United States Patent

Asker et al.

[15] **3,664,253**

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[54] CONDITIONED AIR DISTRIBUTION SYSTEM

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[52] **U.S. Cl.** **98/36,** 165/59

[51] **Int. Cl.** **F24f 9/00**

[58] **Field of Search** 98/36, 40; 165/59

[56] **References Cited**

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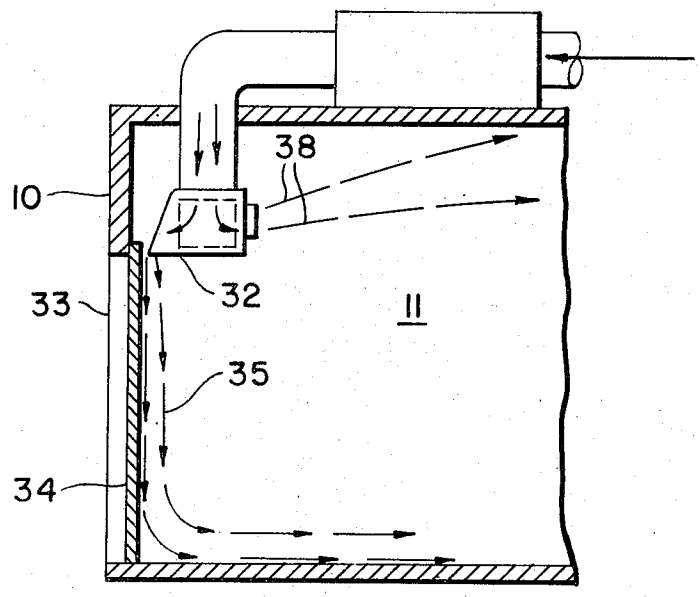
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Attorney—Sol B. Wiczer

[57] **ABSTRACT**

Air distribution system wherein polluted air is withdrawn and fresh replenishing air is brought into the system, desirably with heat exchange and temperature adjustment to that of a conditioned space, and is distributed alternately as an air screen over any open doorway or conveyor opening and when the doorway or conveyor opening is closed, the fresh air flow is shifted by damper means to a central distribution point.

13 Claims, 5 Drawing Figures



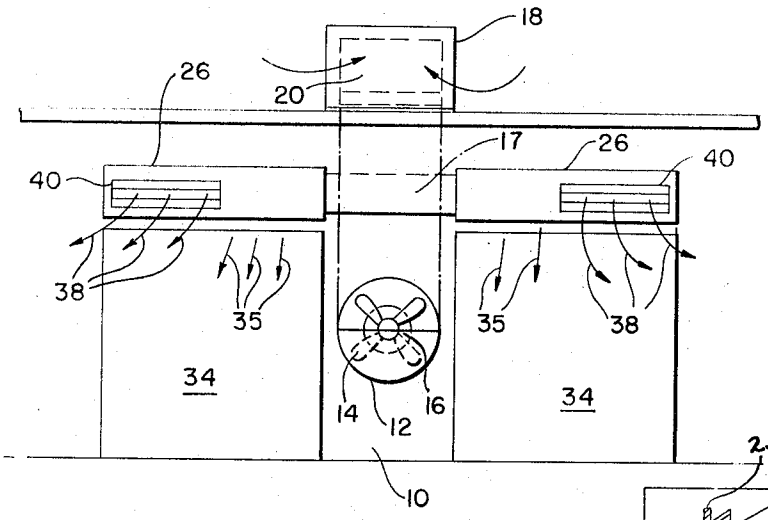


FIG. 1

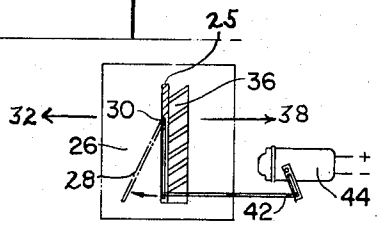


FIG. 4

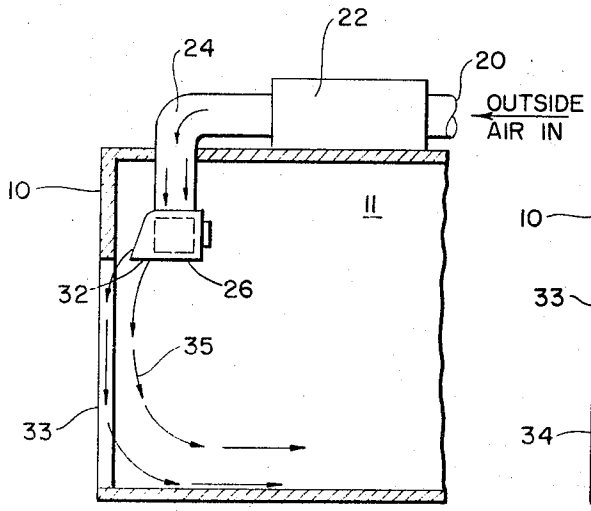


FIG. 2

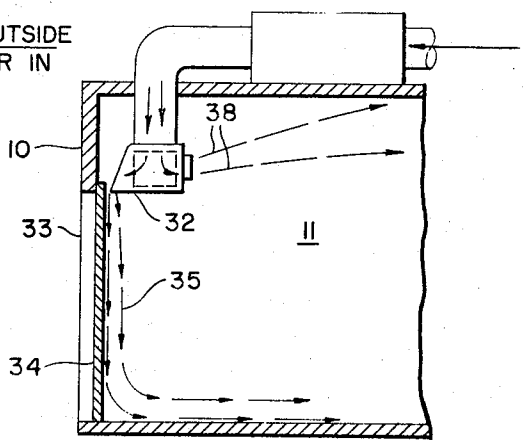


FIG. 3

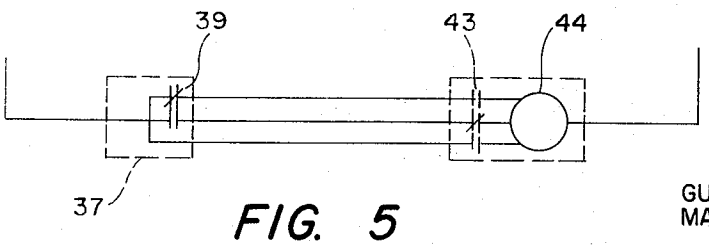


FIG. 5

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CONDITIONED AIR DISTRIBUTION SYSTEM

This invention relates to a system for distributing conditioned air in buildings, warehouses, factories, and the like, and particularly to the distribution of fresh air or conditioned air to such internal spaces, usually where polluted air is continuously exhausted and replaced by fresh makeup air, which may be conditioned to normal and usefully distributed as needed, protectively over open doorways or wall openings only when these are open and need a protective screen.

In many buildings, such as warehouses, factories, storage spaces and other buildings wherein contaminated air is desirably replaced, it usually has a continuous exhaust fan expelling the contaminated air. Such exhaust fan may be from large spaces or from spaces of greatest air contamination such as spray cabinets, painting areas, and the like; or it may be from large buildings where people assemble and a continuous air contamination needs to have the air replaced by fresh conditioned air. Moreover, such continuous exhaust tends to reduce the pressure in the air space as contaminated air is withdrawn, which tends to be replaced by air seepage through doorways or open windows with air at a contrasting high or low temperature and/or high or low humidity.

According to the present invention, a distribution system is provided particularly useful in a system where the air from such contaminated spaces is continuously exhausted to the atmosphere and seepage to replace the exhausted air would take place largely from open doors or windows. The fresh replacement air is drawn in preferably in heat exchange with the exhausted air in quantity sufficient to replace the exhausted air and equalize any negative pressure created by the continuous exhausting of the contaminated air. The fresh replacement air is alternately distributed, according to the present invention, sometimes in general distribution into the conditioned space from whence the contaminated air was removed when all doors and windows have been closed, so that there is optimum conditioned replenishment. Alternately when a wall opening or door is open to allow the conditioned space to communicate freely with outside ambient air, according to the present system, the inlet air, usually conditioned and heat adjusted, is diverted into an air screen mounted protectively over the open doorway or opening, so that air would flow into the structure or space which is the conditioned air of the screen over the open doorway, and not uncontrolled air seeping through the open doorway.

The fresh incoming air in alternately controlled flow is thus directed in all or greatest volume as an air screen, protectively over one or more open doorways or openings and the like, but when the doors or openings are closed, requiring no protective air screen, then in alternate flow all or most of that fresh conditioned air by selected damper control is diverted more directly to the general space for better replacement of contaminated exhausted air.

The invention is further described with relation to the drawings wherein:

FIG. 1 is an end view of the present system showing inlet ducts, doorways and exhaust fan;

FIG. 2 illustrates in a side view the operation of the system as an air screen mounted over a doorway which is open;

FIG. 3 illustrates the same system as FIG. 2 with the doorway closed;

FIG. 4 is a detail showing operation of a damper for alternate air flow in the system; and

FIG. 5 is a wiring diagram showing the hook-up for control of the damper motor in operation of the system.

Referring first to FIGS. 1, 2 and 3, the system comprises, for purposes of illustration, a wall **10** enclosing a space such as a factory, building or the like, having an exhaust opening **12** with a fan **14** mounted therein and a driving motor **16** connected to said fan for continuous rotation of its blade and expulsion of air from the room outwardly of the wall **10**. The fan unit **14** preferably is of the type wherein sensible heat or total heat may be recovered from the exhausted air with a commercially known type of exhaust air exchanges such as an

ECONOVENT exhaust fan, wherein air is passed in heat exchange with incoming air to recoup the sensible heat or total heat. For this purpose air enters from the lower half of the fan which is sealed to allow heat exchange but prevent intermixture of incoming with exhaust air, so that the incoming air to the system will recover some of the conditioned raised or lowered temperature of air expelled from the building. The incoming air in replacement can enter the system as ambient air through a duct **18** having an opening **20** communicating with the outside of the system. It can be passed through the exchanger fan **14** and returned by way of a line **17** to another conditioner unit **22**. Thus, sensible heat or air total heat, as desired, may be recovered from the exhaust air through fan **14** and further heating and cooling as needed can be supplied to the air entering the system in replacement of the air that has been exhausted at conditioner **22**.

The temperature adjusted air from conditioner **22** passes through the system by way of a duct **24** and passes first to an air pressure plenum chamber covering the entire width of each doorway to be protected. These plenum chambers **26** are preferably mounted adjacent to each doorway in the building, which is frequently kept open and exposed to the weather.

The plenum chamber may have a long slot nozzle opening **32** to discharge all or substantially all of the air as an air screen **35** over the open doorways to separate the inside and outside climates. When the door or doors are closed, it is not desirable or needed to discharge all of the air through the long slot nozzle. The air pressure plenum is therefore equipped with automatic adjustable damper means which when actuated from door operated switches to allow the air in the pressure plenum to divide and flow, not only through the nozzle, but much or most, as desired, may flow through the opened damper as well. By proper sizing of the full open area of the automatic damper in ratio to the free area of the nozzle opening, the system can be designed to allow for 100 to 50 percent flow through the nozzle with the balance through the bypass dampers when the doors are open, and for 10 to 50 percent through the nozzle opening and the balance through the bypass damper when the doors are closed.

It is sometimes feasible to use a damper chamber **25**, preferably strategically mounted near a wall **10** and doorway **33** or between two doorways **33** when that is the building structure desired. As shown in FIG. **4**, the damper chamber **25** may have one or more vanes **28** which oscillate from a hinge **30** to direct the flow of air alternately to cover a nozzle outlet **32** which directs the air downward over a door **34** to provide an air screen shown by the arrows **35** covering the said doorway **34**.

The vane **28** in the operation shown in FIG. **4** closes nozzle outlet **32**, thereby stopping or substantially reducing the air flow comprising the air screen **35** and most of the air then becomes diverted through an opposite side opening vanes **36**, passing outward in the direction of the arrows **38**, and will supply the bulk of the air stream outward of the damper chamber. Since the damper chamber **25** is generally located near a wall opening, the flow of air in stream **38** is toward an upper or ceiling portion of the chamber **11** so that the conditioned warm or cold air passes as shown by the arrows **38** adjacent to the ceiling of the space. The air passes outward from the damper chamber **25** through grills **40** as a ceiling air stream indicated by arrows **38**.

Thus, depending upon the position or disposition of the damper vane **28**, the air will flow as an air screen **35** formed by nozzle **32**, protectively over the open doorway **33** and thus prevent ambient air from entering chamber **11** by way of the open doorway **33**, as shown in FIG. **2**; or will in largest part replace any ambient air that would otherwise tend to enter through the open doorway **33** into the system. As shown in FIG. **3**, when door **34** is closed, sealing the doorway **33** thereby, most of the air emitted from the nozzle **32** then becomes diverted as a heavy ceiling stream of air flowing according to the arrows **38**.

It will be understood that while the damper **25** may completely seal the flow of air in either alternate direction, it is not necessary to entirely seal the flow of air from either direction. Rather, it will suffice to divide the air flow so that the greater bulk is diverted to form air curtain **35** over the doorway **33** whereby only a little air then flows outward as a ceiling stream, according to arrows **38**. When the door **34** is closed, it will suffice for the damper to substantially control the flow in the opposite direction whereby little air is emitted from the nozzle **32**, and the great bulk of the air becomes diverted according to the ceiling stream defined by arrows **38**. Such partial diversion is effected either by a leaky vane **28** or one which has a few perforations (not shown). For operating, the damper vane **28** may have a hinged arm **42** operated by a damper motor **44**.

As shown diagrammatically in FIG. **5**, the system may operate on closing or opening of a door switch **39** to activate the damper motor **44** which stops after a predetermined rotation by cam actuated switch **43** or **45** and upon reopening or closing of door **34** the damper vane **28** becomes reset by the damper motor, alternately to pass the air protectively as an air screen over the opening **33**. When the door **34** is closed, the damper motor will move vane **28** to opposite position to direct the air flow substantially as a ceiling flow stream of air defined by arrows **38**.

As thus described, in a building or enclosed space, contaminated air may be continuously exhausted to expel it to the outside. In economical passage, the incoming air is preferably passed in heat exchange with the exhausted air to recover the sensible heat of the exhausted air. The incoming air is further conditioned to a desired temperature either by heating or cooling and is passed through alternate paths controlled by a damper in replacement of the air expelled from the conditioned space.

In one position of the air control damper vane the air is formed into an air screen and passed protectively over an open doorway. In an alternate position of the damper vane, operative when the door is closed, the air is then passed into the upper air body of the room where it most usefully joins the air of the room to modify the existing air as replacement conditioned air.

It will be seen by the present system that only a small amount of air needs to be exhausted and replaced by conditioned air to maintain a constant temperature and pressure within the room by a continuous resupply of fresh air. Since the incoming air needs to be handled by a blower or fan for ready flow; that flow of incoming air is usefully used either protectively over an open doorway when needed to overcome the tendency to destroy the temperature by seepage of outside air to inside of the conditioned space by the open exchange of air through the doorway. This is controlled by the conditioned air brought into the room and used as a screen over the doorway. Where that doorway is closed, then the reduced pressure of the internal space is brought back to normal and maintained normal by alternately the same conditioned air supply diverted by damper flow to a more useful point of distribution within the space.

Certain modifications will occur to those skilled in the art. For instance, it is possible to modify the conditioned air so as to dry it to a usefully low humidity or humidify it to increase the humidity for comfort. Such moisture modifying elements may be used in conjunction with the conditioning elements applied for further conditioning of the incoming air.

What is claimed is:

1. Method of replenishing a conditioned air space enclosed by walls having access doors, windows or the like with fresh air, comprising passing the fresh replacement air from outside of said enclosure into said enclosed space, and directing a major portion of the flow of said incoming replenishing air as an air screen protectively across any doorway or window when such door or window is open to prevent free transfer of air between the outside and inside of said enclosed space through said open doorway or window while simultaneously passing a minor portion of said air more centrally of said enclosure and, alternately, diverting the flow of said incoming replenishing air to direct a major portion of said air to an upper more central area of said enclosed space and a minor portion of said air across said door or window when the doorway or window is closed.

2. The method as defined in claim **1** wherein the inlet air is first conditioned to adjust the temperature and humidity either by heating or cooling to approximate the temperature of said enclosed space before said alternate distribution to said enclosed space.

3. The method as defined in claim **1** wherein the used air is continuously withdrawn from said space and passed in heat exchange with fresh incoming air replacing withdrawn air while recovering the useful heat contained in the withdrawn air as it is expelled from said space, a minor portion of said air being passed substantially centrally of said space while the major portion is used as an air screen, and a minor portion of said air being used as an air screen when the major portion is directed centrally of said space.

4. The method as defined in claim **1** wherein a major portion of said incoming replenishing air, exceeding 50 percent but less than 100 percent is passed as an air screen protectively across said opening when uncovered, the remainder of the air being passed to the more central area of said enclosed space, and approximately the same proportions of air are diverted to pass said major portion of said air to the central area with the remainder as an air screen adjacent to said opening, when said opening is covered.

5. An apparatus for distributing fresh replenishing air to an enclosed conditioned space having openings in the enclosing walls of the character of doorways and windows, said distributing means comprising duct means communicating with ambient air outside of said enclosed space for supply of fresh air thereto and with a distribution chamber, valve means in said distribution chamber controlling the supply of air to alternate outlets, a first outlet duct comprising a nozzle constraining the fresh air flow passed therethrough as an air screen directed across an open doorway, and in alternate valve position, a second outlet duct means leading the fresh air flow to an upper more central position of said enclosed space, said valve means having a driving motor positioning said valve control between alternate air flow positions whereby to pass a major portion of the inlet air flow in one position of said valve as an air screen over an open doorway or window enclosure when the door or window is open, whereby said air screen substantially effects a closure to retard interchange of air through said open doorway or window, and in an opposite position of said valve, to direct a major portion of the fresh air flow upward and more centrally of said enclosed space.

6. The apparatus as defined in claim **5** wherein fresh air passed into said enclosed space has its temperature and/or humidity adjusted for heating or cooling seasonally to temperature condition the fresh air passed into said space to approximately the temperature existing therein.

7. The apparatus as defined in claim **5** wherein the said enclosed space has an exhaust fan for exhausting air from said space and the inlet air has means for passing the same into said space in similar volume to substantially replace the exhausted air.

8. The apparatus as defined in claim **5** wherein the said enclosed space has an exhaust fan for exhausting air from said space and the inlet air has means for passing the fresh air into said space in similar volume to substantially replace the exhausted air, and means for exchanging sensible heat and/or total heat between the incoming air passing to said space and the air exhausted from said space.

9. The apparatus as defined in claim **5** including switch means actuated by said door or window closures to actuate said valve motor to direct the air through a nozzle to provide air screen over the doorway or window when the doorway or window is open, and to direct the air centrally of said space in alternate position of said valve when the door is closed.

10. Apparatus as defined in claim 5 wherein the major portion of said replenished air is directed by said damper in open position in quantity exceeding about 50 percent but less than 100 percent into the air screen across said door or window opening when open, the remainder of said air being directed more centrally to said enclosed space, and in closed damper position the major portion of said air, more than 50 percent and less than 100 percent is directed more centrally to said enclosed space, and the remainder of said air is directed as an air screen adjacent to said opening when the door or window is closed.

11. Apparatus as defined in claim 5 wherein said enclosed space has at least two openings comprising doorways or windows and an elongated duct is mounted over each of said doorways or windows, said duct having nozzle means over both doorways or windows to direct air as an air screen over each doorway or window, a second outlet duct joining said first duct leading the fresh air flow to an outlet in a more central position of said enclosed space, and independent damper controls for the first duct over each doorway or window alternately directing the air flow between the air screen of one doorway or window and the outlet more centrally of said closed space, and independent means of controlling each damper whereby each doorway or window may be provided with an air screen over the opening when either or both doors or windows are open independently of a smaller air flow adjacent to another doorway or window which may be closed.

12. Apparatus for conditioning an enclosed space having at least two openings comprising doorways or windows and having an elongated duct mounted over each of said doorways or windows, said duct having nozzle means over both doorways or windows to direct air as an air screen over each doorway or window, a second outlet duct joining said first duct leading the fresh air flow to an outlet in a substantially central position of said enclosed space, and independent damper controls for the first duct over each doorway or window alternately directing the air flow between the air screen of one doorway or window and the outlet substantially centrally of said closed space, and independent means of controlling each damper whereby each doorway or window may be provided with an air screen over the opening when either or both doors or windows are open independently of a smaller air flow adjacent to another doorway or window which may be closed.

13. Apparatus for distributing fresh replenishing air to an enclosed conditioned space having at least two openings comprising doorways or windows, said distributing means comprising duct means communicating with ambient air outside of said enclosed space for supply of fresh air thereto and with a distribution chamber, said duct means including an elongated duct mounted over at least two of said doorways or windows, said elongated ducts having nozzle means disposed over at least two of said doorways or windows to direct air downward as an air screen thereover, a second outlet duct joining said first duct means leading the fresh air to an outlet in a more central position of said enclosed space, independent damper control means in said distribution chamber controlling the supply of air to each nozzle means, alternately directing air flow between the air screen formed by said nozzle over each doorway or window and the said outlet duct more centrally of said closed space supplying a major flow of said replenishing air flow as an air screen over said doors or windows when open and a minor flow of air over a doorway or window when closed, the remainder of said air supply passing to the said more central position of said enclosed space, and a driving motor independently controlling the movement of each damper whereby each doorway or window may be independently provided with an air screen over the opening when either or both doors or windows are open independently of a smaller air flow adjacent to another doorway or window which may be closed.

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