United States Patent

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[54] **AIR FLOW CONTROL SYSTEM**

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[21] Appl. No.: **636,748**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 577,298, Sept. 6, 1966, abandoned.

[52] **U.S. Cl.** ....**236/13,** 98/38, 98/40 D, 165/16, 236/49

[51] **Int. Cl.** **G05d 11/16,** F24f 13/04

[58] **Field of Search** ....98/38, 40, 38 E; 236/13, 49; 165/22, 16

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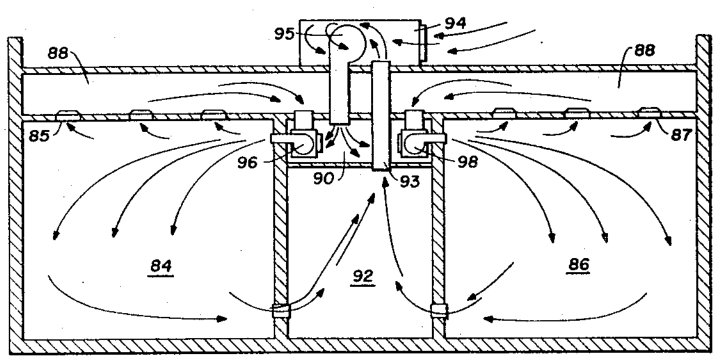
[57] **ABSTRACT**

Environmental temperatures are controlled by selectively proportioning air flow from a pair of air flow paths by generation of a force proportional to temperature and dependent solely upon temperature for oppositely and proportionally changing registration of small openings in pairs of perforated plates laterally disposed in the air flow paths.

10 Claims, 17 Drawing Figures



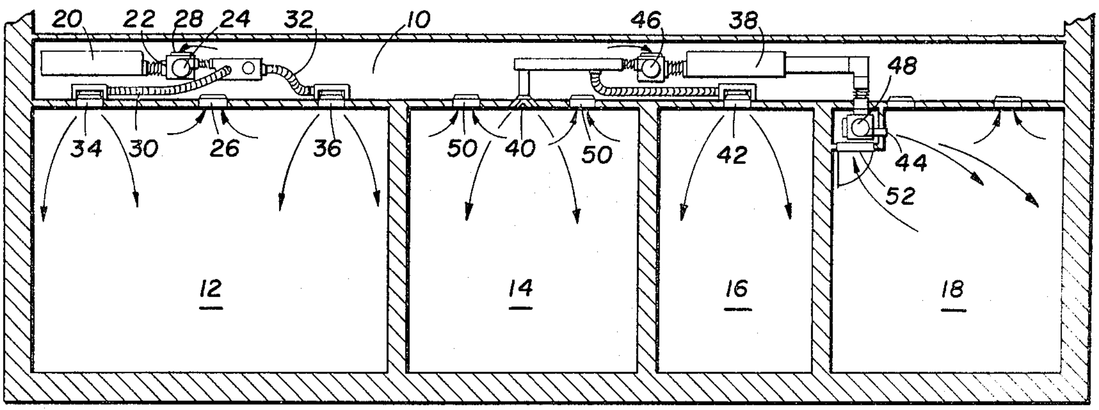


FIG. 1

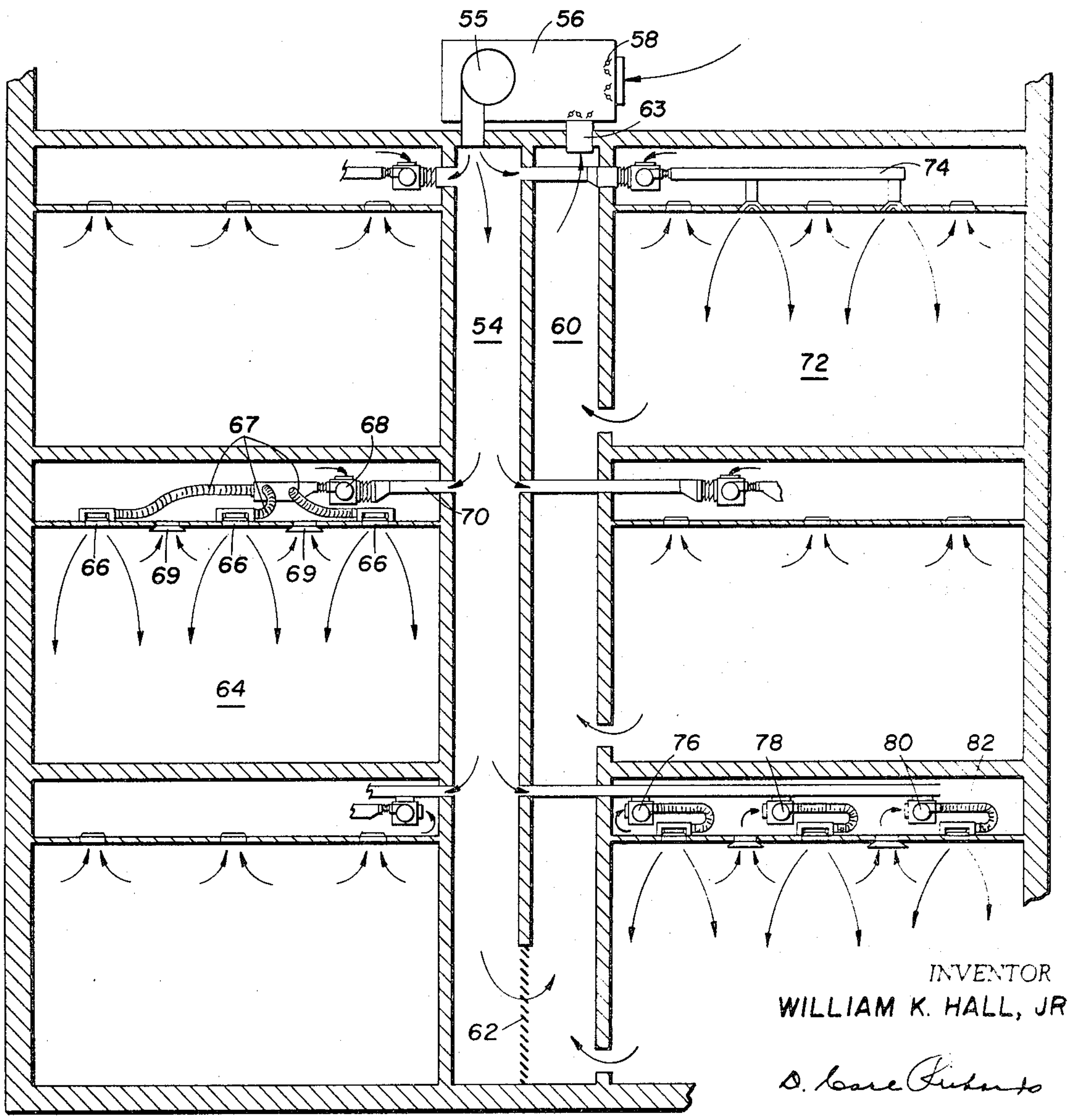


FIG. 2

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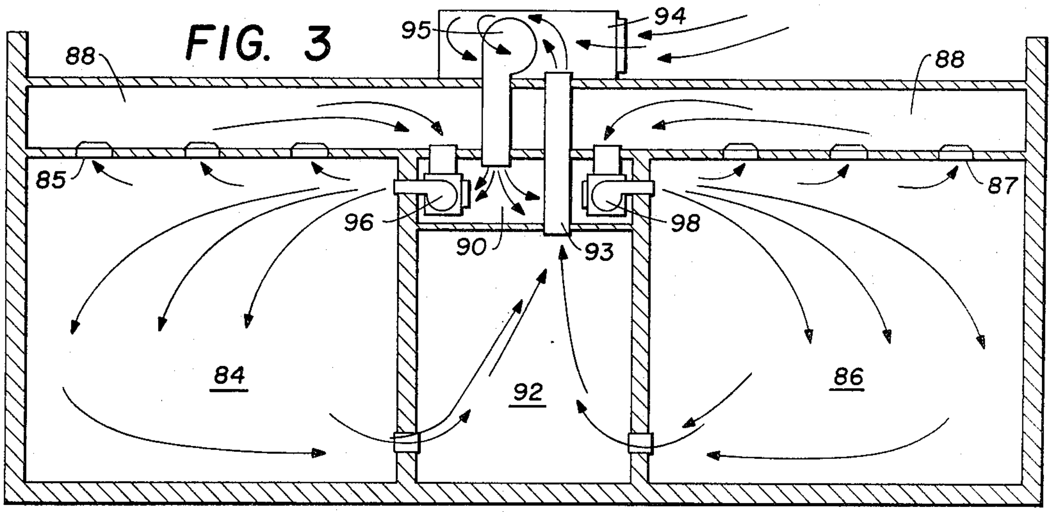

FIG. 3

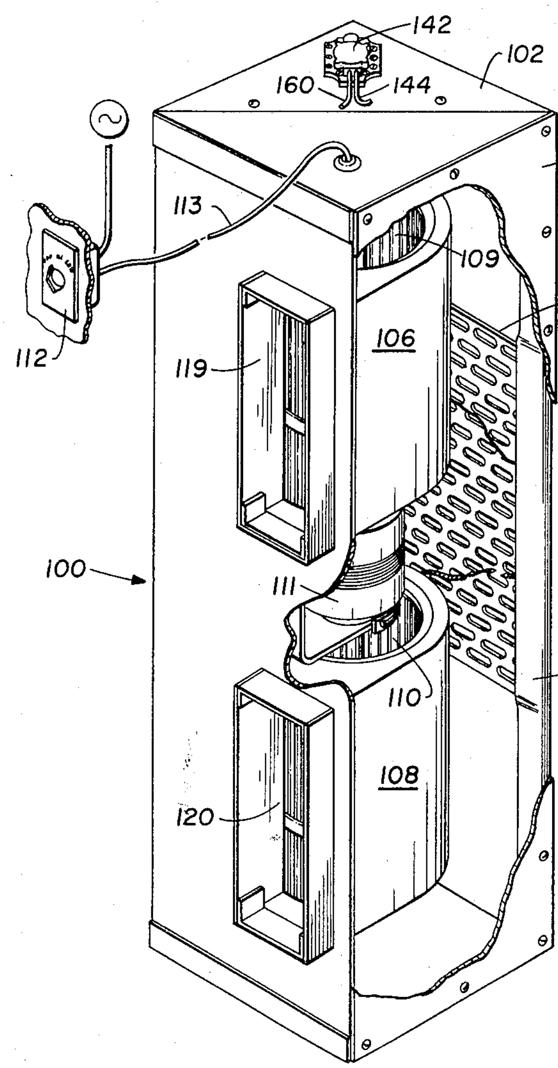

FIG. 4

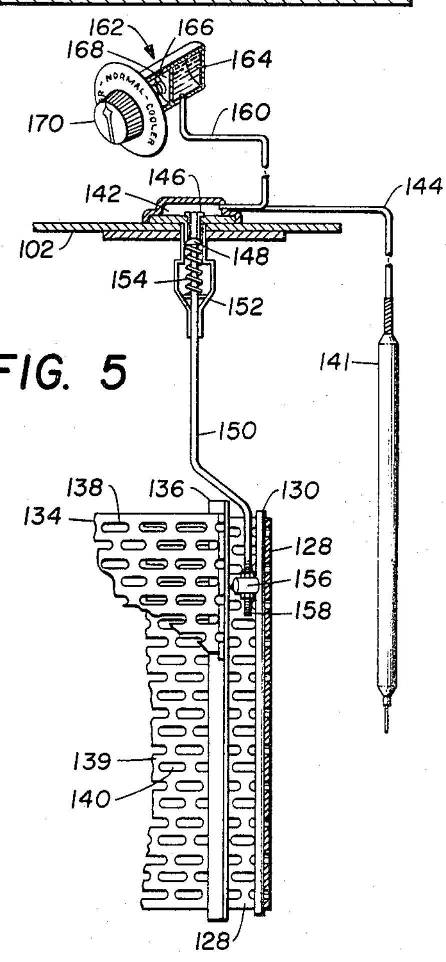

FIG. 5

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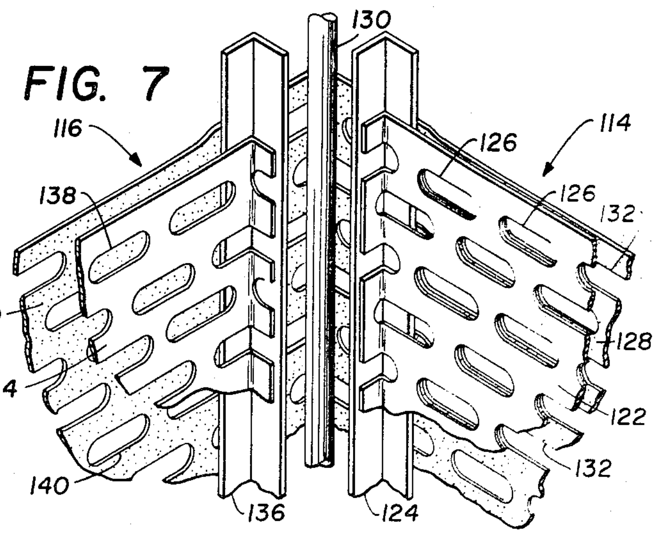
FIG. 7



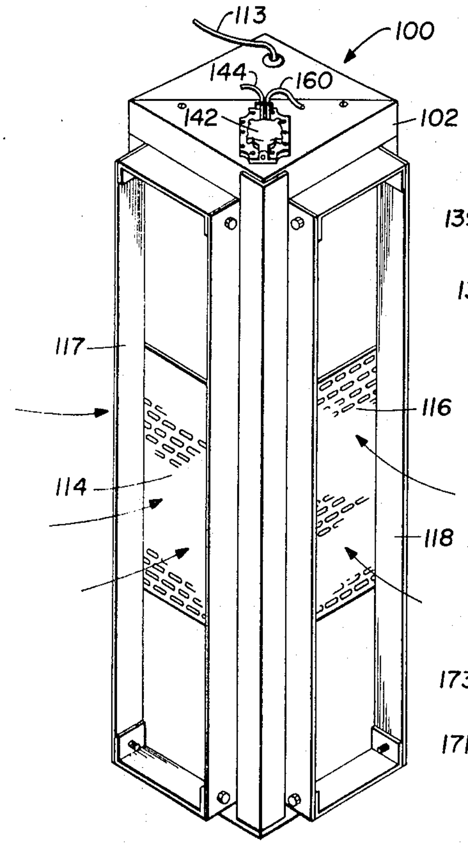


FIG. 6

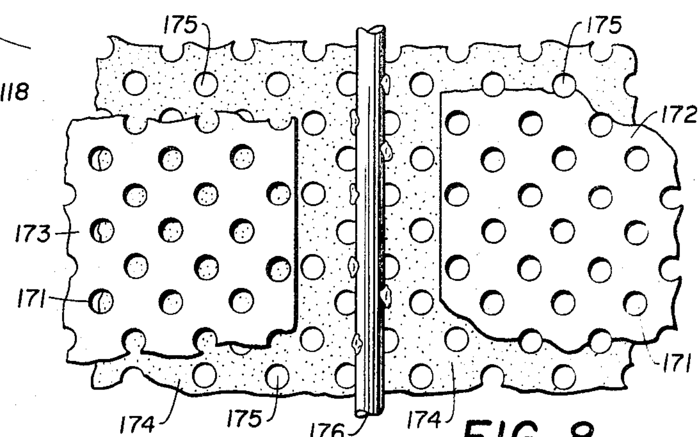


FIG. 8

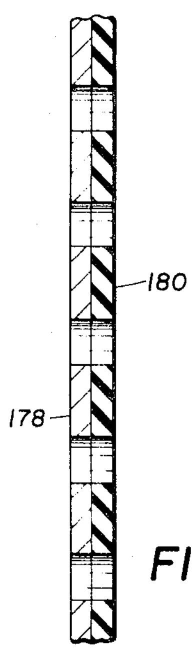


FIG. 9

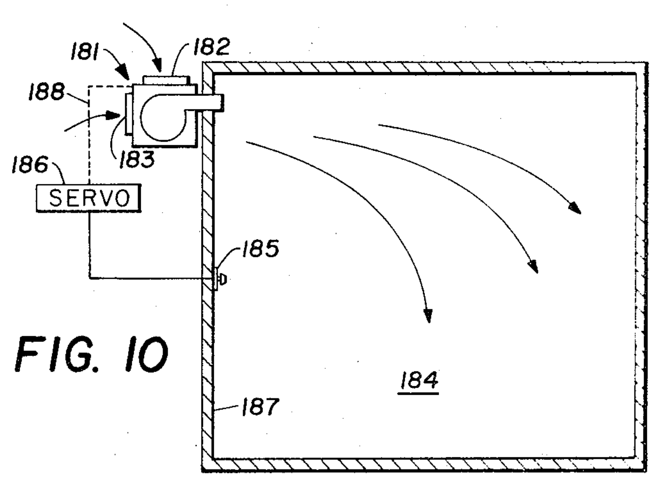


FIG. 10

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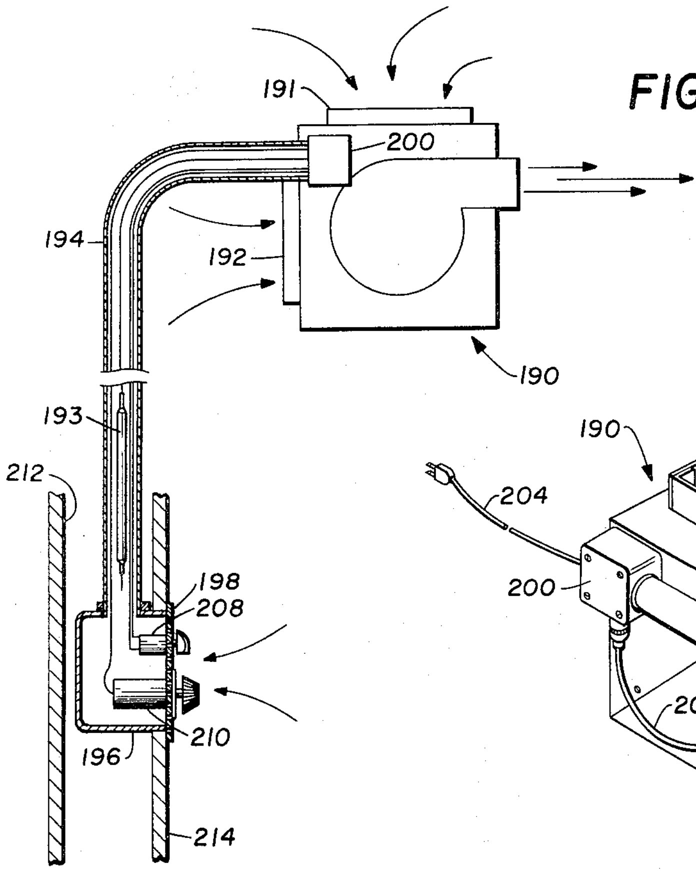

FIG. 12

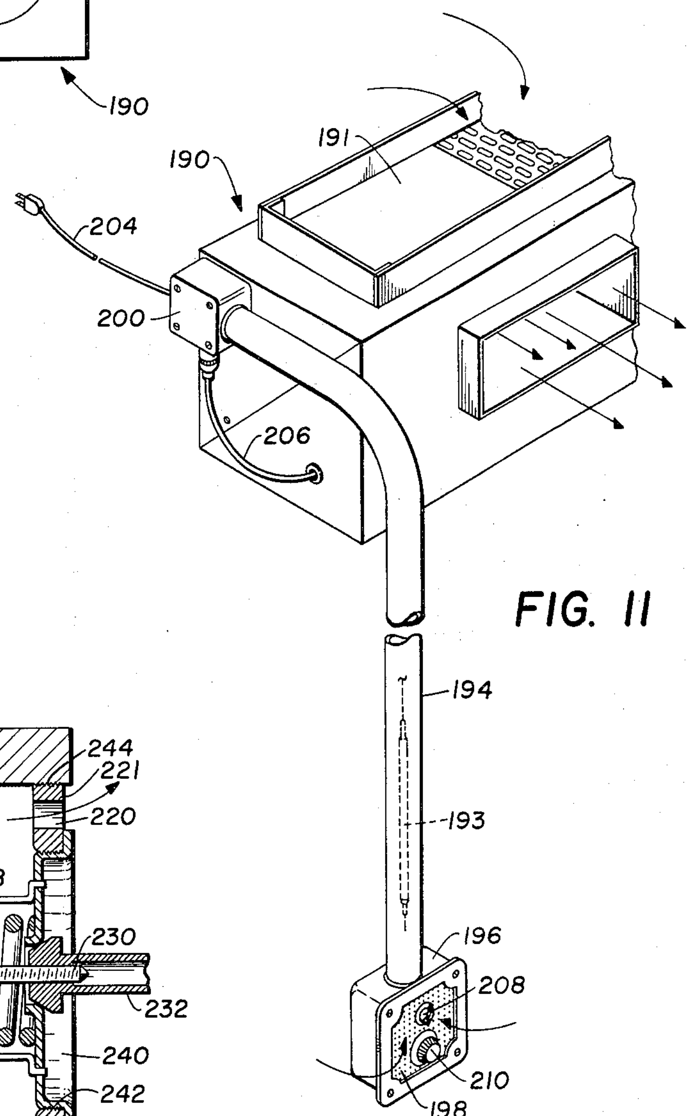

FIG. 11

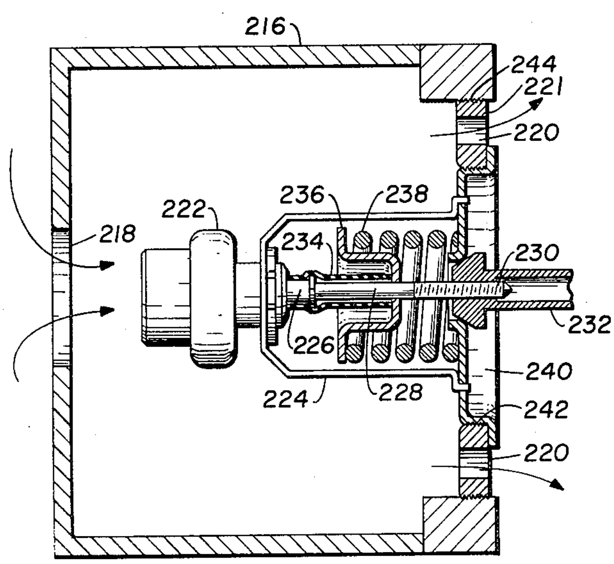

FIG. 13

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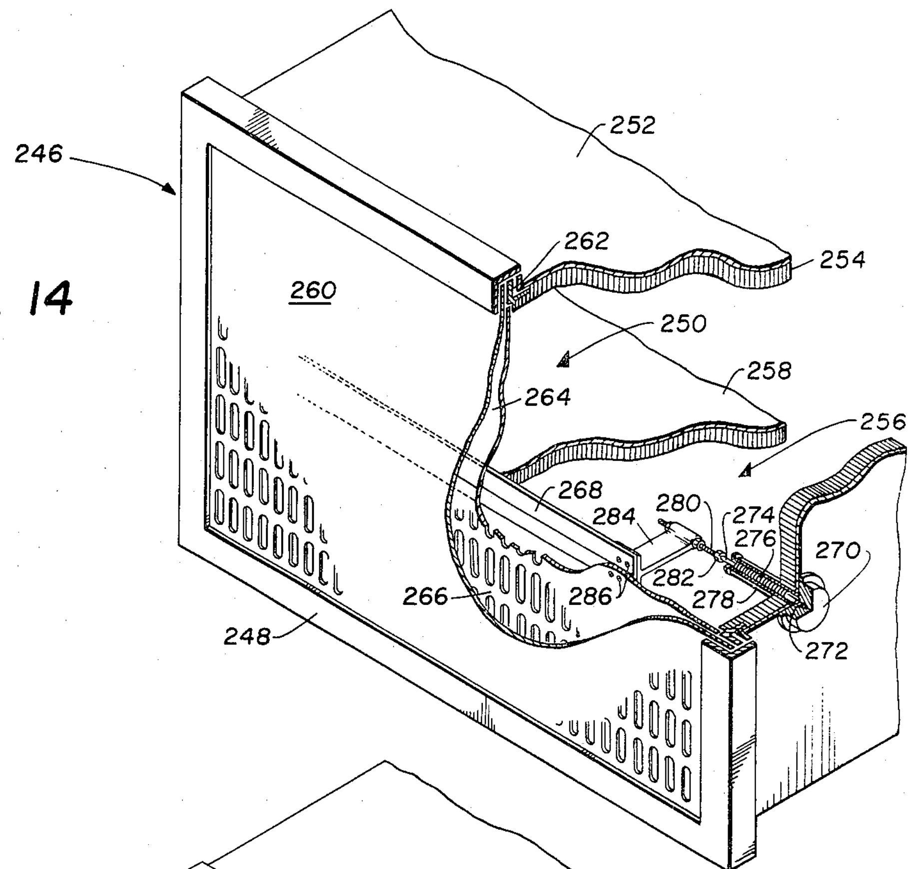
246
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FIG. 14

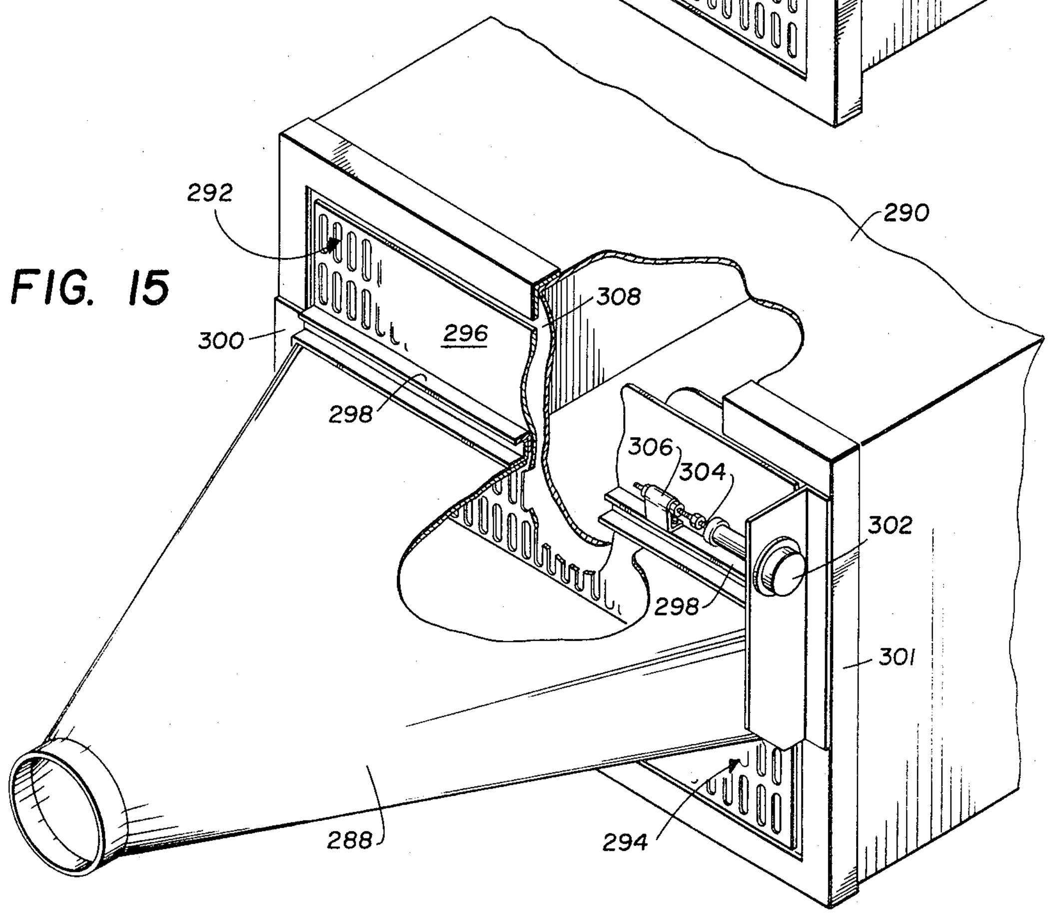
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FIG. 15

FIG. 16

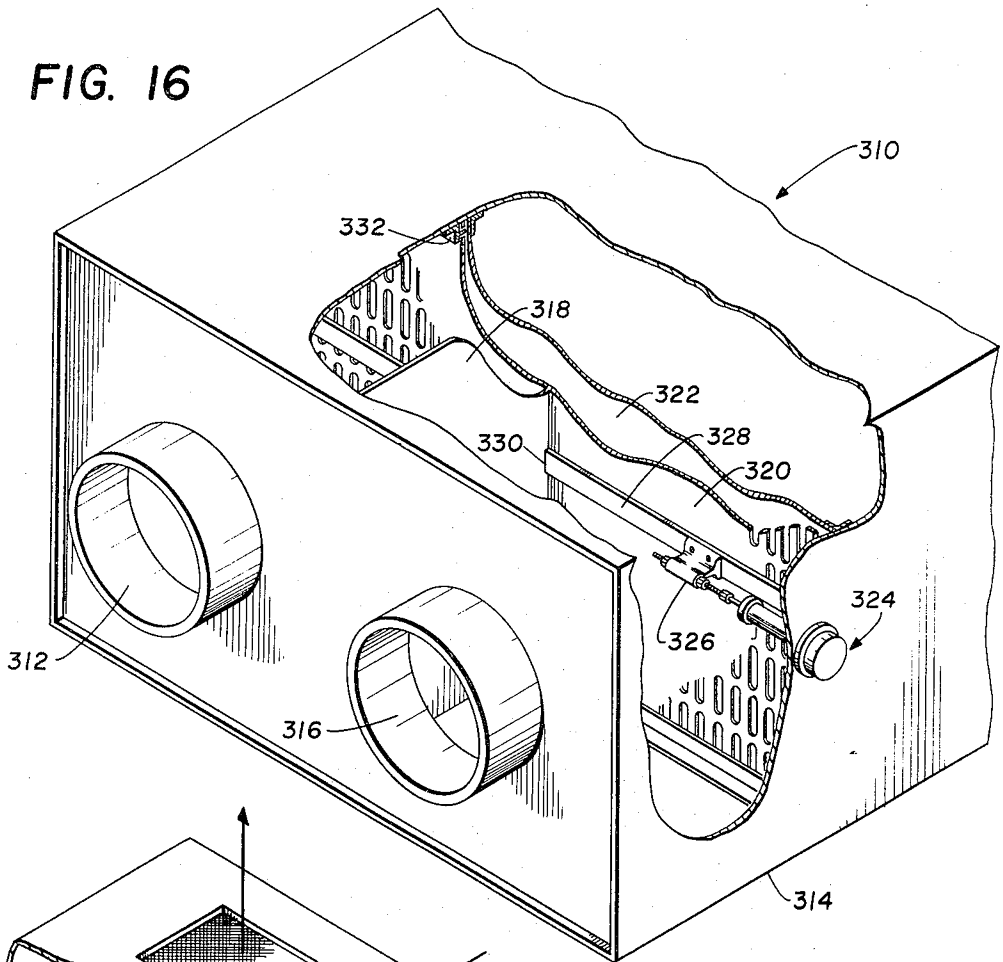
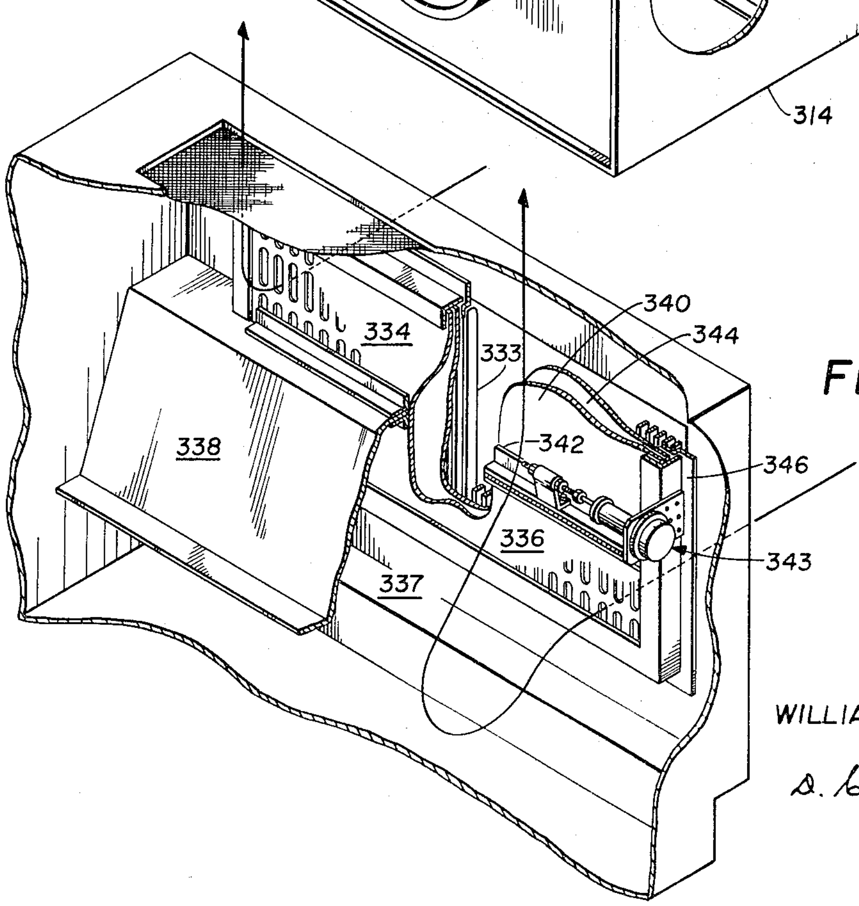


FIG. 17



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AIR FLOW CONTROL SYSTEM

RELATED APPLICATIONS

This application is a continuation-in-part of application Ser. No. 577,298, filed Sept. 6, 1966, now abandoned.

FIELD OF THE INVENTION

This invention relates to environmental control systems and more particularly to the control of air flow from warm and cool sources. In a more specific aspect, the invention relates to a flow control system which includes pairs of relatively slidable perforated plates positioned transversely of the flow paths leading from the sources. In a still further aspect, the invention relates to the development and direct use of forces produced solely in response to change in temperature for varying relative positions of such perforated plates.

PRIOR ART

A wide variety of systems has been heretofore employed in the delivery of air to one or more zones where individual control of the temperature for each zone is desired. In the past, heat exchange units have been supplied for each zone with temperature sensing means for controlling the heat supplied to, or extracted from, air flowing to such zone. In air flow systems, motor-driven mechanically-actuated dampers have been widely employed. Further, in high pressure systems, the flow of supercooled air under high pressure to a particular area has been employed for inducing circulation.

The practical utilization of many of these previously developed temperature control systems has been limited by several factors. Many of the prior systems have not only required complex and expensive control and actuation devices for each temperature control unit, but have often required a separate control unit for each zone for which temperature control is desired. In addition to the economic limitations thus imposed upon many previously developed systems, the complex motor-operated construction of some systems has often not been entirely satisfactory with respect to maintenance requirements or operating efficiency. Further, many of the systems previously employed for zone temperature control have not been responsive to the temperature of air in the desired zone.

SUMMARY

In accordance with the present invention, conduit means is mounted adjacent to a supply opening leading to a zone to be temperature controlled. Structure is provided which forms a pair of air supply paths which lead to the conduit means. A pair of perforated plates are transversely disposed in each air supply path and means is provided for moving one plate of one plate pair relative to the other plate in a first sense while moving one plate of the other plate pair relative to the other plate in a second sense to increase the proportion of air supplied through one path while concurrently decreasing the proportion of air supplied through the second path.

THE DRAWINGS

Other objects and intended advantages of this invention will be more readily appreciated as they become better understood by reference to the following detailed description in connection with the accompanying drawings wherein:

FIG. 1 illustrates a system according to the present invention for individually controlling the temperature in a plurality of adjacent rooms;

FIG. 2 illustrates a system for conditioning the temperature in a plurality of vertically disposed room zones;

FIG. 3 illustrates a system utilizing common returned air to temperature condition adjacently disposed room zones;

FIG. 4 is a perspective view, partially cut away, of one embodiment of the present invention;

FIG. 5 is a cross-sectional view of the sensing unit of the device shown in FIG. 4;

FIG. 6 is another perspective view of the device shown in FIG. 4;

FIG. 7 is a perspective sectional view of a portion of the perforated plates shown in FIGS. 4 and 5;

FIG. 8 is a sectioned view of another embodiment of the perforated plates of the present invention;

FIG. 9 is a cross-sectional view of another embodiment of the perforated plates of the present invention;

FIG. 10 is a schematic diagram of a temperature conditioning system utilizing the present invention;

FIG. 11 is a perspective sectional view of the system embodying the device shown in FIG. 4;

FIG. 12 is a somewhat schematic view, partially in cross section, of the system shown in FIG. 11;

FIG. 13 is a cross-sectional view of another embodiment of a sensing unit of the present invention;

FIGS. 14–17 are perspective views, partially cut away, of four different temperature control systems utilizing perforated plate control according to the present invention.

THE PREFERRED EMBODIMENTS

FIGS. 1–3 illustrate air temperature control systems wherein warm air or cool air reservoirs common to a plurality of individual zones to be temperature controlled may be utilized with the application of the present invention. FIG. 1 discloses a control system wherein the temperature of air in several adjacently disposed rooms may be maintained individually in accordance with their separate requirements. A warm air reservoir or plenum **10**, which may, for example, be an attic space fed by return air from rooms therebelow, is commonly disposed to each of the rooms **12**, **14**, **16**, and **18**. Cool air is supplied from a suitable source through a duct **20** which forms a cool air supply path leading to a first control section **22** in a flow control unit **24** constructed in accordance with the present invention. Warm air is returned from the room **12** through the opening **26** to combined with the warm air in the reservoir **10** to form a warm air supply path leading to a second control section **28** on the control unit **24**. The control sections each comprise pairs of perforated plates, one slidable with respect to the other, and so actuated as to proportion the air flowing therethrough in dependence upon temperature, as will be described in greater detail. A fan is located in the control unit **24** to pull air through the control sections **22** and **28** in such proportions as required to control the temperature of room **12**. The air from the warm and the cool supply paths is mixed and then supplied to room **12** through conduits **30** and **32** and through supply openings **34** and **36**, respectively.

Also illustrated in FIG. 1 is another embodiment of a system utilizing the present invention, wherein cool air from a duct **38** supplies a portion of air through openings **40** into room **14**, opening **42** into room **16**, and opening **44** into room **18** in such proportions as determined by the control units **46** and **48**, constructed in accordance with the present invention. Warm air is returned through opening **50** from room **14** into the reservoir **10** for mixture with the cool air supplied by the duct **38** in such proportions as is determined by the control unit **46**. In a somewhat similar manner, warm air is supplied to an opening **52** from room **18** to be mixed with the cool air supplied by the duct **38** in such proportions as is determined by the control unit **48**. The proportions of warm air and cool air are accurately controlled in response to sensing devices exposed to air of the temperature of the air in the individual rooms, thus allowing individual temperature control of each of the adjacently disposed rooms.

FIG. 2 illustrates the use of the present invention in a temperature control system for a plurality of vertically disposed rooms in a building. A cool air reservoir or plenum **54**, common to a plurality of vertical rooms, contains cool air supplied by a blower **55** in a conventional cooling unit **56**, which may utilize conventional dampers **58** to control the inlet of outside air. A warm air return plenum **60** contains warm exhaust air supplied by the rooms and from the cool air reservoir **54** through the grille **62**. The plenum **60** is connected through conduit **63** and suitable dampers to the cooling unit **56**.

As may be seen, a system utilizing the present invention may take any one of a variety of forms. For instance, the system for independently controlling the temperature of room **64** supplies conditioned air to the inlets **66** through conduits **67**, the conditioned air being mixed by the control unit **68** from the warm air returned through the outlets **69** and the cool air supplied through the path **70**. A similar system is shown for conditioning the air of room **72** wherein rigid ductwork **74** is utilized instead of flexible conduits. If desired, a plurality of control units may be utilized for conditioning a single room, as shown by the three units **76, 78**, and **80**, which selectively proportion the amount of cool air from the reservoir **54** and the warm air from the attic plenum **82** mixed and provided to the room.

FIG. 3 illustrates a conditioning system for a pair of rooms **84** and **86** which are commonly disposed to a warm air attic reservoir **88** and a cool air reservoir **90**. Warm air from rooms **84** and **86** flows to a common plenum **92** and a conduit **93** and thence into a conventional cooling system **94**. A blower unit **95** supplies a continuous supply of cool air to the reservoir **90**. Warm air also flows from the rooms **84** and **86** into the attic reservoir **88** through openings **85** and **87**, respectively. A pair of control units **96** and **98**, constructed in accordance with the present invention, are mounted between the warm air reservoir **88** and the cool air reservoir **90** in order to selectively proportion the mixture of the two air supplies which is fed into rooms **84** and **86**, respectively.

While refrigeration units have been illustrated in conjunction with the embodiments described, it will be appreciated that, if desired, cold air could be provided from an outside environment and heating means could be provided to supply a source of warm air.

The construction of a control unit in accordance with the present invention may be best understood by reference to FIGS. 4–6, wherein the unit **100** is enclosed by a main housing **102**. Housing **102** is an elongated rectangular polyhedron conveniently formed of sheet metal. Housing **102** may have one or more removable panels **104** for repair or maintenance access. A pair of conventional blower fan units **106** and **108** include rotatable vaned cages **109** and **110** driven by an electric motor **111**. The operation of electric motor **111** is controlled by a suitably placed wall switch **112** connected through cable **113** which controls the application of power from a suitable source (not shown) to the motor. Rotation of the cages **109** and **110** induces flow of supply air through a first perforated plate unit **114** and a second perforated plate unit **116**.

Perforated plate units **114** and **116**, as shown in FIG. 6, are disposed relative to one another at an angle corresponding with the junction of warm and cool air supply paths. Rectangular flanges **117** and **118** may be provided about the outer openings of the plate sections in order to enable connection with air conduits. As shown in FIG. 7, plate unit **114** comprises a fixed plate **122** adjacent to a slidable plate **128**. Plates **122** and **128** have perforations therein which may be brought into registration or moved out of registration to open or close the air flow path and thus proportion the air passing through the housing **102**. Plate unit **116** includes slidable plate **139** and fixed plate **134**. Air flowing through plate units **114** and **116** is expelled by the fan units through their respective outlets **119** and **120**.

Referring again to FIG. 7, plate unit **114** comprises a first plate **122** which is fixedly connected at one edge to a bracket member **124** which is in turn connected to the main housing **102** of the unit. The other edge of the plate **122** is connected to housing **102** by means of a folded flange **125** (FIG. 4). Plate **122** includes a plurality of elongated perforations **126** defined therethrough in a predetermined alternating pattern. A second plate **128**, comprising one-half of an integral plate having a central right angle bend, is slidable adjacent to the plate section **122**. Plate **128** is connected to the rod **130**, as by welding, for slide movement relative to plate **122**.

Plate **128** includes a plurality of elongated perforations **132** disposed in the same pattern as the perforations **126** in the plate **122**, so that the perforations in the adjoining plates may be selectively brought into registration or moved out of registration in order control the flow of air therethrough. In FIG. 7, the perforations **126** and **132** are disposed in exact registration so that the passage of air therethrough is substantially unimpeded. Upon a slight vertical movement of the rod **130**, the perforations may be moved out of registration in order to accurately adjust the magnitude of the air flow therethrough.

The second plate unit **116** comprises a first plate **134** rigidly secured to the bracket member **136** and having a plurality of elongated perforations **138** disposed therethrough in a predetermined pattern. The plate **134** is offset with respect to the plate **122** so that the perforations through the two plates are not aligned. The second half of the bent plate, plate **139**, has a plurality of perforations **140** and is adjacent to the plate **134**. Because the perforation patterns of plates **122** and **134** are offset, when the perforations of the plate unit **114** are exactly aligned, the perforations of the second plate unit **116** are unaligned. In such case, the flow of air through the second plate unit **116** is thus totally obstructed.

Upon movement of the rod **130**, however, the plates **128** and **139** would be moved relative to both the plates **122** and **134**, thereby decreasing the proportion of air allowed to pass through the first plate unit **114**, while concurrently increasing the proportion of air allowed to pass through the second plate unit **116**. It will be understood that fine control of the passage of air, and similar control of mixing of air from two different air supply paths, may be accomplished by the present device. Only a very small mechanical movement is required to change one pair of plates from open to closed. The elongated slot configuration shown in FIG. 7 has the distinct advantage of not requiring extremely accurate manufacturing dimensioning to provide substantial registration of the perforations while maintaining at a minimum the travel necessary to open and close a pair of plates.

FIG. 5 discloses means for moving rod **130** to adjust the positions of the perforated plates. A fluid filler sensor **141** is connected in fluid communication with a fluid chamber **142** by means of a line **144**. An insert **146** within the chamber **142** limits the upward movement of the end **148** of an elongated linkage **150**. A housing **152** provides a fluid-tight seal about the linkage **150**, and a bias spring **154** is disposed between the end **148** and the housing **152**. A threaded portion **158** on the linkage **150** provides for connection to an extension **156** on the rod **130** in order to allow initial adjustment of the position of the rod **130** for proper alignment of the perforations.

A fluid conduit **160** connects the chamber **142** in fluid communication with an adjustment mechanism **162** comprising a hollow chamber **164** also filled with the fluid. A slidable piston **166** is biased against the fluid in the chamber **164** by a spring **168**. A dial **170** may be manually turned to selectively increase or decrease the tension applied by the piston **166** against the fluid. The variance of pressure on the fluid acts on the end **148** to move the linkage **150** vertically. By suitable adjustment of dial **170**, therefore, the static position of the rod **130** and the outer plate sections **128** and **139** may be adjusted to provide either warmer or cooler air flow.

In operation of the present unit, the dial **170** is set to the desired operating temperature. The sensor **141** senses air of the temperature of air in a room. If the temperature increases, the fluid inside the sensor **141** tends to expand, overcoming the bias pressure of the spring **154** and moving the linkage **150** downwardly. This causes the rod **130** and thus the perforated plate sections **128** and **139** to be moved downwardly, thereby changing the registration of the perforations. This movement concurrently increases the amount of cool air and decreases the amount of warm air supplied to the room.

Conversely, if the temperature of the room air drops, the volume of the fluid inside the sensor **141** and the chamber **142** will decrease. Spring **154** moves the perforated sections **128** and **139** upward. The change causes the temperature of the air in the room to be raised. The novel construction of the present invention thus allows very accurate control of the air supply to a room in response to only a very slight mechanical movement. This movement is within the capabilities of the expandable fluid sensing device **141**.

Other configurations of perforations may be employed in the perforated plates. For example, FIG. **8** illustrates a plurality of substantially circular perforations **171** distributed in predetermined patterns through fixed plates **172** and **173**. A movable outer plate **174** is connected, as by welding, to the rod **176** for movement relative to the fixed plates **172** and **173**. The plate **174** includes a plurality of circular perforations **175** which may be moved into registration with the openings of only one of the fixed plates **172** or **173** at a time.

FIG. **8** illustrates a position of the plate **174** such that the perforations **175** are in registration with the perforations in plate **172**. In this position, the perforations in plate **174** are out of registration with the openings of the plate **173**, thereby preventing the passage of air therethrough. It will be understood that other configurations of perforations may also be employed for the plates, as, for example, square, rectangular, and the like.

The plates above described may advantageously be constructed of rigid material, preferably of stainless steel. Plate sections of other metals, such as aluminum or the like, may also be used when corrosion will not adversely affect operation.

It may be found advantageous to construct one or more of the plates from a flexible material, in the manner illustrated in FIG. **9**. In this embodiment, the perforated plate **178** is constructed from stainless steel, while the perforated plate **180** is constructed from a flexible material, such as neoprene-covered canvas or the like. By placing the flexible plate upstream of the rigid plate section, the pressure of the air flow against the flexible plate will press it against the rigid plate, thereby minimizing the loss of air through the space between the plates. Alternatively, a felt-like material may be bonded to one side of two stainless steel plates of a pair, and between them, in order to cut down air loss and to resist corrosion.

FIG. **10** illustrates another embodiment of a sensing apparatus for use with the present control unit **181** above described for control of the temperature in room **184**. A bimetallic circuit controller **185** is mounted on the wall **187** or in some other suitable place in order to sense the temperature of air in room **184**. Such a bimetallic controller conventionally changes from one position to another in order to open or close an electrical contact (not shown). The controller **185** serves to energize and de-energize a servo motor **186** which is connected through a mechanical linkage **188** to the movable perforated plate sections **182** and **183**. Energization of the servo motor **186**, also of a conventional construction, selectively varies the alignment of the perforations in the plate sections in order to control the content of the air being supplied to room **184**.

FIGS. **11** and **12** illustrate a system utilizing the sensing device shown in FIG. **5**. In this application, the control unit **190** has perforated plate sections **191** and **192** operated in dependence upon an expandable fluid sensor **193**. Sensor **193** is disposed in an air conduit **194**. The conduit **194** is connected at one end to a wall panel box **196** having a perforated front panel **198** to allow the passage of air from a room therethrough. The other end of the air conduit **194** is connected to a junction box **200** mounted on the unit **190**. Electric power from a suitable source may be provided to energize the blower fans in the unit **190** through cables **204** and **206**.

An electrical switch **208** is remotely disposed from the unit **190** and is mounted on the perforated panel **198** in order to allow remote adjustment of the speed of the blower in unit **190**. Similarly, a temperature selector mechanism **210**, similar to that shown in FIG. **5**, in fluid communication with the expandable liquid sensor **193**, is mounted on the perforated panel **198** in order to allow remote adjustment of the temperature of the air of the room.

The wall panel box **196** ordinarily will be mounted in the space between room wall panels **212** and **214**. The end of the air conduit **194** connected to the junction box **200** is disposed upstream of the blower of the unit **190** so that room air passes through the conduit **194** and flows over the sensor **193**. If desired, the remote end of the conduit **194** may be disposed between the wall panels **212** and **214** in order to sample warm air from the room being returned to a warm air reservoir. Alternatively, the sensor **193** may be disposed in a region downstream from the blower fans of the unit **190** in order to sample the air flow to a given room.

FIG. **13** illustrates another embodiment of a suitable temperature sensor for mechanically moving perforated plates relative to one another. A housing **216** includes an inlet port **218** for entry of air whose temperature is to be sampled and further includes an annular ring **221** having outlet ports **220** for exhausting air.

A temperature sensitive device **222** contains an expandable material and may be of the type manufactured by American-Standard Controls Division, Detroit, Michigan, and sold under the name Vernatherm Valve. Unit **222** is mounted on a bracket **224**. A piston **226** is movable into and out of unit **222** in response to expansion of the material therein in response to temperature changes. A pin **228** is connected to the piston **226** and includes a threaded portion **230** adapted to connect to a rod **232**. Rod **232** is to be connected to the movable perforated plates above described. A sleeve **234** abuts a cup **236** which is biased by a spring **238**. A base cup **240** abuts the lower end of spring **238** and has a central opening through which pin **228** passes.

The base cup **240** includes a threaded section **242** which threadedly mates with threads in the annular ring **221**. Ring **221** also includes a threaded portion **244** which mates with threads in the housing **216**. The threaded portions **242** and **244** may be provided with threads of different pitch to allow for initial adjustment of the static position of the sensing device. A coarse adjustment may be made by rotation of the annular ring **221**. A fine adjustment may be made by rotation of the base member **240** relative to the ring **221**.

The sensor illustrated in FIG. **13** preferably is mounted on or near a control unit and is mechanically linked to movable perforated plates through the rod **232**. The unit of FIG. **13** may be mounted in the conduit opening into a room in order to sense the temperature of the air being supplied to the room. Alternatively, it may be mounted in or near the return paths from a room. In each of these embodiments, a mechanical linkage may connect the cup **240** to a manually operable wall-mounted actuator or control knob to allow adjustment of the set point.

Other applications of the present invention will be apparent upon consideration of FIGS. **14–17**, wherein perforated plate control according to the present invention is utilized in four different types of temperature control systems. FIG. **14** illustrates a supply grille or conduit **246** which has a rectangular frame **248** adapted to be releasably mounted in a supply opening leading to a room. A warm air supply path **250** is partially defined by a duct collar **252** having insulation **254** installed therein. A cool air supply path **256** is located beneath the warm air supply path **250** and is defined by the collar **252** and an insulated divider partition **258**.

The two air supply paths **250** and **256** are fed into the room from suitable sources through pairs of perforated plates constructed in accordance with the present invention. More particularly, an integral perforated plate **260** is rigidly mounted between the frame **248** and a bracket **262** connected to the duct collar **252**. A pair of movable perforated plates **264** and **266** are slidably disposed in a groove in the bracket **262** and are connected to the horizontally movable bar **268**. Thus, a first pair of perforated plates comprising the upper portion of plate **260** and the movable plate **264** is transversely disposed in the warm air path **250**. Similarly, a second pair of perforated plates comprising the lower portion of the fixed perforated plate **260** and the movable plate **266** is transversely disposed in the cool air supply path. The plate section pairs may thus be relatively moved, in the manner previously described, to selectively adjust the registration of the perforations in adjacent plates to control the mixture of warm and cool air which is supplied to the room.

The force for moving bar **268** is provided by the power unit **270**, which may, for instance, be of the expandable fluid or material type previously described. Pressure resulting from fluid expansion in the power unit **270** acts upon the head **272** of a rod **274**. A spring **276** biases the head **272** against the bottom of the lower housing **278** of the power unit. The lower end of rod **274** is connected to a threaded member **280** by adjusting nut **282** in order to allow initial adjustment of the position of the perforated plates. The threaded member **280** is connected to a projection **284** from bar **268** by a plurality of screws **286**. The frame **248** and the fixed perforated plate **260** are thus made to be easily removed for maintenance purposes. More particularly, screws **286** are disposed to be easily accessible upon the removal of frame **248** and plate **260** to allow the movable plates **264** and **266** to be removed for servicing.

FIG. **15** illustrates the use of perforated plates in a temperature control system wherein cool air is forced into a room through a nozzle **288** and a duct **290**. Return air from a warm air plenum may be selectively mixed with the cool air by means of a venturi type action created by the flow of air through the nozzle **288**. This venturi action induces flow of warm air into the duct **290** through the perforated plate pairs **292** and **294**.

The perforated plate pairs include a horizontally slidable plate **296** which is transversely disposed across both of the warm return air paths and also across the cool air supply path. Plate **296** is connected to a guide bracket **298** which is horizontally slidably mounted upon a frame member **300** which rigidly connects nozzle **288** to the front duct frame **301**. A power unit **302** is connected to move the rod **304**, which in turn moves a projecting member **306** and bar **298**.

A perforated plate **308** is mounted in the duct **290** adjacent to the movable perforated plate **296**. The fixed perforated plate **308** may comprise a unitary plate having a predetermined pattern of aligned perforations at the top and the bottom portions of the plate which are disposed adjacent the movable plates **292** and **294**, and a pattern of horizontally offset perforations in the middle portion of the plate which is disposed transversely across the opening of the nozzle **288**.

Alternatively, the movable plate **296** may comprise three sheets mounted adjacent to each other, with the perforations of the top and bottom plate sections being aligned and the perforations of the middle plate being horizontally offset. In either embodiment, it will now be apparent that when the movable perforated plate **296** is horizontally translated in response to changes of air temperature in the room to be conditioned, the proportion of cool air supplied through the duct **290** may be selectively modulated in one sense while the proportion of warm return air is concurrently modulated in the opposite sense.

FIG. **16** illustrates another type of temperature control system **310**, generally known as a double duct constant volume system. Warm air under a high pressure is fed through the supply inlet **312** into the housing **314**, while cool air under high pressure is supplied through the inlet **316**. A partition **318** divides the air supply paths inside the front portion of the housing **314**. The warm and the cool air are then mixed in the back portions of the housing **314** in proportions determined by transversely disposed perforated plates **320** and **322**. The plate **322** is rigidly connected to the housing **314**. Plate **320** is movable in response to movements of the temperature sensitive power unit **324**. The power unit **324** moves the movable plate **320** by means of a projection **326** mounted on a transversely disposed bar **328** rigidly connected to plate **320**. The bar **328** is slidable through a slot **330** in the partition **318**.

The perforated plates are supported by a spacer member **332** which has provisions to allow a sliding movement of the plate **320**. The perforations in the movable plate disposed in the warm air supply path are horizontally offset with respect to the perforations in the movable plate disposed in the cool air supply path. This allows the proportion of air supplied to the room by the warm air supply path to be selectively increased while concurrently the proportion of air supplied to the room by the cool air supply path is decreased, or vice versa.

FIG. **17** illustrates the use of the present invention in a temperature control system commonly termed a high velocity induction unit. In this system, a bypass control simultaneously modulates the amount of return room air which passes over heating or cooling coils and the amount of return room air bypassed around the coils. For example, in the illustrated system of FIG. **17**, return room air is induced to flow through a grille **333** and then through perforated plate units **334** and **336**. Air flow through plates **334** bypasses the heating or cooling coils in zone **337**. A baffle **338** separates the two flows of air. Air passing through plates **336** contacts the heat exchange elements in zone **337**. The perforated plate pairs are constructed in a manner similar to the units previously described, with a slidable plate **340** being connected to a bracket **342** which is horizontally moved by a power unit **343**. The bracket **342** slides along an edge portion of the baffle **338**. A fixed plate **344** is connected to the frame **346**.

It will be understood from the embodiments previously described that the perforations of one perforated plate section in each of the perforated plate pairs **334** and **336** are horizontally offset with respect to one another so that the proportion of room air return supplied through one path may be concurrently increased while the proportion of room air return supplied through the second path is concurrently decreased.

Whereas the present specification has been described in considerable detail with respect to several embodiments, it is to be understood that this description is merely for purposes of illustration and that changes or variations in the described embodiments may be made by persons skilled in the art without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. In a system for control of air in a room having a supply opening leading thereto, the combination which comprises:
   a. a powered mixing box adapted to be mounted adjacent to said supply opening for directing air through said supply opening into said room;
   b. said powered mixing box having a first inlet opening, a second inlet opening, and an outlet opening,
   c. a first structure forming a warm air supply path leading to said first inlet opening of said powered mixing box;
   d. a second structure forming a cool air supply path leading to said second inlet opening of said powered mixing box;
   e. a first pair of plates, at least one of which is perforated;
   f. said first pair of plates being mounted so they are always immediately adjacent said first inlet opening and are transversely disposed in, and substantially normal to, said warm air supply path;
   g. a second pair of plates, at least one of which is perforated;
   h. said second pair of plates being mounted so they are always immediately adjacent said second inlet opening and are transversely disposed in, and substantially normal to, said cool air supply path;
   i. means interconnecting one plate of each pair for moving one plate of said first pair relative to the other in a first sense while moving one plate of said second pair relative to the other in a second sense to increase the proportion of air supplied to said powered mixing box through one air supply path while concurrently decreasing the proportion of air supplied to said powered mixing box through the other air supply path;
   j. said outlet opening being located in one wall of said powered mixing box and both of said inlet openings being displaced short distances from said one wall of said powered mixing box to define a space which is wholly within said powered mixing box and which is bounded by said outlet opening and by said pairs of perforated plates, and

k. a fan that is mounted in said space within said powered mixing box and that is immediately adjacent to said pairs of plates;

l. said fan being disposed within said space within said powered mixing box but being located downstream from said plates of said first pair of plates and also being located downstream from said plates of said second pair of plates,

m. said fan receiving warm air from said warm air supply path via said first inlet opening and said first pair of plates and receiving cool air from said cool air supply path via said second inlet opening and said second pair of plates and mixing said warm air and cool air and then moving said mixed air through said outlet opening and into said room through said supply opening.

2. The combination set forth in claim **1** wherein said first inlet opening is located in a second wall of said powered mixing box, wherein said second inlet opening is located in a third wall of said powered mixing box, wherein said second and said third walls abut each other to subtend an angle of substantially ninety degrees, whereby said pairs of plates are disposed relative one to another at an angle of substantially ninety degrees, and wherein three sides of said space within said powered mixing box are defined and delimited by said one and said second and said third walls of said powered mixing box.

3. A system for controlling the temperatures within a plurality of rooms which comprises:

a. a plenum forming a cold air reservoir common to said plurality of rooms,

b. means including an air unit having the outlet thereof connected to said plenum for supplying and creating flow of cold air into said cold air reservoir,

c. a second plenum common to said plurality of rooms,

d. structure connecting each of said rooms with said second plenum to permit return air from said rooms to enter said second plenum,

e. said air unit having the inlet thereof connected to said second plenum to receive said return air from said rooms via said second plenum,

f. a plurality of separate air drive means opening into said rooms,

g. each of said air drive means having a first inlet for receiving warm air, a second inlet connected to the first said plenum for receiving cold air from said cold air reservoir, a fan, a proportioning damper between said inlets and said fan, and an outlet for mixed air,

h. said proportioning damper varying the proportions of warm air and cold air which said fan draws through said first and second inlets, respectively, and then discharges through said mixed air outlet,

i. the first said plenum being substantially larger in cross section than the discharge outlet of said air unit, and being substantially larger in cross section than the second inlet of any of said separate air drive means, whereby the first said plenum holds a large volume of cold air immediately available to said separate air drive means,

j. said second plenum being substantially larger in cross section than said inlet of said air unit, whereby said second plenum holds a large volume of return air immediately available to said air unit, and

k. means responsive to the temperature of air in a given room for control of the position of said proportioning damper, in said air drive means for said room, to determine the relative proportions of warm and cold air introduced into said room by its air drive means.

4. A system for controlling the temperatures within a plurality of rooms which comprises:

a. a plenum forming a cold air reservoir common to said plurality of rooms,

b. means including an air unit having the outlet thereof connected to said plenum for supplying and creating flow of cold air into said cold air reservoir,

c. a second plenum common to said plurality of rooms,

d. structure connecting each of said rooms with said second plenum to permit return air from said rooms to enter said second plenum,

e. said air unit having the inlet thereof connected to said second plenum to receive said return air from said rooms via said second plenum,

f. a plurality of separate air drive means opening into said rooms,

g. each of said air drive means having a first inlet for receiving warm air, a second inlet connected to the first said plenum for receiving cold air from said cold air reservoir, a fan, a proportioning damper between said inlets and said fan, and an outlet for mixed air,

h. said proportioning damper varying the proportions of warm air and cold air which said fan draws through said first and second inlets, respectively, and then discharges through said mixed air outlet,

i. the first said plenum being substantially larger in cross section than the discharge outlet of said air unit, and being substantially larger in cross section than the second inlet of any of said separate air drive means, whereby the first said plenum holds a large volume of cold air immediately available to said separate air drive means,

j. said second plenum being substantially larger in cross section than said inlet of said air unit, whereby said second plenum holds a large volume of return air immediately available to said air unit,

k. means responsive to the temperature of air in a given room for control of the position of said proportioning damper, in said air drive means for said room, to determine the relative proportions of warm and cool air introduced into said room by its air drive means,

l. the first said plenum and said second plenum being horizontally directed,

m. one of said plenums being located immediately above the other of said plenums,

n. the lower limit of said one plenum and the upper limit of said other plenum being defined and delimited by a horizontally-directed partition means,

o. the return air flow through said second plenum being in one direction relative to said rooms, and

p. the cold air flow through said one plenum being in the opposite direction relative to said rooms.

5. A system for controlling the temperatures within a plurality of rooms which comprises:

a. a plenum forming a cold air reservoir common to said plurality of rooms,

b. means including an air unit having the outlet thereof connected to said plenum for supplying and creating flow of cold air into said cold air reservoir,

c. a second plenum common to said plurality of rooms,

d. structure connecting each of said rooms with said second plenum to permit return air from said rooms to enter said second plenum,

e. said air unit having the inlet thereof connected to said second plenum to receive said return air from said rooms via said second plenum,

f. a plurality of separate air drive means opening into said rooms,

g. each of said air drive means having a first inlet for receiving warm air, a second inlet connected to the first said plenum for receiving cold air from said cold air reservoir, a fan, a proportioning damper between said inlets and said fan, and an outlet for mixed air,

h. said proportioning damper varying the proportions of warm air and cold air which said fan draws through said first and second inlets, respectively, and then discharges through said mixed air outlet,

i. the first said plenum being substantially larger in cross section than the discharge outlet of said air unit, and being substantially larger in cross section than the second inlet of any of said separate air drive means, whereby the first said plenum holds a large volume of cold air immediately available to said separate air drive means,

j. said second plenum being substantially larger in cross section than said inlet of said air unit, whereby said second plenum holds a large volume of return air immediately available to said air unit,

k. means responsive to the temperature of air in a given room for control of the position of said proportioning damper, in said air drive means for said room, to determine the relative proportions of warm and cool air introduced into said room by its air drive means,

l. a warm air reservoir located above, but common to, said rooms, and

m. connecting means for permitting warm air flow from said warm air reservoir into said first inlets of said air drive means through said connecting means.

6. An atmosphere control system for a building having a plurality of rooms which comprises:

a. a cooling unit that includes a blower which can supply quantities of cooled air,

b. structural elements of said building which define and delimit parts of rooms of said building and which also define and delimit part of a large cross section plenum that extends from a point adjacent said cooling unit to the immediate proximity of said rooms,

c. the outlet of said blower of said cooling unit being connected to said plenum for feeding cool air into said plenum from said cooling unit, and said plenum conducting said cool air to the immediate proximity of said rooms,

d. a plurality of air-mixing boxes,

e. said air-mixing boxes being disposed adjacent said rooms, and each of said air-mixing boxes having structure forming two inlet ports, a fan mounted between said inlet ports and a discharge port leading to a room,

f. said fan in said air-mixing box acting to move air from said inlet ports to and through said discharge port and thence into said room,

g. a cool air flow path between said plenum and one of said inlet ports of each said air-mixing box to conduct cool air from said plenum to said one inlet port,

h. further structural elements of said building which define and delimit parts of rooms of said building and which also define and delimit part of a second large cross section plenum that extends from the immediate proximity of said rooms to a point adjacent said cooling unit,

i. the inlet of said blower of said cooling unit being connected to said second plenum,

j. a warm air flow path from each said room to a second of said inlet ports of said air-mixing box feeding said room to conduct air from said room to said second inlet port,

k. structure forming flow paths from said rooms to said second plenum to include return air from said rooms in the air flowing through said second plenum,

l. said second plenum conducting return air from said rooms to said cooling unit and thereby enabling said cooling unit to cool return air from said rooms and to include the cooled return air in the air which said cooling unit supplies to the first said plenum,

m. temperature responsive means in said rooms, and

n. proportioning damper means in each said air-mixing box between the inlet ports thereof and the fan therein to vary the relative amounts of cooled air entering each air-mixing box from the first said plenum and the amounts of air entering each air-mixing box from the room.

7. An atmosphere control system for a building having a plurality of rooms which comprises:

a. a powered cooler for supplying quantities of cool air,

b. means which define and delimit an air-distributing passage that extends from a point adjacent said powered cooler to the immediate proximity of said rooms,

c. the outlet of said powered cooler being connected to said air-distributing passage for feeding cool air into said air-distributing passage from said powered cooler, and said air-distributing passage conducting said cool air to the immediate proximity of said rooms,

d. a plurality of air-mixing boxes,

e. said air-mixing boxes being disposed adjacent to said rooms and each of said air-mixing boxes having structure forming two inlet ports, a fan mounted between said inlet ports and a discharge port leading to a room,

f. said fan in said air-mixing box acting to move air from said inlet ports to and through said discharge port and thence into said room,

g. a cool air flow path between said air-distributing passage and one of said inlet ports of each said air-mixing box to conduct cool air from said air-distributing passage to said one inlet port,

h. a warm air flow path from each said room to a second of said inlet ports of said air-mixing box feeding said room to conduct air from said room to said second inlet port,

i. structure forming a return flow path from said rooms to the inlet of said powered cooler to enable said powered cooler to receive and cool return air from said rooms and to incorporate the cooled return air in the air which said powered cooler supplies to said air-distributing passage,

j. temperature responsive means in said rooms,

k. a proportioning damper in each said air-mixing box between the inlet ports thereof and the fan therein to vary the relative amounts of air entering each air-mixing box from said air-distributing passage and the amounts of air entering each air-mixing box from the room, and

l. means providing a continuously-open path which extends from the outlet of said powered blower to the inlet of said powered blower,

m. said continuously-open path means conducting substantially all of the air, supplied by said powered blower, from said outlet of said powered blower to said inlet of said powered blower whenever all of said proportioning dampers in all of said air-mixing boxes are closed and act to prevent air in said air-distributing passage from entering said air-mixing boxes,

n. thereby preventing any build-up of pressure within said air-distributing passage,

o. said continuously-open path means conducting progressively less of the air, supplied by said powered blower, from said outlet of said powered blower to said inlet of said powered blower as said proportioning dampers in said air-mixing boxes respond, to said temperature responsive means in said rooms, to progressively permit air from said air-distributing passage to enter said air-mixing boxes.

8. An atmosphere control system for a building having a plurality of rooms which comprises:

a. a powered cooler for supplying quantities of cool air,

b. means which define and delimit an air-distributing passage that extends from a point adjacent said powered cooler to the immediate proximity of said rooms,

c. the outlet of said powered cooler being connected to said air-distributing passage for feeding cool air into said air-distributing passage from said powered cooler, and said air-distributing passage conducting said cool air to the immediate proximity of said rooms,

d. a plurality of powered air-mixing boxes,

e. said air-mixing boxes being disposed adjacent to said rooms and each of said air-mixing boxes having structure forming two inlet ports, a fan mounted between said inlet ports and a discharge port leading to a room,

f. said fan in said air-mixing box acting to move air from said inlet ports to and through said discharge port and thence into said room,

g. a cool air flow path between said air-distributing passage and one of said inlet ports of each said air-mixing box to conduct cool air from said air-distributing passage to said one inlet port,

h. a warm air flow path from each said room to a second of said inlet ports of said air-mixing box feeding said room to conduct air from said room to said second inlet port,

i. structure forming a return flow path from said rooms to said powered cooler to enable said powered cooler to cool return air from said rooms and to include the cooled return air in the air which said powered cooler supplies to said airrdistributing passage,

j. temperature responsive means in said rooms,

k. a proportioning damper in each said air-mixing box between the inlet ports thereof and the fan therein to vary the relative amounts of air entering each air-mixing box from said air-distributing passage and the amounts of air entering each air-mixing box from the room,

l. continuously-open passages interconnecting said rooms with said return air structure,

m. means providing a continuously-open path between said air-distributing passage and said return air structure,

n. said continuously-open passages between said rooms and said return air structure and said continuously-open path means coacting to connect said rooms with said air-distributing passage via said return air structure,

o. whereby said rooms are connected to said air-distributing passage both by said air-mixing boxes and by said continuously-open path means and the continuously-open passages which interconnect said air return structure with said rooms.

9. An atmosphere control system for a building having a plurality of rooms which comprises:

a. a cooling unit that includes a blower which can supply quantities of cooled air,

b. structural elements of said building which define and delimit parts of rooms of said building and which also define and delimit part of a large cross section plenum that extends from a point adjacent said cooling unit to the immediate proximity of said rooms,

c. the outlet of said blower of said cooling unit being connected to said plenum for feeding cool air into said plenum from said cooling unit, and said plenum conducting said cool air to the immediate proximity of said rooms,

d. a plurality of air-mixing boxes,

e. said air-mixing boxes being disposed adjacent said rooms, and each of said air-mixing boxes having structure forming two inlet ports, a fan mounted between said inlet ports and a discharge port leading to a room,

f. said fan in said air-mixing box acting to move air from said inlet ports to and through said discharge port and thence into said room,

g. a cool air flow path between said plenum and one of said inlet ports of each said air-mixing box to conduct cool air from said plenum to said one inlet port,

h. further structural elements of said building which define and delimit parts of rooms of said building and which also define and delimit part of a second large cross section plenum that extends from the immediate proximity of said rooms to a point adjacent said cooling unit,

i. the inlet of said blower of said cooling unit being connected to said second plenum,

j. a warm air flow path from each said room to a second of said inlet ports of said air-mixing box feeding said room to conduct air from said room to said second inlet port,

k. structure forming flow paths from said rooms to said second plenum to include return air from said rooms in the air flowing through said second plenum,

l. said second plenum conducting return air from said rooms to said cooling unit and thereby enabling said cooling unit to cool return air from said rooms and to include the cooled return air in the air which said cooling unit supplies to the first said plenum,

m. temperature responsive means in said rooms,

n. proportioning damper means in each said air-mixing box between the inlet ports thereof and the fan thereinto vary the relative amounts of cooled air entering each air-mixing box from the first said plenum and the amounts of air entering each air-mixing box from the room,

o. the first said plenum and said second plenum being horizontally-directed,

p. one of said plenums being located immediately above the other of said plenums,

q. the lower limit of said one plenum and the upper limit of said other plenum being defined and delimited by a horizontally-directed partition means,

r. the return air flow through said second plenum being in one direction relative to said rooms, and

s. the cold air flow through said one plenum being in the opposite direction relative to said rooms.

10. An atmosphere control system for a building having a plurality of rooms which comprises:

a. a cooling unit that includes a blower which can supply quantities of cooled air,

b. structural elements of said building which define and delimit parts of rooms of said building and which also define and delimit part of a large cross section plenum that extends from a point adjacent said cooling unit to the immediate proximity of said rooms,

c. the outlet of said blower of said cooling unit being connected to said plenum for feeding cool air into said plenum from said cooling unit, and said plenum conducting said cool air to the immediate proximity of said rooms,

d. a plurality of air-mixing boxes,

e. said air-mixing boxes being disposed adjacent said rooms, and each of said air-mixing boxes having structure forming two inlet ports, a fan mounted between said inlet ports and a discharge port leading to a room,

f. said fan in said air-mixing box acting to move air from said inlet ports to and through said discharge port and thence into said room,

g. a cool air flow path between said plenum and one of said inlet ports of each said air-mixing box to conduct cool air from said plenum to said one inlet port,

h. further structural elements of said building which define and delimit parts of rooms of said building and which also define and delimit part of a second large cross section plenum that extends from the immediate proximity of said rooms to a point adjacent said cooling unit,

i. the inlet of said blower of said cooling unit being connected to said second plenum,

j. a warm air flow path from each said room to a second of said inlet ports of said air-mixing box feeding said room to conduct air from said room to said second inlet port,

k. structure forming flow paths from said rooms to said second plenum to include return air from said rooms in the air flowing through said second plenum,

l. said second plenum conducting return air from said rooms to said cooling unit and thereby enabling said cool-ing unit to cool return air from said rooms and to include the cooled return air in the air which said cooling unit supplies to the first said plenum,

m. temperature responsive means in said rooms,

n. proportioning damper means in each said air-mixing box between the inlet ports thereof and the fan therein to vary the relative amounts of cooled air entering each air-mixing box from the first said plenum and the amounts of air entering each air-mixing box from the room,

o. the first said plenum being located between said rooms,

p. the first said structural elements being the upper portions of confronting walls of said rooms plus a horizontally-directed ceiling extending between said upper portions of said confronting walls, and

q. a lower ceiling defining the bottom of the first said plenum.

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