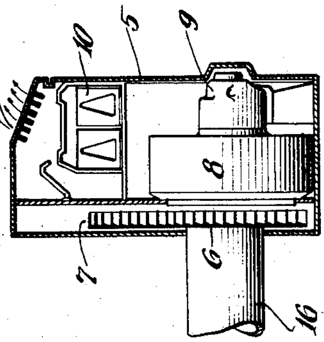


Fig. 2



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METHOD AND APPARATUS FOR VENTILATION

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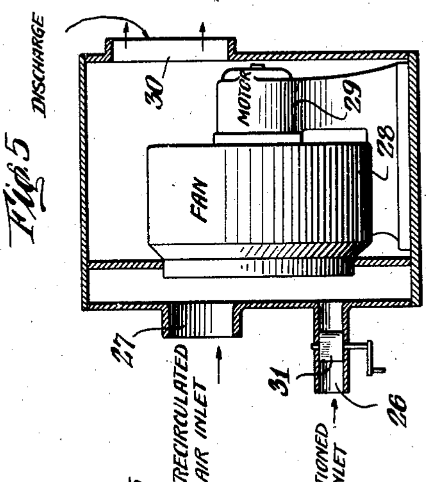

Fig. 5

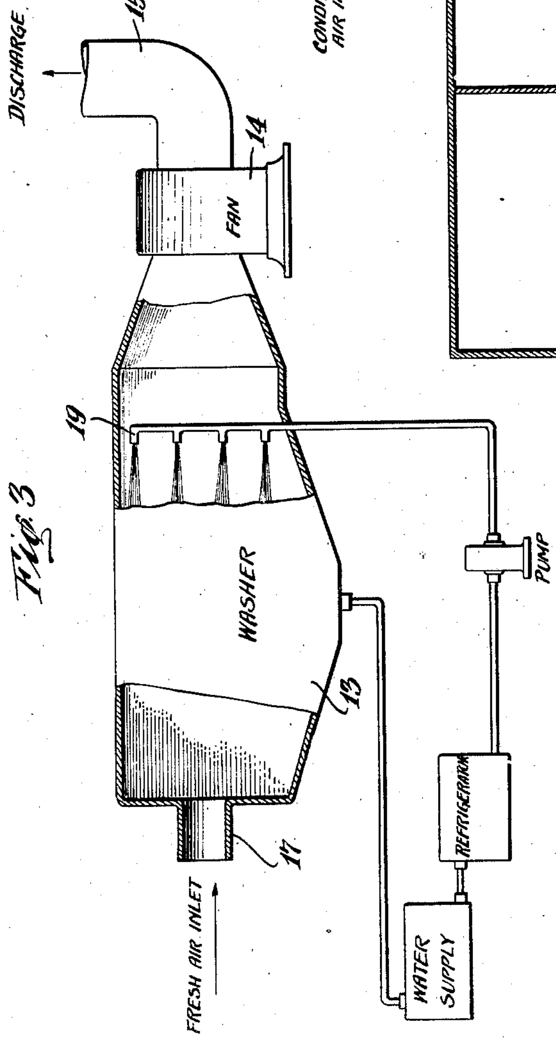

Fig. 3

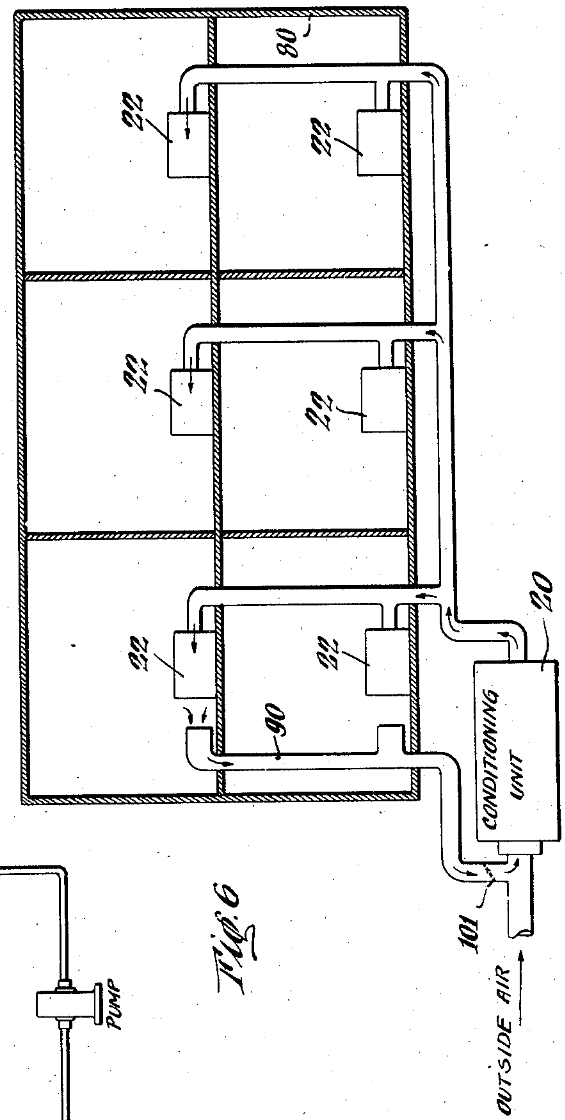

Fig. 6

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METHOD AND APPARATUS FOR VENTILATION

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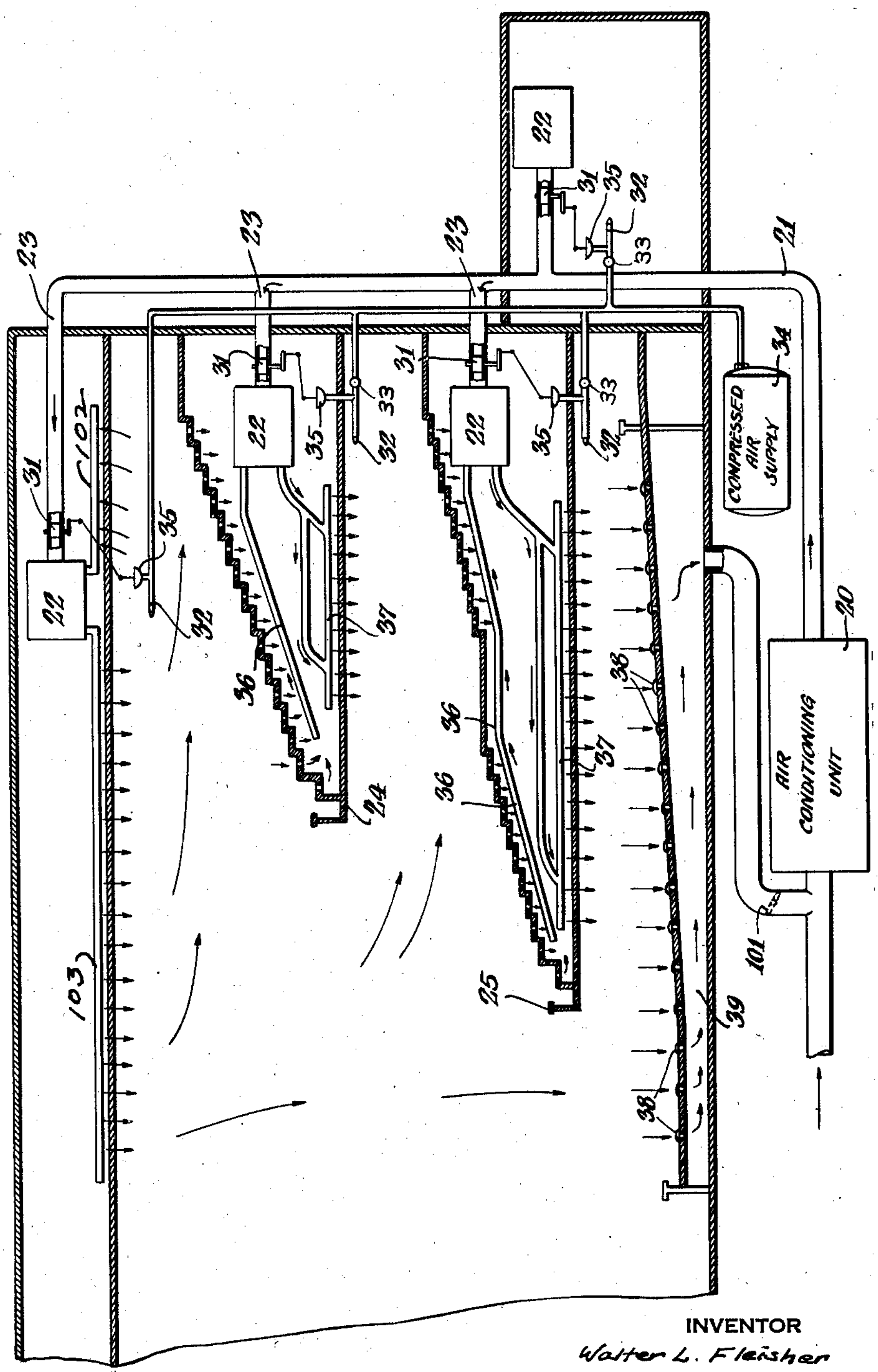
Fig. 4



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METHOD AND APPARATUS FOR VENTILATION

Filed Jan. 14, 1932 4 Sheets-Sheet 4

Fig. 8

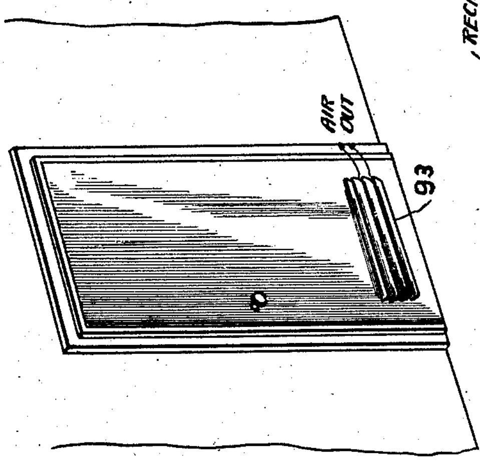


Fig. 9

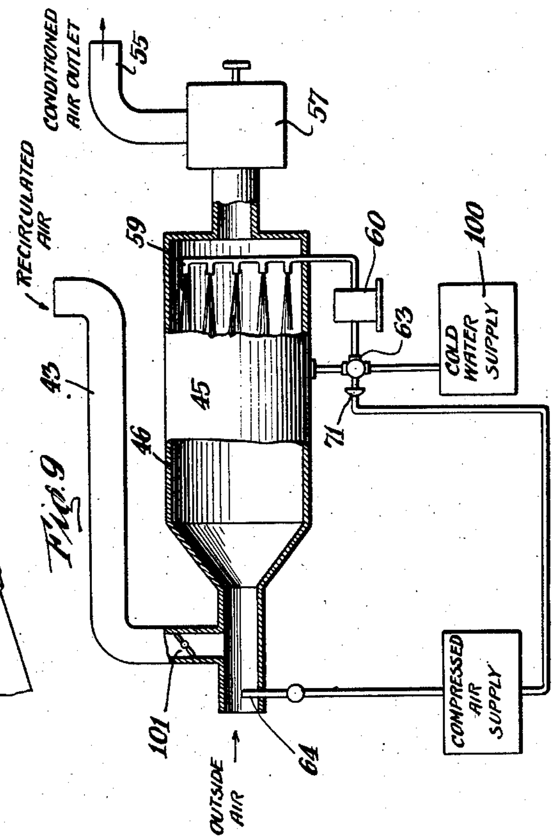
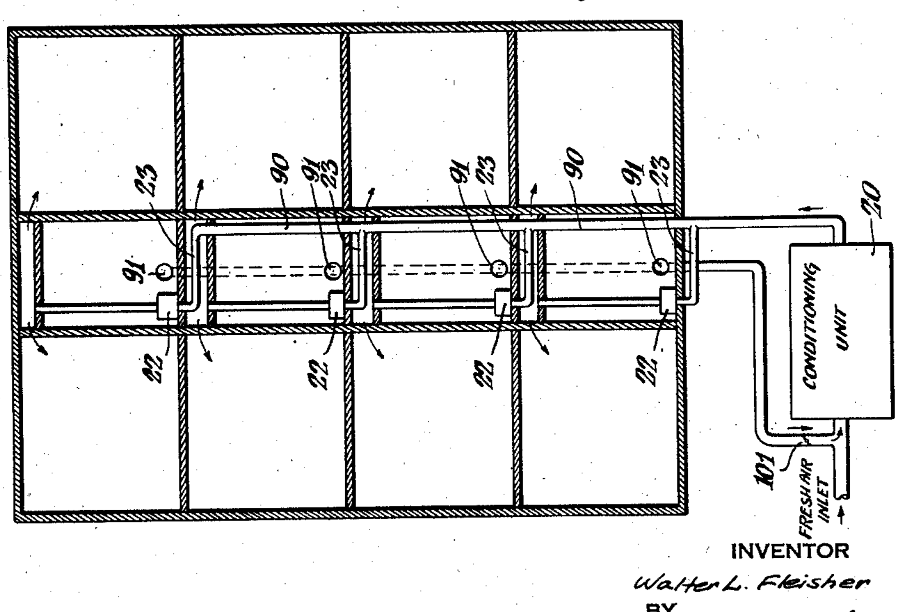


Fig. 7



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UNITED STATES PATENT OFFICE

1,983,023

METHOD AND APPARATUS FOR VENTILATION

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Application January 14, 1932, Serial No. 586,512

8 Claims. (Cl. 98—33)

This invention relates to methods and apparatus for conditioning air, and relates more particularly to an air conditioning system in which a small amount of air is intensively conditioned and is distributed to a plurality of spaced delivery units, within which it is mixed with a larger amount of unconditioned air and discharged.

The application is a continuation in part, of my co-pending application, Serial No. 118,728, filed June 26, 1926.

To maintain comfort conditions in enclosures where people are accustomed to assemble, it is desirable not only that the proper temperature be maintained within the enclosure, but that the air furnished to the enclosure be at a temperature only slightly less than the temperature that it is desired to maintain, in order to avoid drafts. It is also desirable, especially in summer months, to maintain the temperature and the relative humidity of the air within the enclosure lower than the temperature and relative humidity of the outside air, and also to keep the air circulating so as to quickly absorb the heat and moisture from the bodies and exhalations of the people in the enclosure. It is also desirable that the incoming air be admitted through the supply ducts to different portions of the enclosure, where variations from the desired temperature, due to proximity of exit points, changing number of occupants, etc., are most likely to take place. In large auditoriums, a number of discharge points for the air is desirable in order that a large volume of air may be circulated without inequalities of air flow.

The air conditioning systems up to the present time for theaters and other enclosures have, it is believed, required expensive and involved apparatus, and great operating expense for obtaining the comfort conditions outlined above. In such systems, it has been customary to circulate a large amount of air which has been treated to take on a temperature differing only in a small degree from that within the enclosure, in order to avoid drafts. It is my belief that such systems have required the treating of too large quantities of air, too much apparatus has been required to treat such large quantities, and the duct work for handling the large quantities of air have, of course, had to be of large size.

In developing the present invention, it was recognized that the air within an enclosure is, after a period of conditioning and particularly in summer months, nearer the standard it is desired to maintain than the outside or fresh air. In summer, the outside air usually has too great a degree of humidity and too high a temperature for comfort. Obviously, after an air conditioning system has been in operation for a sufficient period of time, the air inside the enclosure, to which cooled and dehumidified air is being supplied, has a temperature and a humidity which is near the desired standard. According to this invention, the air within the enclosure is utilized to as great an extent as possible, rather than outside air. A small amount of air is cooled to a much lower temperature than that within the enclosure, is supplied through small ducts to a plurality of distribution points suitably located within the enclosure, and a large quantity of air from within the enclosure is mixed with the highly treated air, the mixture of treated air and air from the enclosure being discharged at constant volume from the distribution units. As a result of the mixture of a small amount of highly cooled air with a much larger amount of warmer air, the mixture discharged is at a temperature closely approaching that of the enclosure and no drafts are caused, nor does the discharged air differ too much either in temperature or humidity from the standard to be maintained.

The invention comprises, therefore, a small and compact air conditioning plant adapted to cool small quantities of air to a high degree, together with ventilating ducts of small proportions, and a plurality of local discharge stations, each of which, in itself, comprises an inlet for the cool air, an inlet for the air from the enclosure, a mixing chamber, a fan for mixing the two air currents, and an exit for the discharge of the mixed air. The small, compact conditioning unit may be placed in a basement or attic, or any other unoccupied space which is not desired for another purpose. The supply ducts are of small proportion because only a small amount of air is conducted therethrough. No return ducts are necessary. The local discharge stations may be positioned in the walls or floors of the enclosure, or may be installed in especially constructed mountings to harmonize with the interior decoration of the building where they are installed. A constant volume of air is supplied to the enclosure, temperature variations being compensated for by varying the proportion of conditioned air to air withdrawn from the enclosure.

An object of the invention is to maintain the air within an enclosure at the desired relative humidity and temperature, by mixing a small amount of intensely conditioned air with a large amount of air withdrawn from the enclosure, within a discharge station.

Another object of the invention is to intensely condition small amounts of air and to mix same with larger amounts of recirculated air within a plurality of discharge stations positioned at desired points.

In one embodiment of this invention, in a central conditioning plant, a small amount of highly conditioned air is passed through a series of small supply ducts, and a larger amount of recirculated air is mixed with the conditioned air and the mixture is discharged at constant volume into the enclosure from a plurality of discharge stations. The two currents of air are mixed within the discharge stations prior to discharge, there being required no return ducts for carrying air back to the conditioning unit, thus eliminating considerable conditioning expense as well as maintenance expense, and requiring less space.

The invention will now be described with reference to the drawings, of which:

Fig. 1 is a diagrammatic representation of an enclosure equipped with a system incorporating one embodiment of the invention;

Fig. 2 is a diagrammatic view of a local discharge station which is equipped to mix conditioned air with air withdrawn from the enclosure, and to discharge the resultant tempered mixture at predetermined temperature and humidity conditions;

Fig. 3 is a diagrammatic view of a washer unit which is adapted to condition the air supplied to the system of Fig. 1;

Fig. 4 is a diagrammatic view of another embodiment of the invention, illustrating a system for the conditioning of air within a theater;

Fig. 5 is a diagrammatic view of a local discharge station adapted to be used with the system illustrated by Fig. 4;

Fig. 6 is a diagrammatic view of an air conditioning system, illustrating the invention applied to the conditioning of air, for comfort purposes, in an industrial building;

Fig. 7 is a diagrammatic view of a system, illustrating the application of the invention to conditioning of air within a hotel;

Fig. 8 is a diagrammatic view of a door which is adapted to be used with each room of the hotel utilizing the system shown by Fig. 8, and

Fig. 9 is a diagrammatic view of an air conditioning unit adapted for conditioning the air supplied to the systems of Figs. 4, 7 and 8.

Referring now to Figs. 1, 2 and 3 of the drawings, the numerals 3 and 4 represent the orchestra floor and balcony respectively, of a theater. A number of local distributing units or local discharge stations 5 are positioned, as illustrated, at desired points in the balcony 4 and the orchestra 3. Each unit or station 5 has an inlet 6 adapted to receive conditioned air from the air conditioning unit 13, through the main supply duct 15, and the branch supply ducts 16. As shown in detail by Fig. 2, each unit or station 5 is provided with an adjustable inlet 6 through which the conditioned air is received, an adjustable recirculating inlet 7 through which air from the enclosure is drawn, and a fan 8, coupled to motor 9, which draws recirculated air through the inlet 7, mixes the recirculated air and the conditioned air, and discharges the mixture through the exhaust opening 11. Heating apparatus 10 is located within the unit 5 between the fan and exhaust and may be used, in winter, to heat the mixed air.

The adjustable conditioned air inlet 6 and recirculated air inlet 7 may be thermostatically controlled to automatically vary the proportions of recirculated to conditioned air delivered through the units. The capacity of the system is made sufficiently large to compensate for extreme variations in climatic conditions and to assure delivery of recirculated and conditioned air in sufficient quantity and proper ratio to maintain the constant desired operating condition and rate of circulation.

The central air conditioning apparatus 12 is located in the basement of the building for convenience and comprises the usual refrigeration and tempering equipment, as illustrated diagrammatically in Fig. 3. The details of such a system are well known to those skilled in the art and are described in the 1916 edition of "Mechanical Engineer's Handbook", published by McGraw-Hill Company of New York city. Incoming air is drawn through the inlet 17, through the washer 13 in contact with spray from the spray nozzles 19, where it is cooled to a comparatively low degree, and is then supplied by the fan 14 through the main discharge ducts 15 and the branch supply ducts 16 to the spaced units 5.

The local discharge stations or units 5 and the air conditioning unit 12, together with their connecting supply ducts, are so designed that a small amount of highly conditioned air is supplied to each of the units 5 and is there mixed, through the action of the fan 8 in drawing recirculated air through the air inlet 7, with a much larger amount of air from the enclosure. In summer, the conditioned air has a much lower temperature than the air from the enclosure, but due to the fact that it is mixed thoroughly within the unit 5 with a much larger amount of air from the enclosure which has a temperature slightly above or at that desired to be maintained, the resulting air mixture discharged through the discharge outlet 11 has a temperature only slightly less than that within the enclosure so that there are no drafts produced as were a stream of colder air discharged. As an example of the operating conditions encountered in a theater, as shown in Fig. 1, in summer, it is desired to maintain 75° dry bulb temperature. The outside temperature is much higher and the problem is to keep the theater cool and at a low relative humidity. The air within the theater, if not conditioned adequately, would obviously take on a high temperature and a high relative humidity due to the heat and moisture given off by the occupants, and due to outside conditions. Now, it is known that ten cubic feet of conditioned air per minute, per person, introduced at approximately 50° F. would maintain a given portion of the building at the desired temperature of 75°, but only with extreme discomfort to the occupants due to the draft produced by the comparatively cold air. The practice in the past, in order to avoid drafts, has been to introduce the larger quantities of conditioned air at higher temperatures. In fact, it is known that a 6° or 7° difference between the temperature of the entering air and the desired temperature to be maintained is the best temperature difference for comfort. As the difference between the temperature of the conditioned air and the temperature of the air within the enclosure diminishes, the quantity of air which must be supplied for maintaining the desired temperature increases, and where there is only a 6° or 7° difference between the temperature of the entering air and the temperature to be maintained, at least thirty cubic feet per minute, per person, of treated air must be circulated. It is seen that from a purely efficiency and economy standpoint, disregarding for the moment the discomfort of the occupants of the building, ten cubic feet of cold air per minute, per person, are adequate for cooling, but thirty cubic feet per minute, per person, are required so that, in effect, twenty cubic feet of air per minute, per person, or two-thirds of the air circulated, is wastefully handled with the present systems of cooling, the waste involving not only equipment for handling and conditioning three times the amount of air, but provision of large supply ducts and large return ducts, and, of course, greater operating expense.

In the system of conditioning according to this invention, thirty cubic feet of air per minute, per person, are supplied to the enclosure, but only ten cubic feet of conditioned air per minute, per person, are required, this because every ten cubic feet of very cold, conditioned air is mixed with twenty cubic feet of air from the enclosure, the thirty cubic feet being discharged from the local discharge stations at a temperature differing only the proper amount from the temperature of the enclosure. Thus, not only is a smaller amount of equipment required for conditioning the air, but the supply ducts are smaller, and the air within the enclosure, which, after a period of operation, is nearer the desired temperature condition than the outside air, is utilized to reduce the expense of continuously supplying large amounts of fresh air. Another advantage of the system, according to this invention, is that each of the local discharge stations or local supply units 5 may be individually controlled as the temperature in various parts of a building vary. Another advantage of the system is that the air conditioning equipment may be remotely located in any convenient location quite distant from the enclosure to be cooled and only relatively small and inexpensive supply ducts are required to carry the small amount of highly conditioned air to the plurality of discharge stations where the highly conditioned air is mixed with non-conditioned air and discharged.

Great economies in operating expense are gained by mixing non-conditioned and intensively conditioned air prior to the discharge of the mixed air into the enclosure. According to this invention, not only is less refrigeration required in the air conditioning unit, but there is no need to heat the conditioned air, as is done according to the present and practiced methods. In order that the economies gained by this invention may be appreciated, a brief discussion of the principles and thermodynamics entering into the problem are presented.

A certain temperature and relative humidity has always been maintained in the enclosure. This temperature and humidity represents a definite heat condition of the air made up of the sensible heat, indicated by the ordinary thermometer, and the heat necessary to evaporate the moisture in the air and which creates the latent heat. The total heat is the sum of the sensible heat and the latent heat of evaporation.

The air that is brought into the enclosure for conditioning purposes must have a moisture content per cubic foot which is less than the amount that it is desired to maintain in the house in order that it may absorb the moisture given off by the people.

In the former methods of conditioning, where all of the air was put through the conditioner, both the air from out-of-doors and the air returned from the enclosure which was mixed with it were taken through the conditioner and all of this air brought down to a condition below the dew point or moisture holding temperature desired in the house. This meant that all of the air taken through the conditioner had to have its sensible heat removed as well as part of its latent heat. This meant that the air with the right amount of moisture was too cold to introduce into the house, and, consequently, had to have sensible heat put back into it by means of a heating system.

In the system of conditioning for comfort, according to this invention, only a small part of the air is taken through the conditioner and this part is intensively conditioned and more moisture removed from this small part per cubic foot than would be removed per cubic foot were all of the air conditioned. This intensely conditioned air is then mixed with a large amount of air recirculated from the house, which has sufficient sensible heat in it, to make up for the deficiency of sensible heat in the intensely conditioned air. Therefore, where ordinarily a great deal of sensible heat would be destroyed, which otherwise could have been usefully used, as is the case in the old method of conditioning, in the present method only a very small amount of useful, sensible heat is destroyed and the balance is kept for bringing up the sensible temperature of the air which is to be introduced into the house without the necessity of using steam or involving any additional cost. The sensible heat which is unnecessarily removed in the old method is a charge on the refrigerating system, and the sensible heat that is put back is necessarily a charge on the heating system.

This method which has just been described, contrary to the usually preconceived ideas, is even more economical and advantageous with decreasing numbers of people, assuming always that the same quantities of air, in order to give proper circulation in the house, must be circulated regardless of the number of people. This is due to the fact that the total heat in each cubic foot of air in the house must be maintained at the same condition in order to secure comfort, irrespective of the number of people in the house, and the moisture content per cubic foot must be maintained at practically the same condition, irrespective of the number of people in the house. Therefore, with the old methods, the refrigeration requirements are maintained practically the same irrespective of the number of people in the house, but the amount of sensible heat which must be readded, increases with decreasing number of people, due to the fact that the air must be brought in at a higher dry bulb temperature, to add heat to the air, to bring it up to the required condition. Whereas, in the present method, with decreasing numbers of people, a smaller amount of air is taken through the conditioner, and a larger amount of air is recirculated to give the increased amount of sensible heat necessary to allow the mixture to enter the enclosure at a higher temperature than would be essential with a full house, and more sensible heat given up by the occupants. In this way, a saving in refrigeration is made due to the lesser amount of air through the conditioner, and the additional sensible heat required, because of the fewer number of people, is given by the larger amount of recirculated air.

Fig. 4 illustrates another embodiment of the invention applied to theaters. In this embodiment of the invention, not only is a small amount of highly conditioned air mixed with air from the enclosure, but automatic controls are provided at each local discharge station 5 to vary the temperature of the air discharged from each unit, as required by varying conditions within the enclosure being cooled, and a portion of the air within the enclosure is recirculated through an air conditioning unit and is there mixed with incoming air and conditioned. The conditioning unit 20, which is illustrated in more detail by Fig. 9, and the operation of which will be explained later, supplies the highly cooled air through the supply duct 21 to the local discharge stations or supply units 22 through the branch ducts 23. The discharge stations or units 22 are illustrated in more detail by Fig. 5. It is seen that each unit 22 is provided with a conditioned air inlet 26, a recirculating air inlet 27, a fan 28, coupled to motor 29, and a discharge outlet 30. In each of the air inlets 26 is provided with a damper 31 which is operated by thermostatic equipment to control the amount of conditioned air entering the unit 22, as temperatures adjacent each unit 22 vary. The operation of the thermostatic controls is illustrated more clearly by Fig. 4. There, the dry bulb thermostats 32 have their actuating elements interposed in the compressed air lines 33 between the compressed air supply 34 and the actuating motor 35, which are connected by suitable link motion, as shown, to the dampers 31 in the conditioned air inlets 26 of each of the discharge units 22. As the temperature of the body of air being supplied with conditioned air by one of the discharge units 22 varies, its associated thermostat 32 operates to open or close its conditioned air inlet 26 by means of the damper 31. As the damper 31 acts to close the conditioned air inlet 26, obviously, more recirculated air is drawn in through the recirculated air inlet 27, this because the fan 28 operates at a constant speed to deliver a constant volume of air through the discharge outlet 30. Likewise, as the temperature affecting the thermostat 32 increases, the damper 31 is actuated to allow more cool air to enter through the conditioned air inlet 26 and the proportion of cooled air to recirculated air is increased, resulting in cooler air being discharged through discharge outlet 30.

While the control of the recirculated and conditioned air has been described as being automatic due to the action of the thermostats 32, it is obvious that the dampers may be manually controlled, their position being varied from time to time by observation of the thermometers. Each local discharge unit has been shown provided with a thermostat responsive to temperature changes in the area served by the unit for varying the proportion of conditioned to non-conditioned air. Thus, colder or warmer air may be discharged, as required, from each local discharge unit independent of the temperature of the air discharged from the other units. Of course, in buildings where it is not expected that extreme temperature variations will be encountered in different portions of the building, one or more thermostats may be positioned to control the temperature of the conditioned air supplied by the conditioner.

As shown by Fig. 4, a local discharge unit 22 is located adjacent each of the balconies, the one in the upper balcony serving the area including the seats of the lower balcony; the one in the lower balcony serving the area directly underneath in the orchestra section, and one unit is provided in the outer lobby to supply it with conditioned air. The balconies 24 and 25 are provided with the ducts 36, through which air from the auditorium is drawn through grills beneath the seats, as in the usual manner, this air being drawn into the local units 22 through the recirculated air inlets 27. The highly conditioned air, as usual, passes through the conditioned air inlets 26, is mixed within the units and dischargd through the discharge ducts 37, through suitable openings in the ceilings of the balconies. The arrows indicate the direction of air flow. Another unit 22 located in an enclosure above the ceiling of the auditorium draws in air from the auditorium through the duct 102, takes conditioned air in through the duct 23, and discharges the mixture into the auditorium through the duct 103.

The floor of the orchestra area, beneath the orchestra seats, is provided with the mushrooms 38, through which air from the auditorium is drawn into the discharge duct 39, from which it passes into the air conditioning unit 20 to be mixed with outside and conditioned air, as will be explained later in the discussion of Fig. 9. This embodiment of the invention is much more elaborate than the embodiment shown in Fig. 1, and is provided for the most modern elaborate theaters where initial expense is of less consideration and where the ultimate in air conditioning equipment is desired. In this embodiment, not only is air from the auditorium mixed with highly conditioned air at each of the discharge units 22, but air from the auditorium is continuously withdrawn and mixed in the conditioning unit 20 with outside air.

The air conditioning unit 20, illustrated by Fig. 9, is used not only with the theater installation shown by Fig. 4, but with the industrial installation shown by Fig. 6 and by the hotel installation shown by Fig. 7, and will now be explained. The air conditioning apparatus 20 comprises a washer 45 connected with the mixing chamber 46. The air from the enclosure, with which the air conditioning unit is associated, is carried into the conditioning unit 20 by a conduit 43. The mixing chamber 46 is in direct communication with the conditioning apparatus and a fan 57 is arranged to withdraw air from the conditioner and to return it through a conduit 55 to be discharged into the enclosure through the usual supply ducts. The sprays 59 are supplied with water by the pump 60, the valve 63 being provided and controlled by the wet bulb thermostat 64, located in the outside air duct, to supply the sprays 59 with recirculated water from the washer 45, or cold water from the cold water supply 100, as required by changing temperature conditions. With a rising wet bulb temperature, the thermostat acts to switch the pump 60 from recirculating water to refrigerating water. These controls are actuated in the well known manner, by the diaphragm motor 71, which is actuated by the thermostatic element in the thermostat 64, which, in turn, is supplied with air by a compressed air supply.

The advantages of this particular type of air conditioning unit are that conditioning may be accomplished with the minimum of expense, the recirculated air from the auditorium being mixed with outside air, since the condition of the recirculated air is nearer the desired comfort conditions than the outside air, and, with this arrangement, less refrigeration is required. By closing the damper 101 in the recirculated air duct 41, the recirculated air is shut off and the air conditioner 20 operates in substantially the same way as the air conditioner 12 shown by Fig. 3 to condition outside air only, there being no recirculation.

In the application of the invention to industrial buildings, as shown by Fig. 6, the local discharge units 22 are similar to those shown by Fig. 5 which are employed in the theater installation shown by Fig. 4. As has already been stated, the conditioning unit 20 is similar to that shown by Fig. 9. Each floor or section of the building 80 is provided with a local recirculation unit 22. These units 22 may be thermostatically or manually controlled, as has already been described in connection with the system illustrated by Figs. 4 and 5 of the drawings. The temperature of the air in each local section of the building governs the proportion of conditioned air to recirculated air which is discharged from each of the local discharge units 22. The return duct 90 is shown connecting with the air of two of the local sections of the building for returning a small portion of recirculated air to the conditioning unit 20, where it is mixed with the outside air to eliminate the expense of treating only outside air which, as has previously been explained, enables more economic conditioning to be done. Each of the local sections illustrated diagrammatically by Fig. 6 may be a floor, a room, or any other subdivision of an industrial building.

The application of an embodiment of the invention to the supply of conditioned air to the hotel, for example, is illustrated by Figs. 7 and 8. There the air conditioning unit 20, which is similar to that shown by Fig. 9, supplies highly conditioned air through the duct 21 to the local discharge units or stations 22, one of each of which is located in the hallway of each floor of the hotel, as illustrated. Each of the units 22 is exactly similar to the units already described in connection with Figs. 4 and 5 of the drawings, they being equipped with thermostatic or manually operated controls, as described in connection with Fig. 4, for controlling the proportion of conditioned air to recirculated air, which is mixed within the local discharge units 22. In operation, a local discharge unit 22 takes highly conditioned air from the air conditioning unit 20 and draws also air from the hall into the unit 22, the two air streams being mixed and discharged into the furred ceiling in the hall from which it is discharged into the room. A portion of the air in each hallway is withdrawn through the exhaust stations 91 and into the exhaust duct from which it passes into the air conditioning unit 20 where it is mixed with outside air prior to conditioning, as described in connection with Figs. 4, 9 and 6. Each room of the hotel is provided with the type of door shown by Fig. 8, which door separates each individual hotel room from its associated hallway. The bottom of the door has the channeled portion 93 through which air passes from the room into the hall. With this type of installation, each floor, or group of floors, of the hotel may be separately supplied with conditioned air to maintain the desired temperature.

In the embodiment of the invention illustrated by Figs. 1, 2, and 3, none of the air from the enclosure is recirculated through the air conditioning unit, there being no conditioning of air from the enclosure. In the embodiments of the invention illustrated by the remaining figures of the drawings, some of the air from the enclosure may be taken back into the conditioning unit to be there mixed with outside air and conditioned. The damper 101 in the duct which carries air from the enclosure to the intake side of the air conditioning unit, and which may be either manually or automatically operated, serves to shut off air from the enclosure when it is not desired to condition same. Under certain operating conditions, it will be desirable to have the damper 101 opened and air from the enclosure conditioned, and under other circumstances it may be desirable to condition only outside air. For example, it is customarily desirable to operate the air conditioning unit 20 to give a fixed degree of refrigeration. Now, if only the average number of people in the theater or other enclosure are present, as has previously been explained, ten cubic feet of air per person per minute may be passed through the conditioning unit, cooled, and then mixed with air from the enclosure to maintain the desired temperature. For economy, the air conditioning unit is designed to cool sufficient air for the average number of people which would be within the enclosure. Suppose, however, that a maximum number of people enter the enclosure, the number of people being a great many more than the average number, obviously, more cooling is required due to the larger number of people, but the air conditioning unit is designed for economic reasons to cool the conditioned air to a certain degree. It, therefore, becomes necessary to pass more air through the conditioner in order to keep the enclosure cooled to a desired temperature. For example, thirteen cubic feet of air per person per minute may be passed through the air conditioning unit under maximum load conditions as against ten cubic feet of air per person per minute under average load conditions. Now, it is seen that three extra cubic feet of conditioned air per person per minute are required to maintain the enclosure at the proper temperature under maximum load conditions. It would not be economic to take this extra air from outside the enclosure since, as has previously been explained, the air within the enclosure is nearer the desired temperature and relative humidity than the outside air. So, according to this invention, the extra air is taken from the enclosure, passed into the intake side of the air conditioning unit, and, with the outside air, is conditioned. Accordingly, therefore, it is seen that the system may be designed to operate with the damper 101 closed under ordinary load conditions, and with the damper open under maximum load conditions, with minimum operating expense.

While, for the purpose of illustration, the invention has been illustrated and described in connection with Figs. 1 to 5 inclusive as applied to theaters, it should be realized that the invention comprehends not only theaters, but office buildings, hotels, schools, and, in fact, every type of enclosure, the air of which it is desired to condition for comfort, for manufacturing, or for other reasons.

While the invention has been described as effecting the cooling of the air in the enclosure in summer months, it should be realized, of course, that the same principles govern heating in winter months, and that, therefore, the invention comprehends heating as well as cooling.

Whereas one or more embodiments of the invention have been described for purposes of illustration, it should be understood that the invention is not limited to the particular embodiments described, but that such embodiments of the invention are capable of modification by, and other embodiments may be involved by, those skilled in the art without departing from the spirit of the invention.

I claim:

1. The process of conditioning the atmosphere of an area in which human beings are accommodated, consisting in conditioning intensively a relatively small volume of air at a point outside said area to a temperature lower than that of the air in said area, delivering the intensively conditioned air to a point within the area for mixing with air from the area, mixing the intensively conditioned air at said point in the area with a larger volume of air from the area of higher temperature, so that a mixture will be formed at a temperature lower than that of the air in the area, but higher than that of the conditioned air, and at a relatively small differential in temperature from the air in the area whereby the mixture may be discharged into the area without producing objectionable drafts, and discharging the mixture into the area in constant volume regardless of changes in the proportions of conditioned air and air from the area.

2. The process of ventilating and conditioning a room, which comprises conditioning air, at a point remote from the room, to a temperature too cold for comfort, mixing therewith at a point within the room air from the room having a condition different from the conditioned air to form a mixture having a dry bulb temperature higher than that of the conditioned air and a relative humidity lower than that of the conditioned air and discharging the mixture at said point of mixture in the room in constant volume regardless of changes in the proportions of conditioned air and room air in the mixture.

3. A method of conditioning the atmosphere of an enclosure in which human beings are accommodated, consisting in conditioning a volume of air to a temperature too cold for human comfort, delivering the conditioned air to a number of distributing points remote from the point where the air is conditioned, raising the temperature of the conditioned air at said distributing points by mixture of the conditioned air with air from the enclosure whereby a mixture is formed at each of said points greater in volume than the conditioned air delivered thereto and at a temperature not too cold for comfort, and delivering the mixture at each of said points in constant volume regardless of changes in the proportions of conditioned air and air from the enclosure.

4. The process of conditioning the atmosphere of an area which includes intensively conditioning, at a point remote from the area, a volume of air insufficient for the circulation requirements of the area to a temperature below that of the area and too cold for comfort, conducting said air to a point adjacent the area and mixing it at said point with air from the area to form a mixture sufficient in volume to take care of the circulation requirements of the area and at a temperature lower than that of the air in the area, and varying the proportion of the conditioned air in the mixture in accordance with the temperature of the air in the area and discharging the mixture within the area, the mixture always being discharged in constant volume regardless of changes in the proportions of conditioned air and air from the area.

5. A method of conditioning the atmosphere of a room which comprises conditioning a volume of air to a temperature too cold for human comfort, delivering the conditioned air to a number of distributing points in the room, the distributing points being remote from the point where said air is conditioned, mixing the conditioned air at each of said distributing points with a volume of air from the room, discharging the mixtures at each of said distributing points always in constant volume, the proportions of conditioned air and room air in each of said mixtures being varied to compensate for variations in atmospheric conditions within the zones served by the respective mixtures, so that uniform atmospheric conditions may be maintained throughout the room.

6. The process of conditioning the atmosphere of a room consisting in conditioning intensively a relatively small volume of air at a point outside the room to a temperature lower than that of the air in the room and too cold for comfort, apportioning the conditioned air between a number of distributing points within the room, mixing the conditioned air delivered to each of said points with air from the room to form a volume at each of said points larger than that of the conditioned air delivered thereto at a temperature lower than the air in the room and higher than the conditioned air, the mixture at each of said points being discharged in constant volume, and varying the proportions of conditioned air and air from the room in the mixture at each distributing point without changing the total volume of the mixture discharged at each of said distributing points whereby the temperature of the respective mixtures will be regulated to compensate for changes in temperature in the respective zones served by the mixtures.

7. A method of conditioning the atmosphere of an area in an enclosure which comprises conditioning a volume of air from a predetermined source to a temperature lower than that of the area and too cold for human comfort, delivering the conditioned air to a distributing point within the area, the distributing point being remote from the point where said air is conditioned, mixing air from the area with the conditioned air at said distributing point to form a mixture greater in volume than the conditioned air and higher in temperature than the conditioned air, varying the proportions of conditioned air and air from the area to compensate for variations in atmospheric conditions in the area, a reduction in the volume of conditioned air in the mixture resulting in an increase of the volume of air from the area in the mixture and vice versa, and discharging the mixture within the area, the mixture always being discharged in constant volume regardless of changes in the proportions of conditioned air and air from the area in the mixture.

8. A method of conditioning the atmosphere of an area which comprises conditioning a relatively small volume of air, insufficient for the circulation requirements of the area, to a temperature too cold for comfort, delivering the conditioned air from the point of conditioning to a point of distribution serving the area at a velocity determined at the point of conditioning, mixing the conditioned air at the point of distribution with air from the area to form an augmented volume greater in volume and higher in temperature than the conditioned air delivered to said point of distribution and discharging the mixture in constant volume into the area at a velocity independent of that of the conditioned air delivered to said distribution point.

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