

Dec. 10, 1963

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3,113,501

AIR DOOR

Filed Sept. 15, 1961

3 Sheets-Sheet 1

Fig. 1.

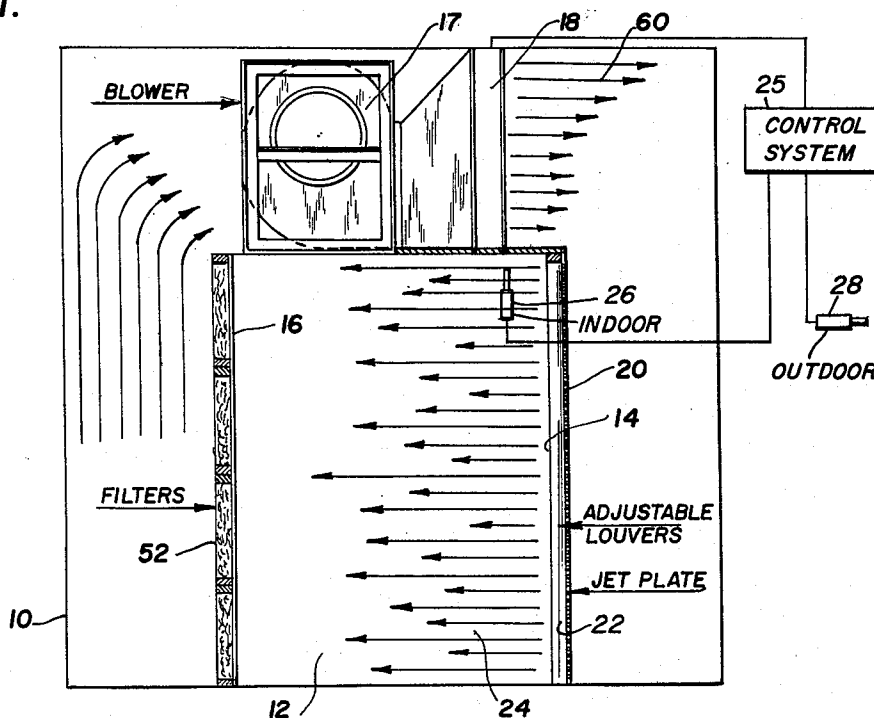


Fig. 2.

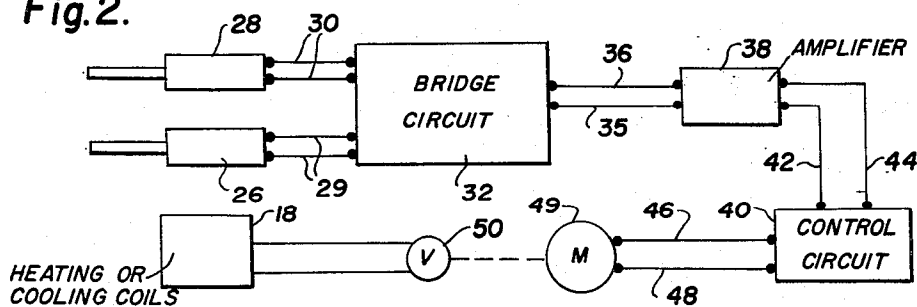
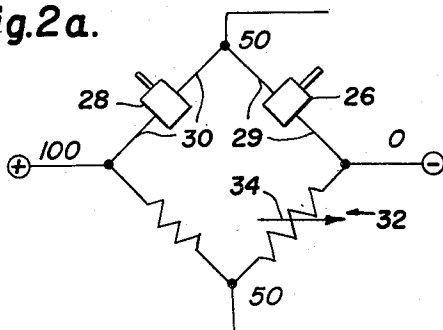


Fig. 2a.



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3 Sheets-Sheet 2

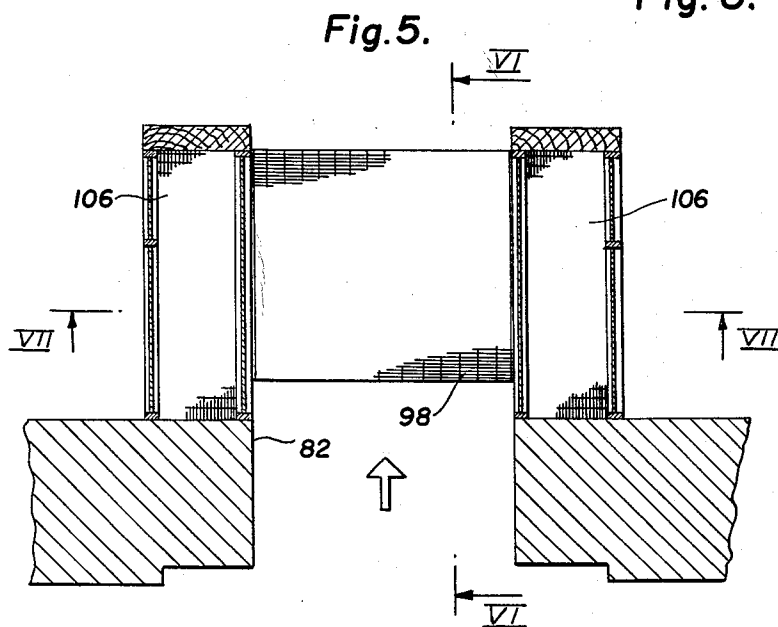
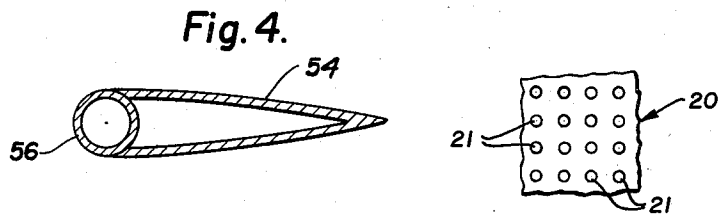
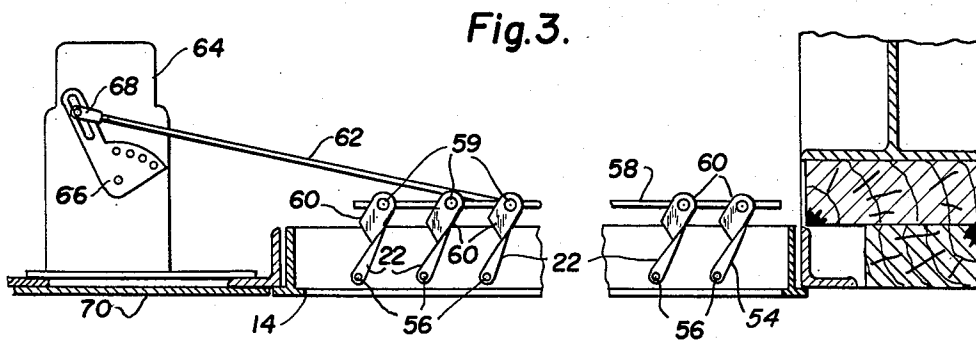


Fig. 8.

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AIR DOOR

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3 Sheets-Sheet 3

Fig. 7.

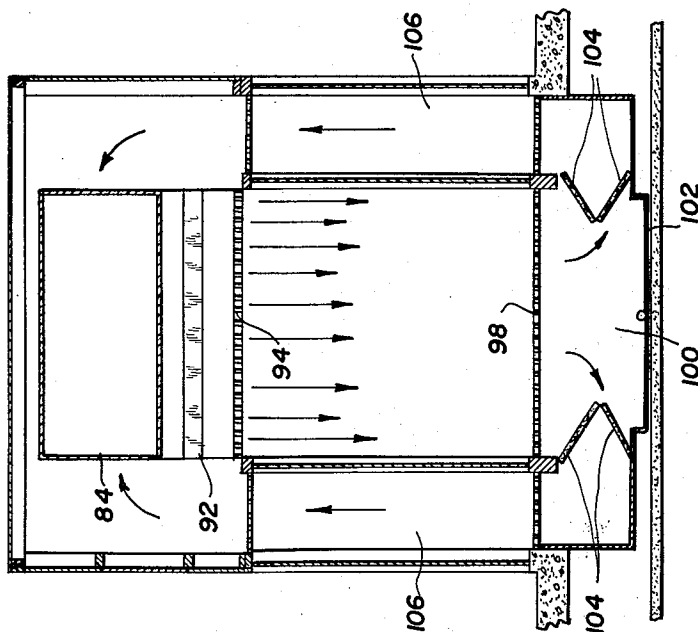
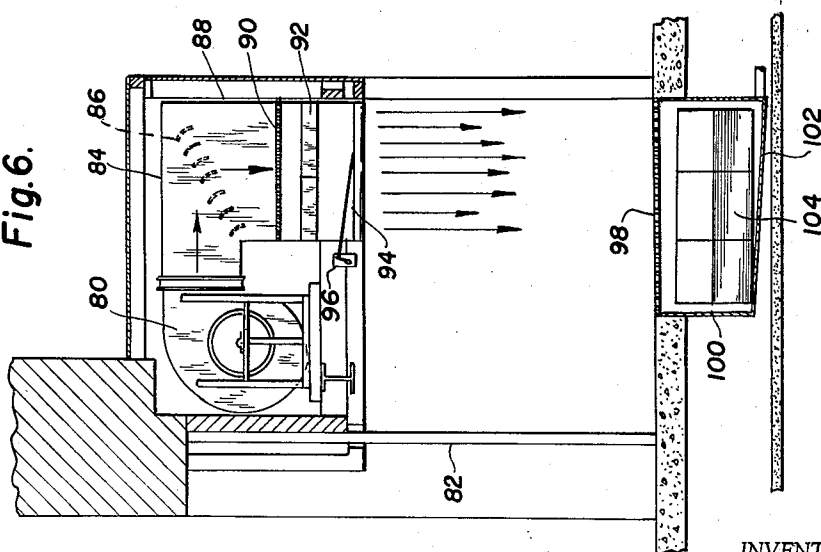


Fig. 6.



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1

3,113,501
AIR DOOR

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2 Claims. (Cl. 98—36)

This invention relates to an air door which is usable for maintaining an interior temperature and condition of cleanliness different from an outdoor temperature and condition of cleanliness. The air door functions to maintain a temperature differential over the outside by being either cooler or warmer than the outside. In addition to serving as a thermal barrier, the air door also functions as a shield against the entrance of pets, insects, dirt, rain, snow, pollen and other objectionable material which it is desirable to exclude from entry. In brief, the air door serves as an equivalent of a solid wood or metal door and performs all of the functions of these substituted solid doors.

Air doors have become popular and are now being more extensively used, principally because of the advantages offered over conventional mechanical doors, in that air doors speed up traffic by eliminating manual effort associated with the operating of mechanical doors. Passing through an air door is inherently quicker than using a revolving or hinge mounted door; and, the air door provides a thermal and mechanical barrier which is less penetrable by outdoor air and contaminants which can easily pass a mechanical door and into the interior when the mechanical door is operated.

Although the public is now accustomed to the experience of passing through an air door, in previous doors of this type there was sometimes an objection to the air current due to its uneven or turbulent characteristics; whereas it should be an experience scarcely perceptible to the pedestrian. In this respect, it is highly desirable to provide an air door wherein the air current is as smooth and even as possible to eliminate any possible discomfort which would be occasioned by an uneven blast of air.

The purpose of an air door is to constantly maintain a difference of climatic condition within the interior of a building over that of the exterior or outdoors, regardless of the temperature, humidity, etc. of the outdoors, by providing a shield of air which substantially fills an open passageway and permits traffic in both directions through the doorway while maintaining controlled interior climatic conditions of air temperature, humidity, cleanliness, etc. In order to function efficiently the air door must use air which is itself conditioned by being heated or cooled to a given temperature in accordance with the temperature differential which is to be maintained across the air door. While conditions within the interior of the building are intended to remain static, i.e., at a given favorable temperature, humidity and cleanliness, the outside temperature will change substantially during the course of time and it is intended that the air door function as efficiently as necessary to maintain the correct interior climatic condition regardless of such change.

Accordingly, it is one of the objects of the present invention to provide an air door having an operating system which will be responsive to changes of outdoor conditions so that regardless of those changes, the air door will maintain the same interior climatic conditions.

It is a further object of the invention to provide an air door which will function automatically to be self-adjusting in order to maintain the appropriate air door temperature in relation to the outdoor temperature, whether the outdoor temperature be warmer than or cooler than the interior temperature.

2

It is a further object of the invention to provide a closed circuit air flow by which the air is constantly filtered, and adjusted to an appropriate size and shape of air curtain in addition to being constantly regulated to a given temperature, so that the air door is ideally suited for continuous uninterrupted usage and requires no regulation to main interior conditions in spite of inevitable fluctuations of outdoor temperature.

Another object of the invention is to provide means in an air door for producing an even and smooth current of air thereacross so as to eliminate any discomfort or annoyance to pedestrians passing through the door, while at the same time insuring full air stream coverage across the door.

Other objects and features of the present invention will become apparent from a consideration of the following description which proceeds with reference to the accompanying drawings, wherein:

FIGURE 1 is a diagrammatic view taken through a portal which is closed by an air door embodying my invention;

FIG. 2 is a diagram showing the control system for operating the heating or cooling coil for the air, in accordance with the temperature differential to be maintained across the air door;

FIG. 2A is a schematic wire diagram of the bridge circuit of FIG. 2;

FIG. 3 is a detail view of the adjustable louvers which are used for controlling the stream of air before its passage across the doorway;

FIG. 4 is an enlarged detailed view of one of the louver blades shown detached from the air door;

FIG. 5 shows a second embodiment of the invention in which the air curtain is produced by vertical circulation of air as distinguished from horizontal circulation of air in the prior embodiment, this view being taken transversely through the doorway and looking downwardly; and

FIGS. 6 and 7 are section views taken on lines 6—6 and 7—7, respectively, of FIG. 5; and,

FIG. 8 is a fragmentary view of a jet plate employed in the present invention.

Referring now to the drawings, and particularly to FIG. 1, there is a duct 10 of sheet metal, fiberglass or the like which forms a hidden archway over the doorway 12 to conduct a continuous closed path circuit air flow, a portion of said closed path including passage of air from the righthand side 14 to the left-hand side 16 of the doorway 12. As the air passes across doorway 12 to form an invisible shield which maintains a temperature differential across the shield, one side of which is the interior of a building to be maintained at a given climatic condition of temperature, humidity and air purity, and the opposite side of which is the outdoor prevailing climate which is subject to change in temperature, humidity and cleanliness.

The invisible shield of air is at a continuous stream of circulating air which is maintained at constant flow by a blower 17 which propels the air at a given rate and pressure suitable for the dimensions and design of the doorway 12. The air circulating in the closed circuit passes, during each cycle, a series of coils 18 which are intended either to refrigerate or heat the air depending upon the temperature of the interior of the building in relation to the outdoors. Thus, if the interior of the building is heated and is of a higher temperature than the outdoors then the coils 18 are made heating coils and, in the event that the interior of the building is at a lower temperature than the outside, then coils 18 are refrigerating coils.

After the air has moved past the coils 18 and is at the prescribed temperature it then moves through a jet

3

plate 20 (see FIG. 8) having a plurality of openings 21 therein, the purpose of which is to smooth out the flow of air and distribute it evenly from the top to the bottom of the doorway and to remove any turbulence which might exist in the flow of air. In the absence of the jet plate, the stream of air would be irregular and gusty producing discomfortable annoyance to pedestrians walking through the air curtain. The air then moves past a series of adjustable louvers 22 which adjust both the shape and intensity of the air stream and direct it along an appropriate path which substantially fills the portal 12 so that there are no gaps or discontinuities in the shield 24 by which air from the outdoors can find entry into the interior.

Although the shield 24 substantially fills the portal 12 it presents no apparent obstacle to the free passage of pedestrians in either direction through the portal 12 and the air stream is sufficiently continuous and flows at such a rate that disruptions, created by traffic are filled immediately so that outdoor air does not penetrate the shield in spite of passage of pedestrians across the air door.

The efficiency of the air door is dependent upon the maintenance of a certain temperature thereof in relation to the temperature differential which it is intended to maintain thereacross. Thus, should the interior temperature be 72° F. and the exterior or outdoor temperature be 32° F. thereby providing a temperature differential of 40° F., then the temperature of the air stream forming the door must increase to maintain the same interior temperature of 72° F. if the outdoor temperature should fall to, say 12° F., giving a temperature differential of 60° F. or a change of temperature differential from 40° F. to 60° F. It is obviously necessary to the efficiency of an air door to maintain a given interior temperature regardless of change in outdoor temperature which is known to vary, and over which the proprietor has neither control nor exact knowledge of when and to what degree it will vary. By means of the present invention, I provide for such variation of temperature in the outdoors so that regardless of the temperature differential, to be maintained across the air door, the circulating air forming the door will be heated automatically to whatever temperature is necessary in response to changes in outdoor weather conditions in order to maintain a constant preselected indoor temperature.

This described control operation of the coils 18 is accomplished by two temperature sensitive elements in the form of probes 26, 28, one of which is in the air shield 24 (indoors) and the other of which is outside the door in the atmosphere. These elements are connected to a control system 25, hereinafter described, which controls the operation of the heating and/or cooling coils 18. As shown in FIG. 2, each of the probes 26, 28 is connected by conductors 29, 30 to a bridge circuit 32 having a variable resistor 34 (FIG. 2A) which is adjusted to the indoor temperature to be maintained within the building. From the bridge circuit 32, two conductors 35, 36 lead to an amplifier 38 and the amplified signal is then communicated to a control circuit 40 through conductors 42, 44. The control circuit 40 connects through conductors 46, 48 with a motor 49 which controls a flow valve 50 regulating the flow of hot water, steam or the like to heating coils 18.

The operation of control circuit 32 shown in FIGS. 2 and 2A is such that for a given setting of variable resistor 34, corresponding to the indoor temperature, the circuit will effect periodic operation of the heating coils 18 to obtain an air temperature for the air door which is a function of the temperature differential between the outdoors and the interior of the building. Should the outdoor temperature be lower than the intended indoor temperature and then fall to a level increasing the temperature differential, the bridge circuit 32 will effect operation of the valve 50 which, in turn, operates the heating coils 18 to bring the air screen temperature to a higher

4

value appropriate for maintaining the increased temperature differential. Therefore, whenever the outdoor temperature falls then the temperature differential is detected by the two probes 26, 28 and actuates valve 50 to increase the heating effect of heating coils 18 and thereby raise the temperature of the air within the air door to a value which can maintain a greater temperature differential.

Referring to FIG. 2, it can be seen that heating effect on the air is obtained by means of a closed loop feedback system in which the temperature of the air door is under constant control and is heated, or cooled continuously by automatic operation of the system, to maintain the temperature differential across the air door.

Because the air forming the air door comes into contact with outside air, it is advisable to pass the air through filters 52 during each cycle of air circulation, and in this way the air constituting the air door is assured of being sufficiently clean and free of pollen, dirt, bugs or other contaminants so that it will not itself be a source of contamination of the interior air.

If desired, suitable provision can be made for periodically washing or replacing the filters 52. The serving of the filters does not form an essential part of the present invention and any convenient arrangement can be provided for servicing thereof.

Referring next to FIGS. 3 and 4, there is shown details of a louver assembly 22, usable in the embodiments of FIG. 1 or FIGS. 5-7. As shown there are a plurality of extruded aluminum louver blades 54 which are proportioned to be of substantially the same length, for example, as the height of doorway 12 and each is mounted on a respective mounting pin 56 so it can be positioned angularly by means of a connecting rod 58 having a pivotal connection 59 with each of louver blades 54 through lugs 60. The lugs are fastened to the louver blades 54 by welding or the like. When the rod 58 is moved to the right or to the left by control arm 62, this will determine the setting of louver blades 54 which, in turn, control the intensity and direction of the air current as it passes over the surfaces of the louver blades. For best operating results, the air flow should be directly transverse to the doorway and in line for passage through the filters and then recycling. If the doorway is exposed to a prevailing wind or periodic wind gusts of a given direction and intensity, it is advisable to adjust the louver blades 54 to a given setting, by means of the damper motor 64 having an actuator lever 66 with connection 68 fastened to control arm 62. In this way, the air stream can be regulated to a given flow and direction for best results. The damper motor 64 can be reached through an access panel 70 located within the doorway and can, for convenience, be made of given decor in order to blend in with the existing building structure.

Referring next to the embodiment shown in FIGS. 5, 6 and 7, the current of air can be arranged to flow downwardly from the door overhead as well as passing from one side of the doorway to the opposite side of the doorway. For particulars of this arrangement, and with special reference to FIGS. 5-7, the air is circulated by means of a fan 80 which is mounted at the upper part of the doorway 82 and propels air in the direction of the arrows (FIG. 6) through the duct 84. The turning vanes 86 are located to divert the air current downwardly through duct section 88 and past jet plate 90 having approximately 40% apertured area with each aperture having a diameter of about 1/8 inch, then past heating coils 92 and an outlet 94 having louvers as in the previous embodiment. After passing the louvers, the air travels vertically downwardly in a continuous flow to provide an air current which seals the entrance against the passage of heat from the indoors to the outdoors and likewise prevents movement of insects, contaminants such as dirt, pollen and the like the same as in the previous embodiment. The jet plate 90 is an important part of the invention in that it creates a plurality

5

of small jets of air at high velocity which produce a smooth air curtain and at the same time insure that a constant stream of air fills the entire doorway. Additionally, the small air jets, as contrasted with the large air blast of prior art devices of this type enable better control with the louvers and eliminate any discomfort or annoyance to pedestrians passing through the door use to an uneven blast of air.

The shape of the air curtain can be controlled by operating the louvers within outlet 94 by means of a damper motor 96 which operates as previously described. The air curtain, substantially fills the doorway so that no portion of the doorway is subject to penetration by dirt or the like, but it offers no resistance to the free passage of pedestrians in both directions through the doorway.

The circulating air forming the air curtain passes downwardly through the floor grating 98 and into a sheet metal pit 100 which is below grade and includes a stainless steel pan 102 having an appropriate drain for running off water which might collect within the pit. Once the air descends into the pit, it is divided into two oppositely directed flows (FIG. 7) each of which passes through its filter 104 and is then directed upwardly through vertical duct 106 where it moves upwardly to the top of the doorway and is repelled by fan 80. In this way, there is a continuously traveling current of air which is constantly controlled for an appropriate temperature and cleanliness, and forms an air current of the desired shape and intensity according to the setting of the louvers.

The control system for heating or cooling the air to its appropriate temperature, is the same as previously described. The air temperature of the air door is therefore a function of the temperature differential between the indoor temperature and the outdoor temperature and it will change constantly to maintain the desired interior temperature regardless of changes in the outdoor temperature.

The operation of the air door, for both embodiments is essentially the same, the principal difference being that in the one embodiment the air current passes horizontally through the doorway from one side to the other and in the other embodiment the air door is provided by the current of air which moves vertically from the top of the doorway downwardly through a floor grate. Choice of construction is determined by customer preference and the existing building construction.

In brief résumé:

The air door shown in FIGS. 1-4 is first adjusted by operation of the motor 64 which provides a setting of the louvers 54; the variable resistor 34 is set in accordance with the inside temperature to be maintained; and the bridge circuit 32 is energized to control the heating coils 13. The blower 17 is then actuated and there is produced a constantly circulating current of air which moves in a clockwise direction as shown in FIG. 1 past the heating coils to receive the heating or cooling to an appropriate temperature, then through jet plate 20 and louvers 22 where it is directed across the doorway, is then filtered and returned to the blower. Since the heating coils 18 are controlled by a combination of signals from the outside temperature sensor 28 and the air curtain temperature sensor 26, and is also controlled by the variable resistor 34, the temperature of the air curtain will be under constant regulation such that the air curtain temperature will be changed responsively to changes of temperature differential between the outdoors and indoors. Should the temperature differential between outdoors and indoors increase and the temperature of the outdoors be colder than indoor temperature, the air curtain temperature will be raised. In the event that the outdoor temperature is higher than the indoor temperature then the coils 18 will effect cooling of the air curtain and the degree of cooling is a function of the temperature differential to be maintained between the indoors and outdoors.

Since cooling or heating of the temperature of the air

6

curtain is automatic, then the air door operates most efficiently for its intended purpose.

Although the present invention has been disclosed and described in connection with the single example embodiment, it will be understood that this is illustrative of the invention and is in no sense restrictive thereof. It is reasonably to be expected that those skilled in the art can make numerous revisions and adaptations of the invention to suit individual design requirements and it is intended that such revisions and changes as incorporate the herein disclosed principles will be included within the scope of the following claims as equivalents of the invention.

I claim as my invention:

1. An air door for a building or the like comprising a portal opening, a duct having an inlet end and an outlet end disposed at opposite sides of said portal opening, for conducting air in a prescribed path which includes said portal opening, means for propelling air through said duct and at a predetermined velocity therein, temperature control means including heat exchanger means to which the air is subjected to effect a predetermined temperature value thereof, means in the outlet of said duct for directing the flow of air across said portal opening as an invisible thermal shield, two temperature sensitive elements, one of said elements being in the flow of air across said portal opening and the other being outside of the portal opening and outside the building, bridge circuit means coupled to said elements for producing an electrical signal which varies as a function of the temperature differential measured by said elements, and control means operatively connected to said bridge circuit means and responsive to said electrical signal for regulating said temperature control means to increase the temperature of the flow of air across said portal opening when the outside temperature decreases and to decrease the temperature of the flow of air across said portal opening when the outside temperature increases.

2. An air shield forming a protective thermal barrier for building doorway openings and the like, comprising air-flow-conducting means for channeling the air along a prescribed path which includes a doorway opening, means for propelling an air mass at a prescribed rate through said path, means in said conducting means for directing and producing uniform flow of said air across said doorway opening to traverse the doorway and form therein a closure of predetermined thickness, two temperature sensitive elements, one of said elements being in the flow of air across said doorway opening and the other being outside of said doorway opening and outside the building, bridge circuit means coupled to said elements for producing an electrical signal which varies as a function of the temperature differential measured by said elements, and a control device operable by said bridge circuit means and responsive to said electrical signal for regulating a temperature control means including heat exchanger means for increasing the temperature of said air when the outside temperature decreases and for decreasing the temperature of said air when the outside temperature increases.

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