Feb. 14, 1950 A. W. CANNEY 2,497,068

AIR VENTILATING SYSTEM WITH MALODOR REDUCING MEANS

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Fig. 1

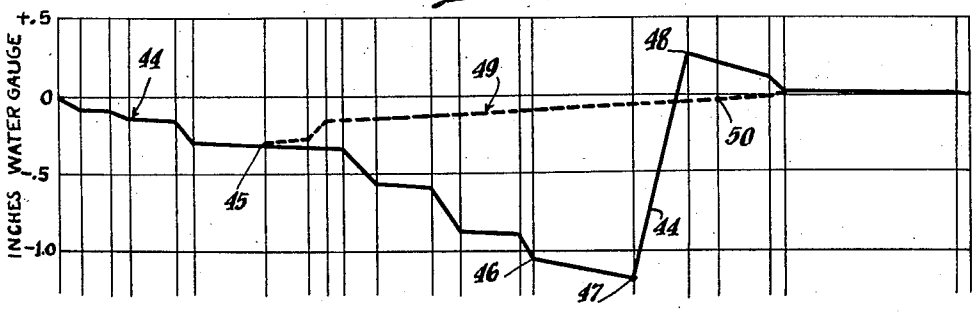
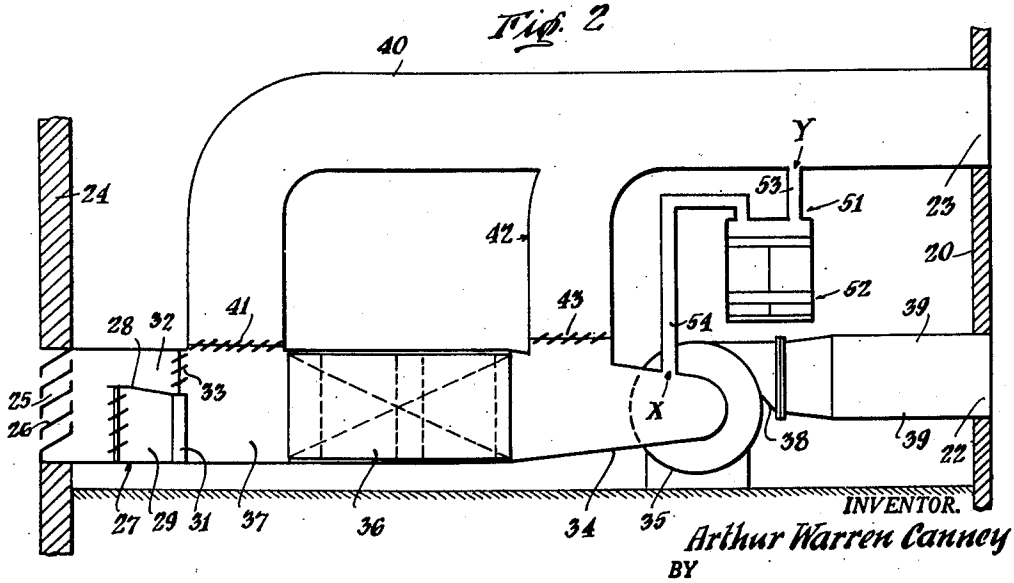


Fig. 2



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Fig. 3

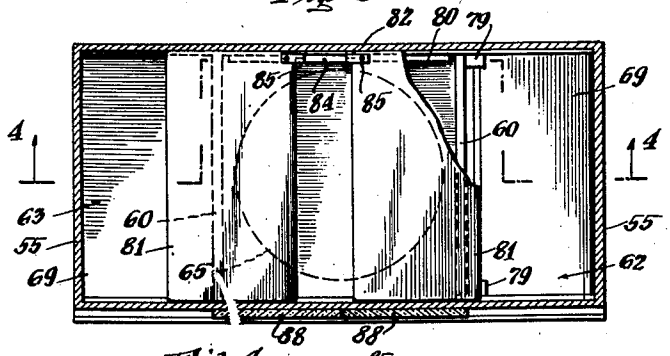


Fig. 7

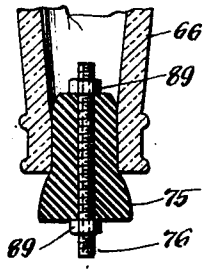


Fig. 4

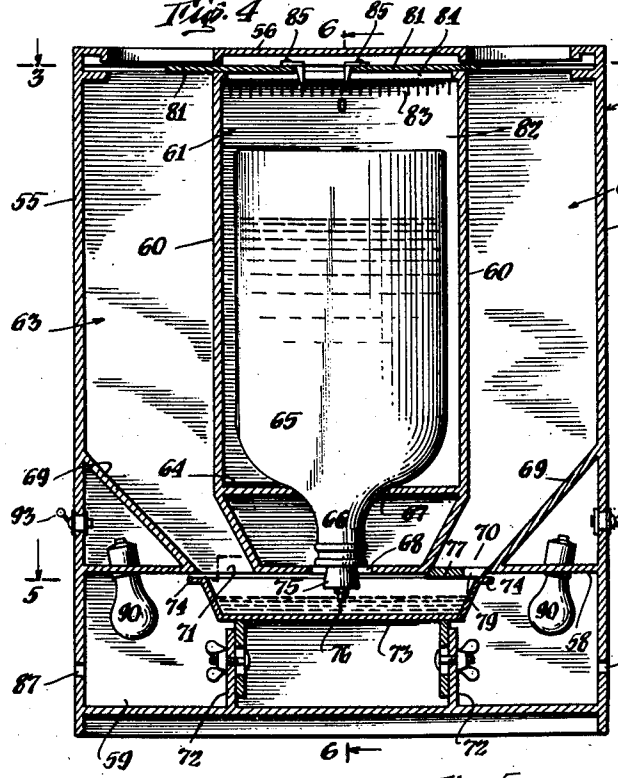


Fig. 6

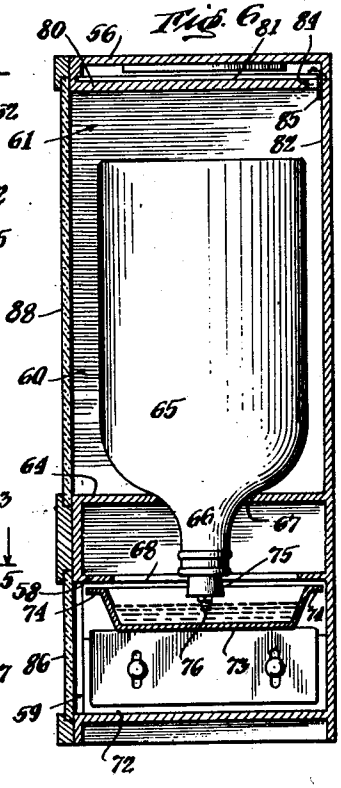
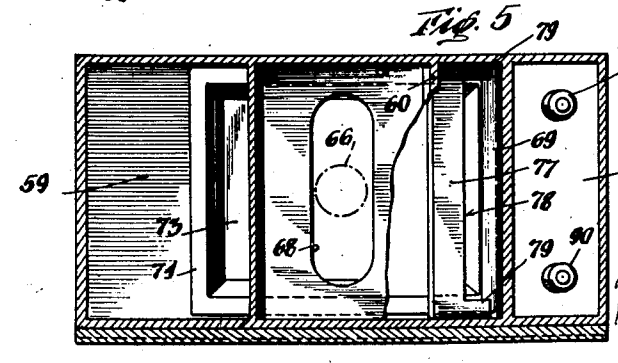


Fig. 5



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Fig. 8

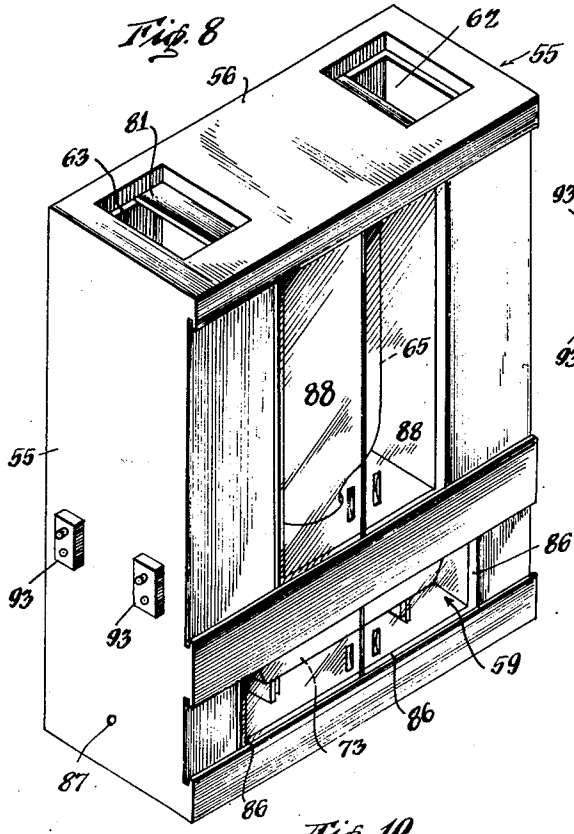


Fig. 9

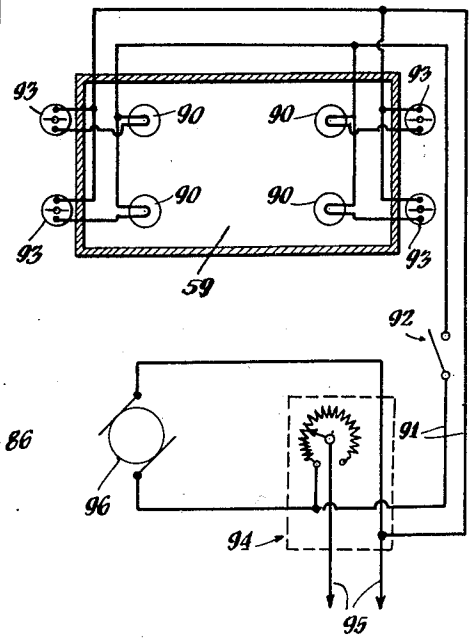


Fig. 10

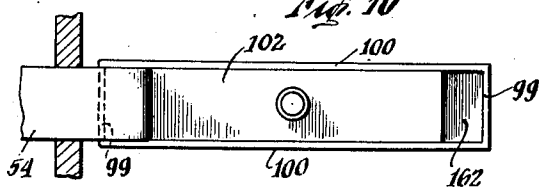


Fig. 11

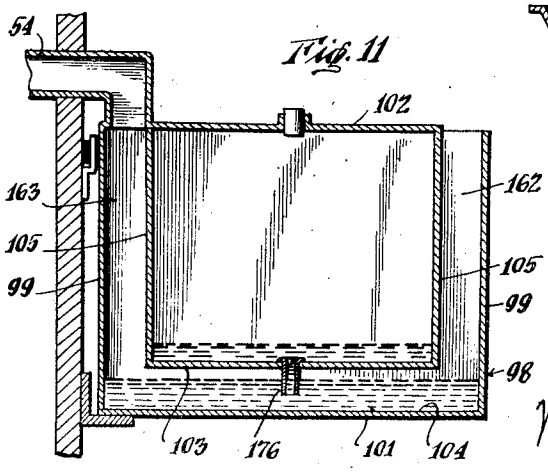
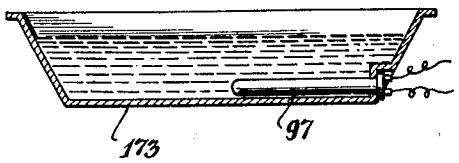


Fig. 12



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Fig. 13

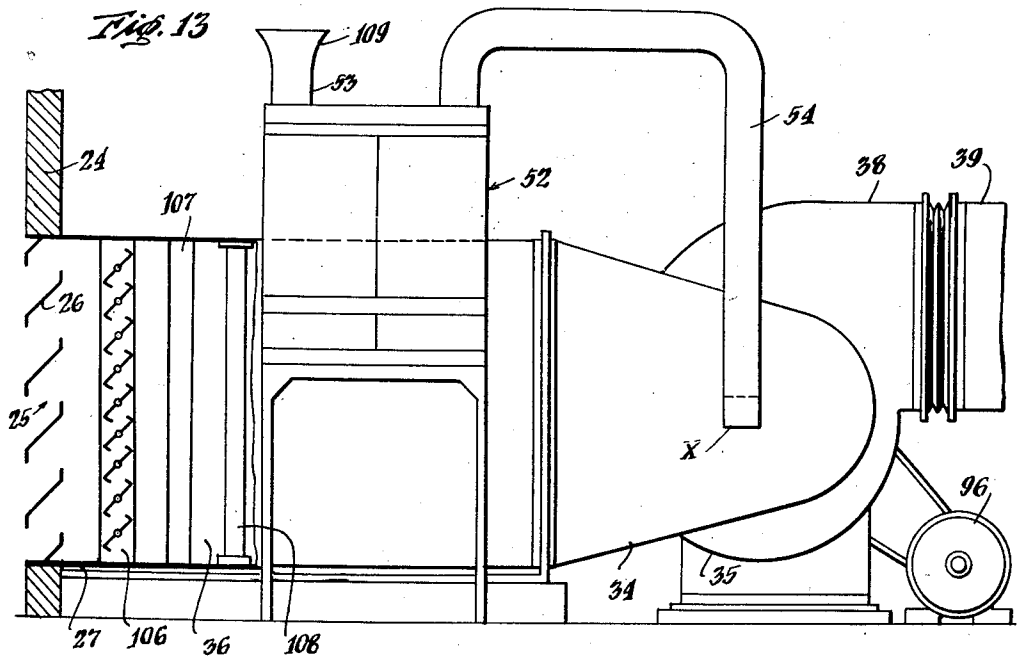
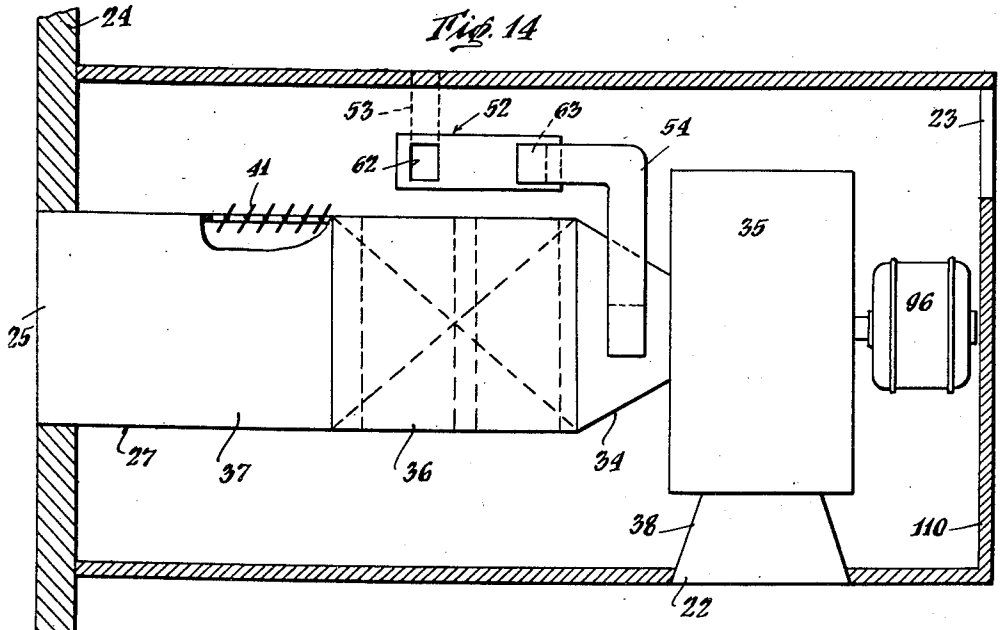


Fig. 14



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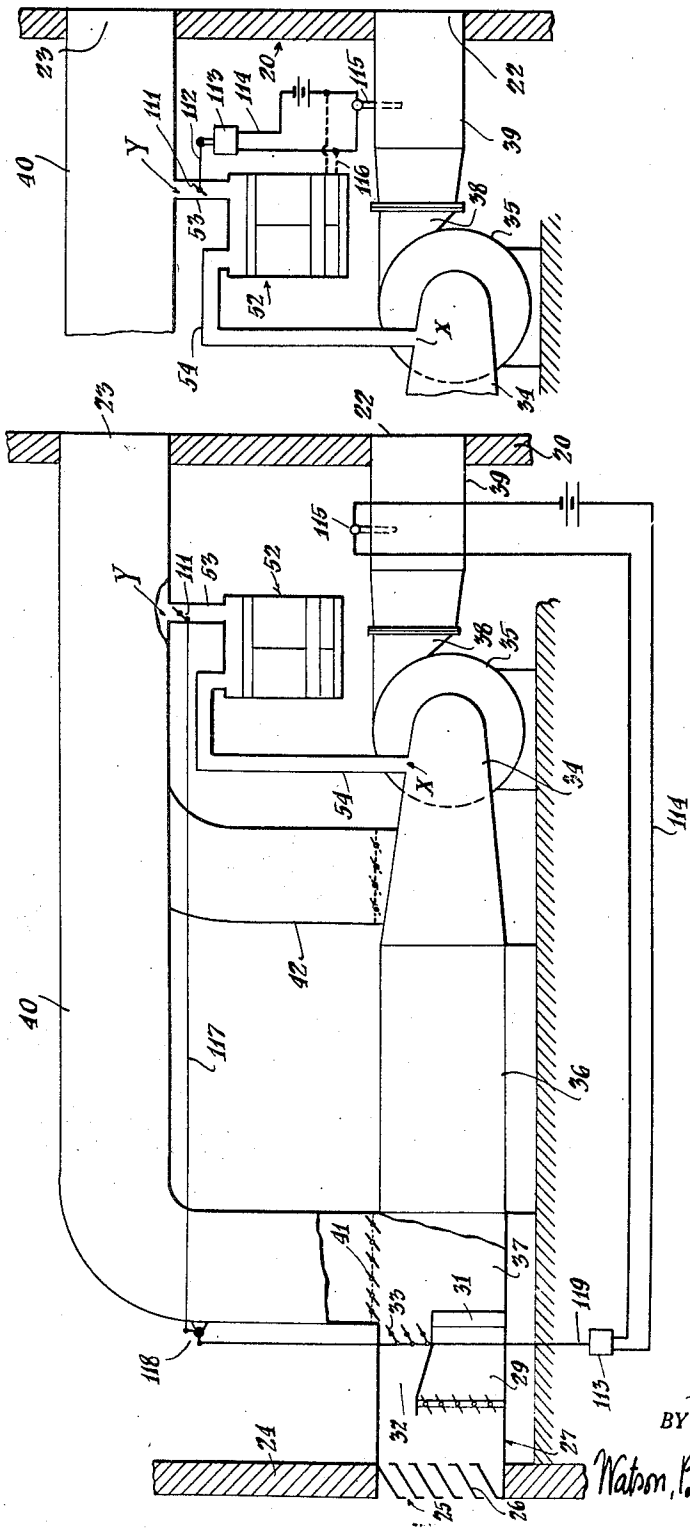


Fig. 15

Fig. 16

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UNITED STATES PATENT OFFICE

2,497,068

AIR VENTILATING SYSTEM WITH MALODOR REDUCING MEANS

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Application January 6, 1945, Serial No. 571,620

9 Claims. (Cl. 98—33)

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The present invention relates to air ventilating systems provided with mal-odor-reducing means for ventilating or air conditioning enclosed spaces of occupancy.

It is a well known fact that inside air of enclosed spaces designed for human occupation soon becomes noticeably and distastefully odorous due to body emanations, smoking, etc. It is also well known that such enclosed spaces, even though only occasionally occupied or absolutely free from occupancy, become noticeably smelly due to odor emanations from interior furnishings, decorations, etc. Ventilating systems for such enclosed spaces have been designed for comfort and in accomplishing this end have involved two major problems. One problem is the conditioning of the air as to chemical makeup to avoid unhealthy conditions, and another problem is the reduction of the odor to below "threshold" value, that is, the level of conscious perception. Carbon dioxide, of course, exists in all air, both inside and outside air, and when a person breathes each exhalation carries with it more carbon dioxide than that in the air inspired. If the factors of toxicity, explosive hazard and of odor should be disregarded the minimum amount of outside air required to be supplied to an enclosed space of occupancy to render the indoor air wholly adequate for human respiratory requirements depends solely on a sufficient amount to dilute the carbon dioxide in the inside air to a harmless concentration.

The minimum amount of outside air is established, not by the need for oxygen, as most people suppose, but by the need for diluting carbon dioxide to a value low enough to preclude any deleterious influence on health. This minimum is many times the amount of air a person can breathe and is so small that under usual conditions of construction and occupancy normal infiltration through cracks in windows and doors is entirely adequate, with certain exceptions, of course, in cases where atmosphere is heavily laden with smoke, communicable disease germs, inflammable or toxic vapors, etc. Except in industrial manufacture where the problem of toxic gases occasionally exists, all air supplied in ventilation and air conditioning practice as the minimum, above the small amount necessary for carbon dioxide dilution, is solely for the dilution of odor vapors. It has been established that a concentration of one-half of one per cent. (½%) carbon dioxide is physically unharmful in otherwise fresh air. This concentration may be maintained by a supply of outside air of only two and

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one-half (2½) C. F. M. (cubic feet per minute) per person doing sedentary work, or about five (5) C. F. M. per person doing heavy physical labor. Since a person breathes only about one-fourth (¼) C. F. M. of air, the minimum amount of air required exceeds what a person can use by about ten times, that is, the minimum amount of ventilation air necessary is about ten times that necessary for supplying oxygen to a person's lungs.

As contrasted therewith, it has been found that enclosed spaces of occupancy necessitate over fifty (50) C. F. M. per person to render them just odorless, that is, at threshold, and this condition cannot always be achieved even if all air conditioning systems handled one hundred per cent. (100%) outside air, since this would usually supply only about forty (40) C. F. M. per person. Long ago the minimum ventilation requirement was established at thirty (30) C. F. M. per person, but in modern air conditioning practice ten (10) to fifteen (15) C. F. M. of outside air per person is generally employed. Thus only about one-fifth (⅕) of the adequate amount for totally effective elimination of bad odor is actually employed in current air conditioning installations. It is to be appreciated and understood that indoor air regarded as lifeless, flat or stale acquires this lifeless cast due to the presence of odor vapors. Threshold is reached only when sufficient outside air is introduced to dispel such impairment to what is generally regarded as fresh air. Accordingly, while current ventilating practice is ineffective in reducing the odor level of inside air to threshold and maintaining that condition, it is enormously uneconomical in that it introduces huge volumes of unnecessary outside air the humidity of which must be properly adjusted and the temperature of which must be corrected. Not only does this involve extra capacity for expensive equipment, but also large quantities of steam or other source of heat to raise the temperature of cold outside air and additionally considerable power for refrigeration to reduce the temperature of hot outside air, and also additional power costs to handle abnormally high quantities of air to dilute the concentration of odor vapors to threshold.

It is an object of the present invention to eliminate difficulties of the prior art and make possible an inspiration of only such volume of outside air as is essential to maintain the desired carbon dioxide dilution or, in certain cases, to correct exceptional conditions where the air is heavily laden with smoke, high concentration

of disease germs, inflammable or toxic vapors, etc., in an economical manner without increasing the instantaneous power load by no more than an almost immeasurable quantity with greatly reduced overall consumption, thus avoiding necessity for an auxiliary power unit, and while assuring a minimum of servicing requirements and substantial elimination of repairs and upkeep.

Another object of the present invention is to assure the attainment of these ends while satisfying desires for simplicity, durability and functional adaptability, in addition to making readily attainable marked improvement in any existing conditions while providing for substantial monetary savings.

A further object of the invention is to assure the attainment of the desired ends with existing ventilating or air conditioning systems or equipment without necessitating major changes or expensive additional equipment, particularly since all such systems are characterized in certain respects by a heretofore unsuspected available source of power which, with the employment of certain simple apparatus of the present invention, can be caused effectively to introduce into air being supplied to enclosed spaces of occupancy vapor from an air-quality-improving liquid in a controlled and positive manner with regard to percentage of its introduction to achieve desired air-freshening and/or odor-combating and/or other desirable effects.

A more specific object of the invention is to provide in such a system an air-quality-improving liquid evaporator which has a passage extending therethrough adapted to bring a fraction of inside air from an enclosed space of occupancy into contact with such liquid and then cause its mixture with other air being supplied by the ventilating system to the enclosed space effectively to combat and correct odor or other objectionable conditions in the enclosed space, the fraction of inside air by-passed through the evaporator being moved by an available differential in pressure existing between the inside air in the enclosed space or in a return duct as inside air is being drawn therethrough from the enclosed space for recirculation. This object is attained with the further advantage that the fraction of air which is employed to pick up vapor from a treating liquid to carry the latter into the enclosed space for adjusting the character of the inside air therein is drawn from a point or source where the inside air is substantially stable as to temperature and humidity, thereby assuring that the air which is brought into contact with the liquid will substantially throughout any particular season cause a substantially uniform evaporation of the liquid, thereby avoiding undesirable changes in conditions.

A still further object of the invention is to provide structural embodiments of system equipment and apparatus thereof which are readily constructed and allow efficient use and operation thereof, and other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combinations of elements and arrangement of parts which will be exemplified in the following detailed disclosure, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had

to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a graphical representation of typical pressures in inches water gauge at various points in a typical air conditioning system modified in accordance with the present invention and diagrammatically shown in Fig. 2;

Fig. 2 is a diagrammatic showing in elevation of such a ventilating system of the present invention showing the employment therein of certain apparatus operable by differential pressures indicated in Fig. 1;

Figs. 3 to 8 inclusive are various views of an embodiment of the evaporator apparatus of the present invention, Fig. 4 being an elevational section thereof taken on line 3—3 of Fig. 3 and with the latter being a sectional view, with parts broken away, taken on line 3—3 of Fig. 4;

Fig. 5 is a sectional view, with parts broken away, taken substantially along lines 5—5 of Fig. 4;

Fig. 6 is a sectional view taken substantially along line 6—6 of Fig. 4;

Fig. 7 is an enlarged sectional view of a portion of the neck of the supply bottle and tube-equipped stopper therein employed in the apparatus shown in Figs. 3 to 6 inclusive;

Fig. 9 is a wiring diagram of the heating electrical circuit which may be employed in the apparatus shown in Figs. 3 to 8 inclusive, showing a possible association thereof with the electrical circuit of the fan motor of a ventilating system;

Fig. 10 is a top plan view, with parts broken away, of a modified form of the evaporator apparatus shown in Figs. 3 to 8 inclusive;

Fig. 11 is an elevational section of the apparatus shown in Fig. 10;

Fig. 12 is a sectional elevation of a modified form of the tray for holding liquid to be evaporated, which may be used in the apparatus shown in Figs. 3 to 8 inclusive;

Fig. 13 is an elevational view, with parts in section and broken away, of another embodiment of the ventilating system of the present invention;

Fig. 14 is a horizontal section of a further embodiment of the ventilating system of the invention, showing certain apparatus thereof in plan view and with parts broken away;

Fig. 15 is a diagrammatic showing in elevation of a portion of the system shown in Fig. 2 indicating means of control that may be employed to advantage in accordance with the present invention; and

Fig. 16 is a view similar to Fig. 2 showing a variation of the controls proposed in Fig. 15.

Referring to the drawings, like numerals identify like parts throughout. In Fig. 2 is shown a ventilating system of the present invention, more particularly identified as an air conditioning system, and Fig. 1 is a pressure graph thereof having the ordinates representing water gauge pressure in fractions of an inch and showing at various points along the air conditioning system typical pressures which occur during the operation of such system. At 20 is diagrammatically indicated a wall of an enclosed spaced adapted for human occupancy, such as a room, which has the usual venting to the atmosphere, that, of course, may be collectively cracks around windows, doors, etc. The enclosed space or room is provided in its wall 20 with the usual supply opening 22 and the usual return duct opening 23 for withdrawing inside air therefrom for recircula-

tion. In an outside wall structure 24, such as the outer wall of a building, is provided a fresh air opening 25 fitted with the usual rain louvers 26. An air inlet passage 27 is provided in the form of a duct and has located therein partition means 28 to divide a portion of the inlet passage into a way 29 which supplies outside air through adjustable damper means 30 to a preheater 31 and occasionally, as is indicated, a second way 32 which is supplied with outside air through adjustable damper means 33, forming a preheater by-pass. The air inlet passage provided by the duct 27 is connected to intake means 34 of a power driven fan 35, and this inlet passage may be considered to be defined into a conditioning chamber 36 which may contain the usual conditioning means, such as filters, cooling coils or water sprays, a reheater, etc., or one or more of these elements, located in the section defined by the crossing dotted lines. The section 37 of the inlet passage between the conditioning chamber 36 and the preheater 31 is normally identified as a mixing or plenum chamber.

The fan 35 has suitable discharge means 38 connected to a supply passage or duct 39 to supply air to the enclosed space including wall 20 through the opening 22 and, if desired, the supply passage or duct 39 may be equipped with a reheater, as is well known in the art. The return air opening 23 in wall 20 of the enclosed space is connected by means of a return air passage or duct 40 to the plenum or mixing chamber 37 for the purpose of returning inside air, thereby minimizing the amount of outside air drawn into the system; and, as is usual, the duct 40 may be equipped with adjustable damper means 41. It is also well known in the art to equip such a system with means to provide an additional path for recirculation of inside air to the system at the fan intake means. Such means is commonly known as an "auditorium" by-pass, such as duct 42 preferably equipped with adjustable damper means 43 which will permit a higher entering air temperature than is otherwise possible since it tends to avoid creation of drafts and, in addition, provides an excellent method of thermal control of the air conditioning system, particularly in summer during the cooling cycle, by means of the adjustable damper means therein.

Referring to the pressure curve 44 shown in Fig. 1, it will be evident that when the fan 35 is operated pressure of the air in the inlet passage 27 progressively drops to a negative value at 45 in the plenum or mixing chamber 37 and that there are further pressure drops to a point 46 as the air is drawn through the flow-resisting conditioning means in the conditioning chamber 36. In the fan intake means 34 there is a further gradual drop in the pressure to a maximum negative pressure indicated at the point 47 on the curve the vicinity of which is indicated in the system by the point marked X. The fan 35, in operating, is usually designed to develop a pressure on the order from one to two inches (1–2″) water gauge, and it will be seen from Fig. 1 that the pressure curve 44 rises to a maximum positive value in the fan discharge means 38 at point 48. The pressure then gradually drops through the supply duct 39 and outlet opening 22 to a value only slightly above atmospheric pressure.

The inside air is drawn through the return duct opening 23 to travel back through the return duct 40 to the mixing chamber 37 with a pressure behavior as indicated by curve 49, and it will be readily understood that the inside air, either in the enclosed space or as it is drawn at least through the first portion of the return duct 40, will be substantially stable, particularly through seasonal operation of the system. This stability comprises a substantial constancy in both dry bulb and wet bulb air temperatures and a substantial constancy in air velocity.

Thus point Y indicated on return duct 40 will represent a general location of a source, considered thermally, of substantially stable inside air and, due to the fact that in most air conditioning systems the initial portion of the return air duct is located fairly proximate to the supply fan 35, it will be seen that points X and Y will be conveniently close together. From the pressure curves shown in the graph it will be seen that a static pressure differential of considerable value exists between the vicinities of points X and Y which is about one and fifteen one-hundredths inches (1.15″) water gauge between point 47 on curve 44 and point 50 on curve 49.

As shown in Fig. 2, the present invention comprises equipping such parts of a typical air conditioning system with an air-treating by-pass 51 connected between the points X and Y. The air-treating by-pass 51 is particularly designed and equipped with apparatus for evaporating into return air passing therethrough an air-quality-improving liquid. Such liquid may be of any suitable chemical composition which will desirably condition the air in an enclosed space when air that has passed through by-pass 51 is admixed therewith, either with respect to odor, addition of air-freshening constituents, germ content, etc. Preferably the liquid composition employed is that described in Paschal Patent No. 2,326,672 issued August 10, 1943, and sold in the market under the trade name "Airkem," which has very unusual simultaneous air-freshening and odor-combating characteristics when vapor thereof is entrained or suspended in air.

The air-treating by-pass 51 preferably comprises an evaporator unit 52, an inlet duct 53 connected between the evaporator unit and the return air duct at Y, and an outlet duct 54 connected between the evaporator unit 52 and the fan intake means 34 at X.

As shown in Figs. 3 to 8 inclusive, an embodiment of the evaporator unit 52 which may be employed in accordance with the teachings of the present invention may comprise a casing having side walls 55, 55 a top wall 56 and a bottom wall 57. Partition or wall means are provided in the casing to subdivide it into air passages and compartments. The latter means may comprise a substantially horizontal partition 58 which subdivides the casing into a tray chamber 59 and an upper chamber which, in turn, is further subdivided by walls 60, 60 to provide a liquid supply chamber 61 and substantially vertically extending similar air passages 62 and 63. The supply chamber 61 may itself be made substantially liquid-tight directly to contain the air-quality-improving liquid therein, but preferably is fitted with a horizontal shelf 64 to support thereon a bottle 65, such as one of about three (3) gallons capacity, in inverted position with neck 66 of the bottle extending down through an aperture 67 in the shelf to locate the bottle mouth substantially at an aperture 68 in the partition 58.

As shown in Figs. 3 to 6 inclusive, the wall means constituting the lower portion of the supply chamber 61 are obliquely arranged in reverse order to cooperate with additional obliquely arranged wall means 69, 69 extending between cas-

ing side walls 55, 55 and the partition 58 for altering the direction of the air passages and further gradually to reduce them in cross-sectional area as they approach the partition 58. The partition 58 is provided with a pair of apertures 70 and 71 which respectively provide communication from passages 62 and 63 to below partition 58.

In the tray chamber 59 are provided suitable supports 72, 72 upon which is positioned an open-top container or tray 73 of substantial length. Supports 72, 72 preferably are adjustable, as shown, so that the end edges of tray 73 at 74, 74 may be brought into close proximity to the under side of partition 58 beyond the outer edges of the apertures 70 and 71. As a result, the tray 73 co-operates with the central portion of partition 58 to provide a duct communicating between the passages 62 and 63.

The mouth of the bottle 65 is fitted with a stopper 75 having a tube 76 extending therethrough to provide communication between the interior of the bottle and the tray 73. By adjusting the height of the lower end of the tube 76, the level of liquid supplied to tray 73 from the bottle 65 is predetermined and the bottle will maintain a substantially uniform amount of liquid in the tray, thereby assuring substantially uniform cross-sectional area of the air passage between apertures 70 and 71 defined by the front and back walls of the tray, the partition 58 and the surface of the body of liquid in the tray. The cross-sectional area of this passage above the surface of the liquid, which is identified herein as the evaporating passage or duct, is purposely maintained much smaller than the cross-sectional area of the passages 62 and 63 to assure a relatively high velocity of the air as it passes along the surface of the tray-contained body of liquid.

It is desirable also further to restrict the passage through the evaporator at the inflow end of the tray. For this purpose there may be provided an inlet plate 77 which is notched on one side as at 78 to define end supporting extensions 79, 79. In setting up the evaporator 52 either of the passages 62 or 63 may be selected, as desired or dictated by convenience, to serve as the inlet passage, with the other serving as the outlet passage. Assuming that passage 62 is selected as the inlet passage, after the tray 73 has been positioned the inlet plate 77 may be dropped down into passage 62 with its ends and extensions 79, 79 supported by top edges of the tray in the aperture 70. It is also preferable to have the notch 78 of inlet plate 77 cooperate with edges of the aperture 70 to provide a passage hole of an area substantially the same as the cross-sectional area of the evaporating passage or duct defined above the surface of the body of liquid in the tray.

The supply chamber 61 is provided with a front closure, preferably comprising a pair of cooperating, laterally slidable doors 88, 88 which may be of transparent material as shown in Figs. 3, 6 and 8. Chamber 61 is also preferably provided with a top wall 80 spaced a slight distance below the casing top 56 reciprocatively to receive therebetween a pair of adjustable damper plates 81, 81 which are slidable across the top surface of the wall 80 to provide variable restrictions in the inlet and outlet passages 62 and 63. Preferably back wall 82 of the casing is provided below the wall 80 with two series of scale marks 83 and the top wall 80 is provided with a slot 84 adjacent the back wall 82 to receive therethrough a pair of pointers 85, 85 with each fixed upon one of the damper plates 81 to cooperate with the scales 83.

With the evaporator 52 installed in a typical air conditioning system, as diagrammatically proposed in Fig. 2, it will be found that, due to resistance to air flow between points Y and X through the return air duct 40 and conditioning means at 36 and/or the dampered "auditorium" by-pass 42, there is a sufficient air pressure drop or static pressure differential between those points to cause a fraction of the thermally substantially stable inside air in the return air duct to flow through the relatively small air-treating passage or by-pass 51. This static pressure differential has been found by exhaustive survey to be on the order of between about two-tenths of an inch (0.2") and one and one-half inches (1.5") water gauge pressure. About ninety-five per cent. (95%) of all air conditioning or ventilating installations will provide such a static pressure differential of the order of at least four-tenths of an inch (0.4") water gauge.

In operating the system of the present invention with the use of the "Airkem" composition identified above, it has been found that it is sufficient to recirculate through the air-treating passage 51 only about one-tenth of one per cent. to three per cent. (0.1–3.0%) of the air circulated by the fan. This is due to the fact that said liquid composition does not act by way of dilution, but when entrained in the air circulated and supplied and carried through the supply duct into the enclosed space it there effectively gives an air-freshening and odor-combating effect which not only reduces the odor to below threshold but actually improves the air to such an extent as to stimulate breathing and make it pleasurable. Accordingly, it has been found that the inlet and outlet ducts 53 and 54 of the air-treating passage 51 may be of a cross-sectional area of the order of about twenty (20) square inches with the opening past the inlet plate 77 being of an area of about (4) square inches provided by notching at 78 to a depth of about three-fourths of an inch (0.75") and adjusting the supply tube 76 so that the surface of the liquid in the body of the tray 73 will be maintained at a level of about three-fourths of an inch (0.75") below partition 58, with an exposure of about one hundred (100) square inches of surface of fluid in the tray when the latter contains about one (1) quart of fluid. Of course, other appropriate combinations of tray area and liquid level may be employed.

It has been found in such a typical embodiment that the frictional resistance through the air-treating passage 51 will require about fifty-five per cent. (55%) of the total available static pressure differential to accommodate the resultant losses. Thus the apparatus is about forty-five per cent. (45%) efficient as to conversion. Accordingly in the most ineffective ventilating systems where the total available static pressure differential is about two-tenths of an inch (0.2") water gauge at least about nine one-hundredths of an inch (0.09") water gauge is available for the purpose of conversion of available static pressure differential to high velocity travel of air over the surface of the liquid. Air velocity of about one thousand two hundred (1,200) feet per minute will be provided by a static pressure differential of the order of nine one-hundredths of an inch (0.09").

Air velocities through the evaporating passage or duct under four hundred (400) feet per minute permit the air to pass without any material disturbance of the surface of the body of the liquid maintained in tray 13, but velocities materially higher, such as from about five hundred (500) feet per minute upwards, cause the passing air to produce ripples in the surface of the liquid. This materially increases the evaporating rate since, in effect, it is a combination of so-called parallel flow and transverse flow. The rippling of the liquid surface results in exposure of extra liquid surface to the air, and causes eddy currents of high velocity in the air in immediate contact with the liquid, producing a heat transfer effect higher than parallel flow and approaching that which is known as transverse flow. This rippling effect has been found to increase the effective rate of evaporation between about twenty-five to fifty per cent. (25–50%) over the rate assured by parallel flow alone.

This high rate of evaporation which is assured by the above described embodiment of the evaporator apparatus makes its use advantageous in connection with very large as well as very small ventilating or air conditioning systems due to the conversion of potential energy in the air stream flowing through the evaporator to kinetic energy. Energy of compression of the air (referred to as static pressure) is converted into velocity pressure in the evaporating duct or passage above the liquid surface. Accordingly it has been found that by a proper selection of dimensions of the evaporating passage and cross-sectional areas of the by-pass 51 at various critical points, such as at damper means therein and entrance to the evaporating passage, with respect to particular systems the velocity of the air through the evaporating duct or passage may be varied from about ten feet (10') per minute up to about fifteen hundred feet (1500') per minute. The energy of conversion at about one thousand feet (1000') per minute, for example, is about 0.0625 inch water gauge pressure, and that at fifteen hundred feet (1500') per minute is about 0.14 inch water gauge pressure. Thus with four-tenths of an inch (0.4") static pressure differential available in most systems and with a velocity of air through the evaporating duct or passage of fifteen hundred feet (1500') per minute there is assured twenty-six one-hundredths of an inch (0.26") water gauge pressure to accommodate all pressure losses in the air-treating passage, which is more than ample.

Preferably the front of the tray chamber 59 is closed by a pair of sliding transparent doors 86, 86 and venting of that chamber to the atmosphere is assured by apertures 87—87 to avoid the necessity of gasketing the top edge of the tray to the partition 58. This is due to the fact that the pressure in the passage through the evaporator will be below atmospheric pressure, as is clear from Fig. 1. Thus during operation of the evaporator air will rush in through apertures 87—87 and over the top edge of the tray which is in proximity to the partition 58, there to create turbulence inside the tray, avoiding egress into the tray chamber of liquid in the tray and vapor thereof.

The inlet plate 77 is preferably employed to eliminate any tendency for drops of liquid to be entrained in the air passing above the body of liquid in the tray and carried away through the outlet passage by virtue of the fact that the outlet aperture from the evaporating duct or passage is larger than the inlet opening thereto, thus assuring lower exit velocity. As a result, higher velocities assuring higher rates of evaporation may be provided while minimizing not only entrainment of liquid droplets in the exit air from the tray but also, it has been found, surging and slopping.

The damper means 81, 81 are of importance in that they provide a ready means for desired regulation. The damper that is always to be used for regulating air flow is the one which happens to be on the air outlet side, that is, in passage 63. The damper on the air inlet side, such as that in passage 62, may be set to limit the maximum allowable air flow through the evaporator when the other damper is wide open. By means of damper 81 in the inlet passage 62, the volume of air flowing through the evaporator may be readily adjusted to a position where, in a given system operating under certain conditions, just the right amount of air-quality-improving liquid will be carried into the system to accomplish the air-freshening and/or odor-combating and/or other effects desired in the enclosed space, that is, for example, an odor level just below threshold, without carrying into the enclosed space an excessive amount of the vapor which might tend to annoy a person who had a very keen sense of smell.

In order to assure that the level of the liquid in the tray will be at the proper height, the stopper 75 is preferably formed of elastic material, such as cork, rubber, or the like, having a bore therethrough receiving tube 76, preferably externally threaded to carry nuts 88, 88 at opposite ends of the stopper, so that the length of tube projecting from the end of the stopper may be readily adjusted for accommodating it to a particular apparatus and to prevent stopper wear from causing variation in the length of the projecting portion of the tube (with resultant variation in the level of the liquid surface in the tray) that could not be corrected. With the maintenance of an air space between the surface of the liquid in the tray and the partition 58 of about three-fourths of an inch (0.75"), and with a static pressure differential of about three-tenths of an inch (0.3") across the evaporator proper the desired high rate of evaporation will be attained. The distance between the liquid level and the partition 58 may slightly exceed three-fourths of an inch (0.75"), but advisedly should not be less.

In large systems it may be desirable to increase the rate of evaporation normally assured by the means indicated above. This may be accomplished by controlled heating of the liquid in the tray. Such heating may be accomplished by the provision of a source of heat in the tray chamber 59, such as by mounting therein a plurality of light bulbs 90—90 which may conveniently be of one hundred (100) watts each. In such case where a source of heat is employed to increase the rate of evaporation, control thereof should be so associated with the means for operating the supply fan 35 in the system as to assure that when the fan is not operating the liquid heating means will be inoperative since, otherwise, when the fan is idle the heat source would cause needless evaporation of the liquid and possibly increase the temperature thereof to a destructive value. This may be conveniently accomplished by equipping the evaporator with an electrical

circuit comprising wires 91, 91 controlled by a master switch 92, and with the light bulbs 90—90 connected in parallel across that circuit with each in series with a snap switch 93, the latter being provided for the purpose of permitting all or any lesser desired number of the light bulbs to be operated for varying the amount of supplied heat. The circuit comprising wires 91, 91 will then conveniently be connected across the motor control 94 through which circuit mains 95 supply current to an electrical motor 96 which operates the fan.

Heating of the liquid in the tray can also be accomplished by immersing a heating source beneath the surface of the liquid. For example, as shown in Fig. 12, a tray 173 similar to tray 73 in Figs. 3 et seq. may be equipped with an electrical heating unit 97 mounted through a wall in the tray in a position to be beneath the surface of the liquid when maintained at a normal level therein. Such heating means may also be associated with suitable control means, such as a rheostat in a circuit connected across the control of the fan motor.

In Figs. 10 and 11 is shown a simplified embodiment of the evaporator apparatus described above. This may comprise an outer container 98 comprising side walls 99, 99, front and back walls 100, 100 and a bottom 101. An inner closed tank 102 provides a liquid supply chamber and may be supported by the front and back walls 100, 100 of the container 98, with the bottom 103 of tank 102 supported above the bottom 101 of tank 98 to provide an open-top container 104 for liquid to be evaporated. By spacing the end walls 105, 105 of the inner tank from the end walls 99, 99 of the outer container, air inlet and air outlet passages 162 and 163 respectively may be provided. A tube 176 in the bottom of the inner tank 102 provides liquid supply means for the open-top container 104 and assures maintenance therein of a substantially uniform amount of liquid for control of the evaporating passage or duct defined between the bottom 103 of the inner tank 102 and the surface of the liquid in container 98. Such a simplified construction has been found to operate satisfactorily in certain installations.

As will now be apparent, the present invention may be practiced in connection with ventilating systems other than those usually identified as air conditioning systems commonly featured by return air ducts. Such a simplified ventilating system is diagrammatically proposed in Fig. 13, wherein the inlet duct 27 is shown to be equipped with damper means 106, filters 107 and cooling or heating coils 108, constituting pressure drop-creating conditioning means. In accordance with the present invention such a ventilating system is to be equipped with the air-quality-improving liquid evaporator by connecting the outlet duct 54 thereof into the fan intake means 34 and providing the inlet duct 53 with a funnel collector or air inlet 109 located in a position to receive air in the enclosed space being ventilated, that is, inside air at a source where it is substantially stable.

Another type of ventilating or air conditioning system which may employ the present invention to advantage is that diagrammatically depicted in Fig. 14, which may comprise an inlet passage including a mixing chamber 37 and a conditioning chamber 36 leading to fan intake means 34 provided with an operating motor 96, all of which equipment is located in a plenum room 110. The plenum room has a supply opening 22 connected directly with the fan discharge 38 and a return air opening 23 to permit inside or room air, that is, air in the enclosed space surrounding the plenum room, to be drawn into the latter and eventually, through damper means 41, into the mixing chamber 37. An evaporator 52 of the present invention may also be mounted in the plenum room 110 and have its inlet passage 62 open to the return air in the plenum room. Thus the evaporator will be connected to a source of inside air or room air where the latter is substantially stable. The outlet passage 63 of the evaporator 52 is connected by the outlet duct 54 to the intake means 34 of the fan 35. When such a plenum room system is employed without the provision of return air means to cause air from the enclosed space to be recirculated, the opening in the mixing chamber 37 controlled by the damper means 41 and the return air opening 23 will be omitted. In such case, in order to supply the evaporator 52 with a source of substantially thermally stable inside air, an inlet duct 53 will be provided in the dotted line position shown in Fig. 14 to provide communication between the exterior of the plenum room and the inlet passage 62 of the evaporator.

In a great many cases air conditioning systems are so equipped with control means that when an enclosed space is entered or occupied by an increasing number of people automatic controls will cause a progressive and somewhat proportional decrease in the temperature of the air supplied to the enclosed space through the supply duct. In such a system apparatus of the present invention may be automatically controlled so that as the number of occupants in the enclosed space is increased the evaporating rate or amount of air-quality-improving liquid picked up and carried into the enclosed space will be increased. This may be accomplished, as proposed in Fig. 15, by automatically operating an adjustable damper in the inlet duct 53 leading to the evaporator 52. This damper may be the damper plate 81 controlling inlet duct 62, but preferably comprises an additional damper 111, which may be of the butterfly type supported upon a rotatable shaft carrying on the outside of inlet duct 53 an operating arm 112 suitably linked mechanically to a control or operating means 113. The control 113 may be an electrical device connected into an electrical circuit 114 which, in turn, may include a thermostat 115 preferably located in the supply duct 39. Thus as the temperature of the air in the supply duct 39 is automatically lowered when the number of occupants is increased, the damper 111 may be caused to increase the opening through the inlet duct 53 leading to the evaporator 52, thus to increase the rate of liquid carried into the air supplied to the enclosed space, and vice versa. Obviously the control 113 operating the damper 111 may be of a pneumatic type suitably connected through conduit means to a pressure varying device responsive to the thermostat 115. As suggested in dotted lines at 116, the electrical circuit of the heating means for the evaporator, should such be provided, may be connected into the electrical control circuit 114, also to be operated in a manner to increase the rate of evaporation as the number of occupants is increased, or the thermostat 115 may, if desired, be employed solely to control such liquid heating means. Such a system provides an effective automatic control due to the fact that odor emanation from occupants generally is di-

rectly proportional to human activity, and thus, in any particular establishment, to the number of occupants.

Further automatic control of a system equipped with apparatus of the present invention may be had as proposed in Fig. 16. The damper 111 in inlet duct 53 leading to the evaporator 52 may be mechanically linked to the air inlet control damper 33, such as by means of a rod 117 connected to a bell crank 118 in turn connected to the inlet air damper 33. Either damper 111 or damper 33 in turn may be connected by a rod 119 to an operating control 113 connected into an electrical circuit 114, including thermostat 115 located in supply duct 39. This particular control system automatically compensates for variable intake of outside air that may be malodorous, such as in a case where exhaust from a restaurant may be in the vicinity of the outside air intake 25. The control 113 (which, of course, may be operated from thermostat 115 either electrically or pneumatically) will automatically increase the opening of the outside air intake damper 33 as the number of occupants is increased. In order to compensate for the malodorous condition of the increased amounts of outside air being drawn in, the damper 111 in the evaporator inlet duct 53 will automatically permit increasing amounts of air to be drawn through the evaporator to increase the amount of air-treating liquid to be supplied in vapor form to the enclosed space, or conversely, the control 113 may be employed to operate the damper 111 with the latter linked with the outside air inlet damper 33, so that they will both be opened gradually as the temperature of the air supplied through supply duct 39 is decreased in response to an increased number of occupants. Thus as the outside air inlet damper is opened wider to permit increase in the amount of outside air drawn into the system, the rate of evaporation of the air-treating liquid will be increased in just the right amount to counteract the malodorous condition of the outside air drawn in. Conversely, a similar control system may be employed as an economy measure so that as the outside air inlet damper 33 is opened wider the evaporator control damper 111 is closed to a greater extent. This may be employed to advantage where the outside air is clean and relatively free of odor as it will permit increased amounts of that air effectively to combat by dilution to a certain extent indoor odor emanation with an economy in the evaporation rate of the air-treating liquid by proportionally decreasing the evaporation rate thereof.

It will thus be seen that the objects of the invention specifically set forth above and alluded to or made apparent in the above description are efficiently attained, and since certain changes in the construction set forth, which embody the invention, may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Air ventilating system for enclosed spaces of occupancy comprising, in combination, an air inlet passage for drawing in outside air, a fan having discharge means and intake means with the latter connected to said inlet passage, a supply passage connected to said fan discharge means to supply air to an enclosed space of occupancy, a mal-odor-reducing air-quality-improving liquid evaporating means having a passage extending therethrough adapted to bring air into contact with such liquid to entrain a quantity thereof in vapor form as that air passes through that passage, and means connecting the evaporating passage at one end substantially directly to a source of substantially stable inside air of an enclosed space of occupancy and at the other end substantially directly to the fan intake means whereby an appreciable differential in pressure will create air flow at a relatively high rate through the evaporating passage.

2. Air ventilating system for enclosed spaces of occupancy comprising, in combination, an air inlet passage for drawing in outside air, a fan having discharge means and intake means with the latter connected to said inlet passage, a supply passage connected to said fan discharge means to supply air to an enclosed space of occupancy, a mal-odor-reducing air-quality-improving liquid evaporating means having a passage extending therethrough adapted to bring air into contact with such liquid to entrain a quantity thereof in vapor form as that air passes through that passage, and means connecting the evaporating passage at one end substantially directly to a source of substantially stable inside air of an enclosed space of occupancy and at the other end substantially directly to the fan intake means where a static pressure differential of between about 0.2 of an inch and 1.5 inches water gauge exists during operation of said fan to cause a fraction of the inside air to flow through said evaporating passage from said source to the fan intake means.

3. Air ventilating system for enclosed spaces of occupancy comprising, in combination, an air inlet passage for drawing in outside air, a fan having discharge means and intake means with the latter connected to said inlet passage, a supply passage connected to said fan discharge means to supply air to an enclosed space of occupancy, a mal-odor-reducing air-quality-improving liquid evaporating means having a passage extending therethrough adapted to bring air into contact with such liquid to entrain a quantity thereof in vapor form as that air passes through that passage, and means connecting the evaporating passage at one end substantially directly to a source of substantially stable inside air of an enclosed space of occupancy and at the other end substantially directly to the fan intake means where a static pressure differential of at least about 0.4 of an inch water gauge exists during operation of said fan to cause a fraction of the inside air to flow through said evaporating passage from said source to the fan intake means.

4. Air ventilating system for enclosed spaces of occupancy comprising, in combination, an air inlet passage having a fresh air opening for drawing in outside air, a fan having discharge means and intake means with the latter connected to said inlet passage, air conditioning means in said inlet passage between the fresh air opening and the intake means, a supply passage connected to said fan discharge means to supply air to an enclosed space of occupancy, a return air passage connected to said inlet passage between the fresh air opening and said conditioning means to return substantially stable inside air from an enclosed space of occupancy to said inlet passage, an air-quality-improving liquid evaporating means having a passage ex-

tending therethrough adapted to bring air into contact with such liquid to entrain a quantity thereof in vapor form as that air passes through that passage, and means connecting the evaporating passage at one end substantially directly to said return air passage and at the other end substantially directly to the fan intake means whereby an appreciable differential in pressure will create air flow at a relatively high rate through the evaporating passage.

5. Air ventilating system for enclosed spaces of occupancy comprising, in combination, an air inlet passage having a fresh air opening for drawing in outside air, a fan having discharge means and intake means with the latter connected to said inlet passage, air conditioning means in said inlet passage between the fresh air opening and the intake means, a supply passage connected to said fan discharge means to supply air to an enclosed space of occupancy, a return air passage connected to said inlet passage between the fresh air opening and said conditioning means to return substantially stable inside air from an enclosed space of occupancy to said inlet passage, a mal-odor-reducing air-quality-improving liquid evaporating means having a passage extending threthrough adapted to bring air into contact with such liquid to entrain a quantity thereof in vapor form as that air passes through that passage, and means connecting the evaporating passage at one end substantially directly to said return air passage ahead of pressure drop-creating equipment therein and at the other end substantially directly to the fan intake means whereby an appreciable differential in pressure will create air flow at a relatively high rate through the evaporating passage.

6. Air ventilating system for enclosed spaces of occupancy comprising, in combination, an air inlet passage having a fresh air opening for drawing in outside air, a fan having discharge means and intake means with the latter connected to said inlet passage, air conditioning means in said inlet passage between the fresh air opening and the intake means, a supply passage connected to said fan discharge means to supply air to an enclosed space of occupancy, a return air passage connected to said inlet passage between the fresh air opening and said conditioning means to return substantially stable inside air from an enclosed space of occupancy to said inlet passage, a mal-odor-reducing air-quality-improving liquid evaporating means having a passage extending therethrough adapted to bring air into contact with such liquid to entrain a quantity thereof in vapor form as that air passes through that passage, and means connecting the evaporating passage at one end substantially directly to said return air passage and at the other end substantially directly to the fan intake means where a static pressure differential of between about 0.2 of an inch and 1.5 inches water gauge exists during operation of said fan to cause a fraction of the return air to flow through said evaporating passage from said return air passage to the fan intake means.

7. Air ventilating system for enclosed spaces of occupancy comprising, in combination, an air inlet passage having a fresh air opening for drawing in outside air, a fan having discharge means and intake means with the latter connected to said inlet passage, air conditioning means in said inlet passage between the fresh air opening and the intake means, a supply passage connected to said fan discharge means to supply air to an enclosed space of occupancy, a return air passage connected to said inlet passage between the fresh air opening and said conditioning means to return substantially stable inside air from an enclosed space of occupancy to said inlet passage, a mal-odor-reducing air-quality-improving liquid evaporating means having a passage extending therethrough adapted to bring air into contact with such liquid to entrain a quantity thereof in vapor form as that air passes through that passage, and means connecting the evaporating passage at one end substantially directly to said return air passage and at the other end substantially directly to the fan intake means where a static pressure differential of at least about 0.4 of an inch water gauge exists during operation of said fan to cause a fraction of the return air to flow through said evaporating passage from said return air passage to the fan intake means.

8. Air ventilating system for enclosed spaces of occupancy comprising, in combination, an air inlet passage having a fresh air opening for drawing in outside air, a fan having discharge means and intake means with the latter connected to said inlet passage, air conditioning means in said inlet passage between the fresh air opening and the intake means, a supply passage connected to said fan discharge means to supply air to an enclosed space of occupancy, a return air passage connected to said inlet passage between the fresh air opening and said conditioning means to return substantially stable inside air from an enclosed space of occupancy to said inlet passage, an "auditorium" by-pass connected directly between said return air passage and the fan intake means, a mal-odor-reducing air-quality-improving liquid evaporating means having a passage extending therethrough adapted to bring air into contact with such liquid to entrain a quantity thereof in vapor form as that air passes through that passage, and means connecting the evaporating passage at one end substantially directly to said return air passage ahead of said "auditorium" by-pass and at the other end substantially directly to the fan intake means thereby by-passing said "auditorium" by-pass and any pressure drop-creating equipment therein whereby an appreciable differential in pressure will create air flow at a relatively high rate through the evaporating passage.

9. Air ventilating system for enclosed spaces of occupancy comprising, in combination, an air inlet duct having a fresh air opening for drawing in outside air, an air conditioning chamber connected to said duct and containing pressure drop-creating air conditioning means, a fan having discharge means and intake means with the latter connected to said chamber, a supply duct connected to said fan discharge means to supply air to an enclosed space of occupancy, a return air duct connected to said inlet duct to return substantially stable inside air from an enclosed space of occupancy to said inlet passage, a mal-odor-reducing air-quality-improving liquid evaporating means having a passage extending therethrough adapted to bring air into contact with such liquid to entrain a quantity thereof in vapor form as that air passes through that passage, and means connecting the evaporating passage at one end substantially directly to said return air duct and at the other end substantially directly to the fan intake means whereby an appreciable differential in pressure will create air

flow at a relatively high rate through the evaporating passage.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
436,130	Gubelmann	Sept. 9, 1890
1,518,162	Parkinson	Dec. 9, 1924
1,601,810	Rogge et al.	Oct. 5, 1926
1,670,656	Fleisher	May 22, 1928
1,839,618	Toepfer	Jan. 5, 1932
1,943,379	Emerson	Jan. 16, 1934
1,981,234	Hetzer	Nov. 20, 1934
2,043,647	Berven	June 9, 1936
2,062,728	Roberts	Dec. 1, 1936
2,083,607	Joseph	June 15, 1937
2,200,581	Pruss et al.	May 14, 1940
2,303,331	Dauphinee	Dec. 1, 1942
2,303,334	Dauphinee	Dec. 1, 1942
2,311,374	Farmer et al.	Feb. 16, 1943

FOREIGN PATENTS

Number	Country	Date
15,294	Great Britain	July 5, 1906
501,358	Great Britain	Feb. 27, 1939
508,831	Great Britain	July 6, 1939
509,220	Great Britain	July 12, 1939
848,363	France	Oct. 27, 1939