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(54) **INDOOR ENVIRONMENTAL PARAMETER BALANCING APPARATUS AND METHOD TO DO THE SAME**

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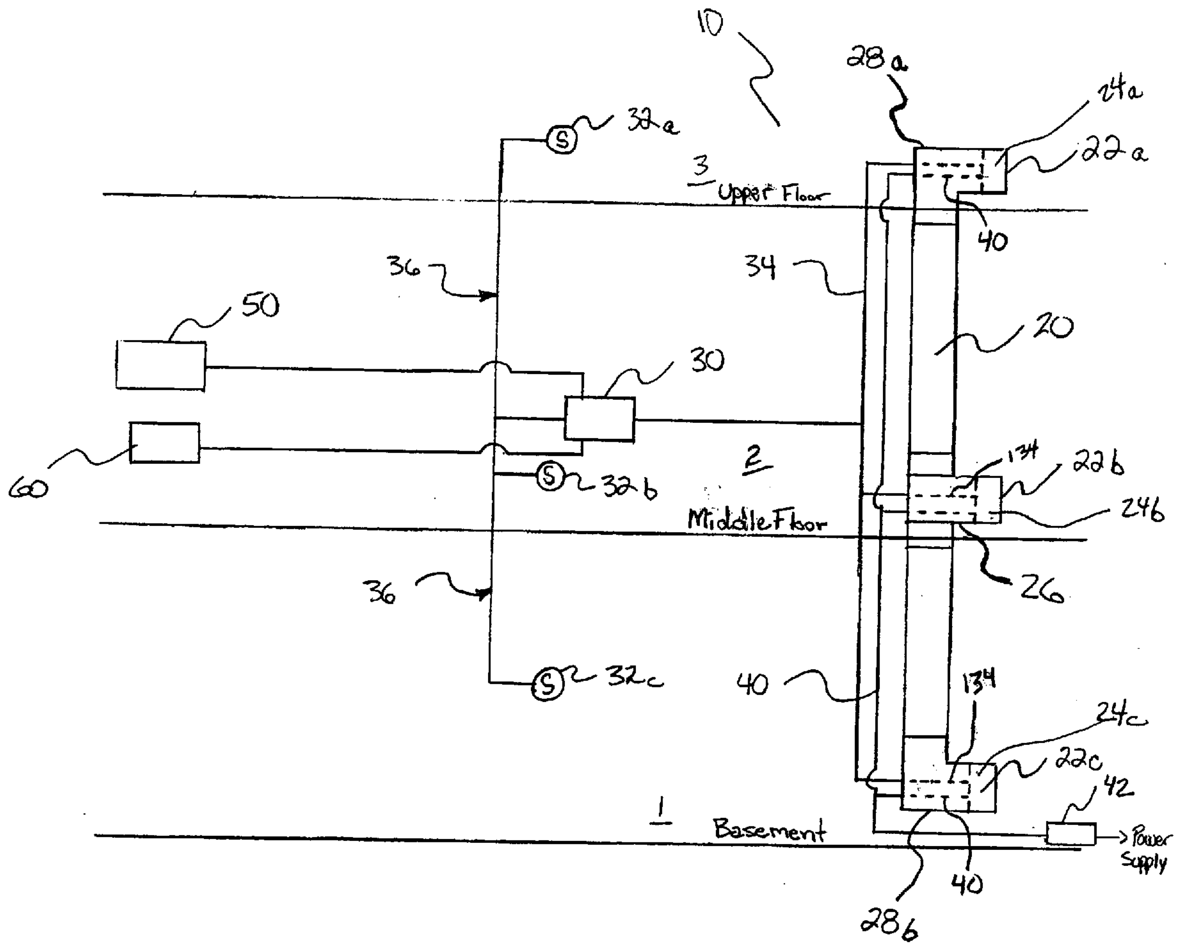
(57) **ABSTRACT**

An indoor environmental balancing apparatus and method for a structure that includes a plenum, a plurality of openings disposed within the plenum and in communication with a plurality of indoor spaces, a fan in communication with the plenum and the plurality of openings, a plurality of sensors disposed within the plurality of indoor spaces and configured to measure an environmental parameter of the plurality of indoor spaces, and a controller configured to monitor the plurality of sensors and respond to a differential in the measured environmental parameter between two or more of the plurality of indoor spaces by operating the fan to move air between the plurality of indoor spaces to bring the differential into equilibrium.



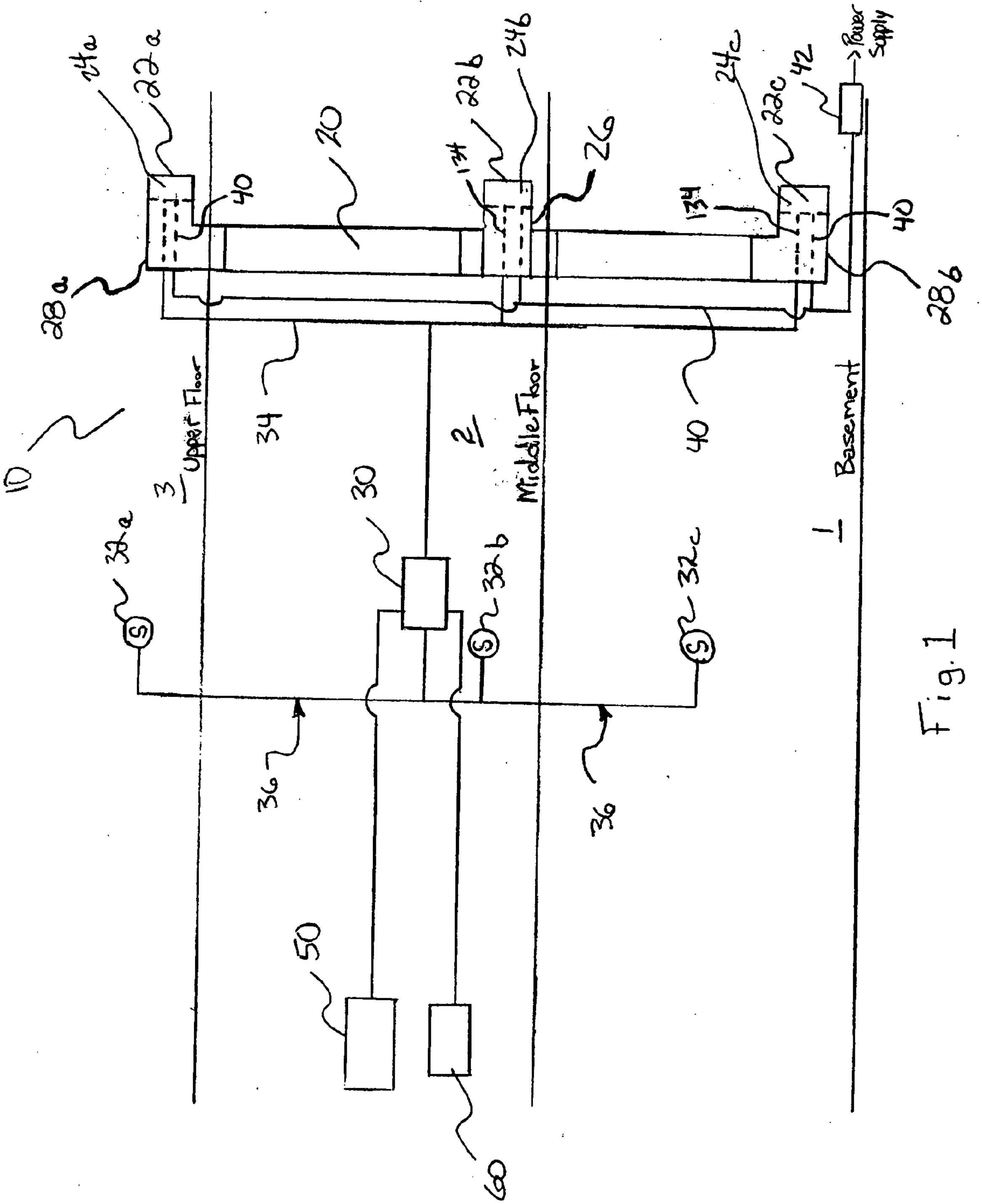

10
Upper Floor
Middle Floor
Basement
Power Supply
3
2
1
20
22a
22b
22c
24a
24b
24c
26
28a
28b
30
32a
32b
32c
34
36
40
42
50
60
134

Fig. 1

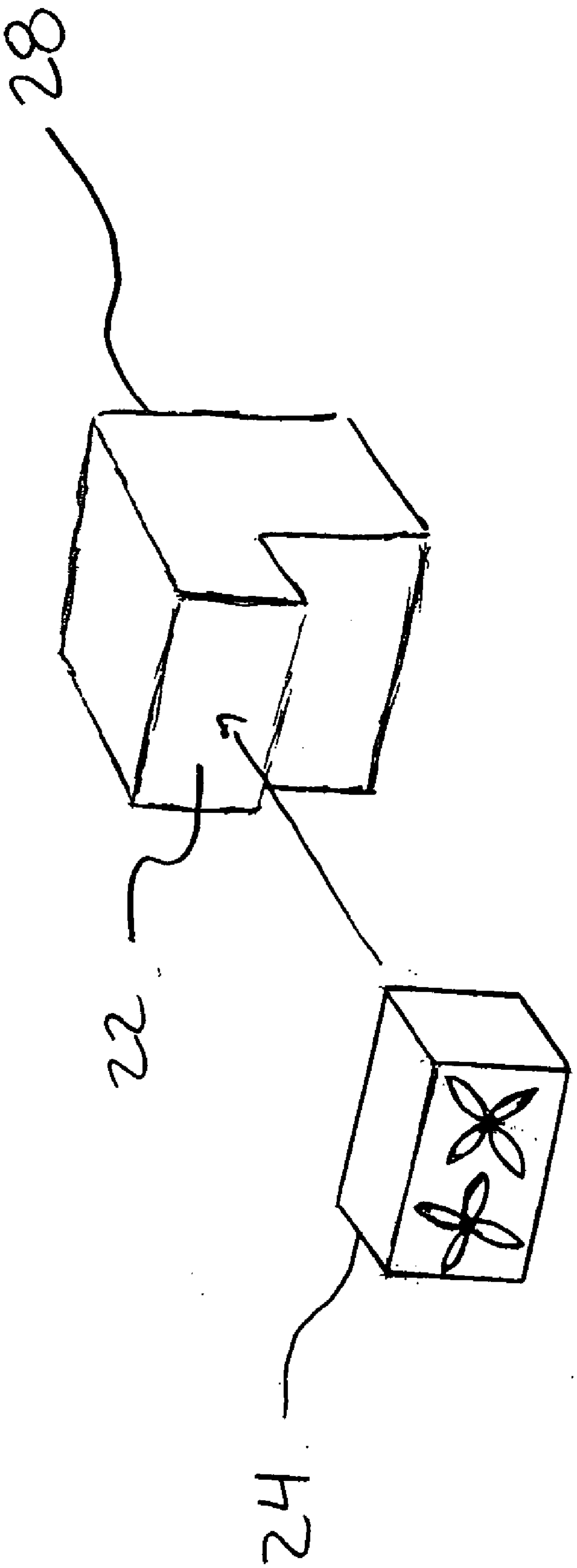


Fig. 2

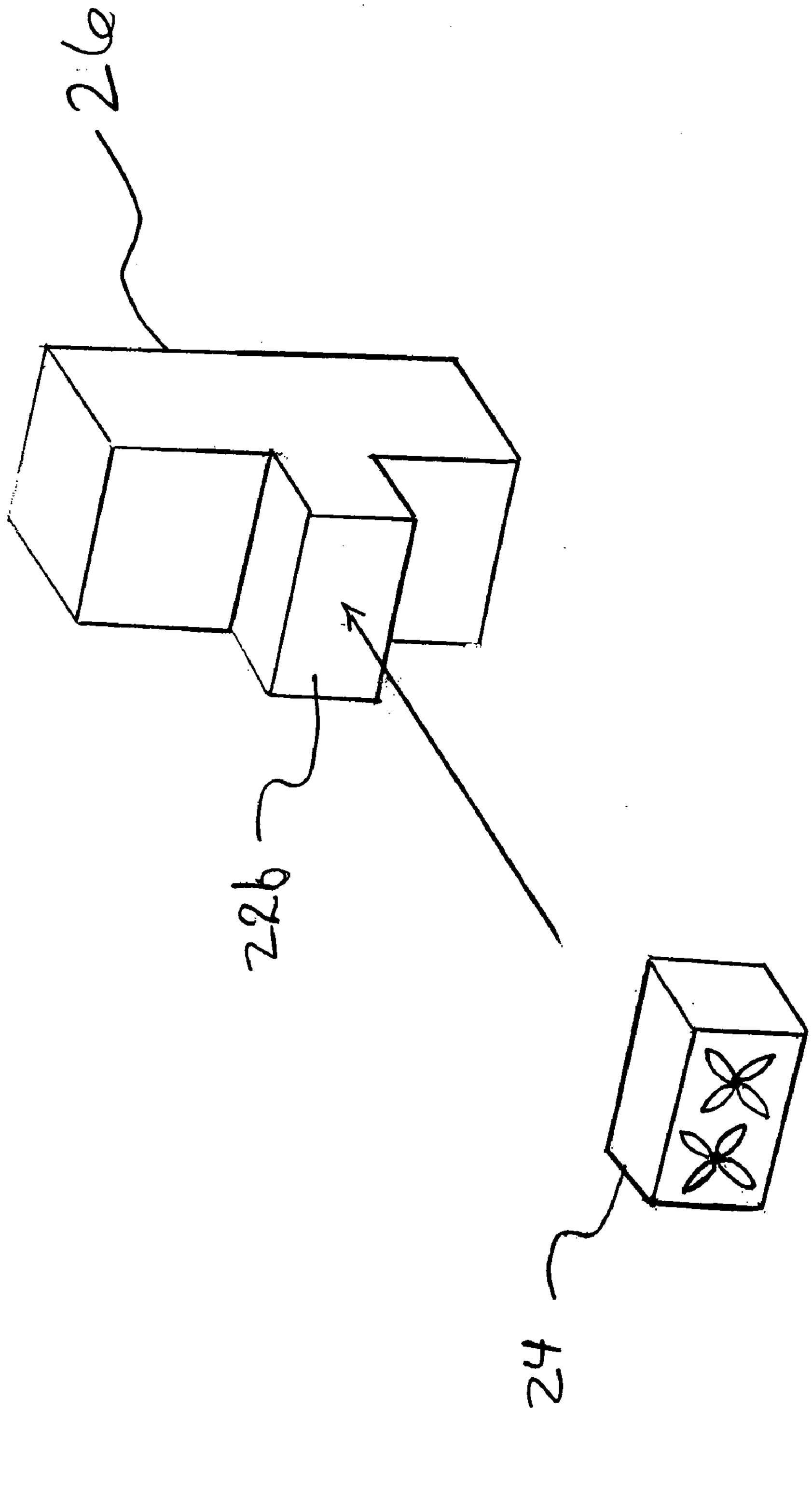


Fig. 3

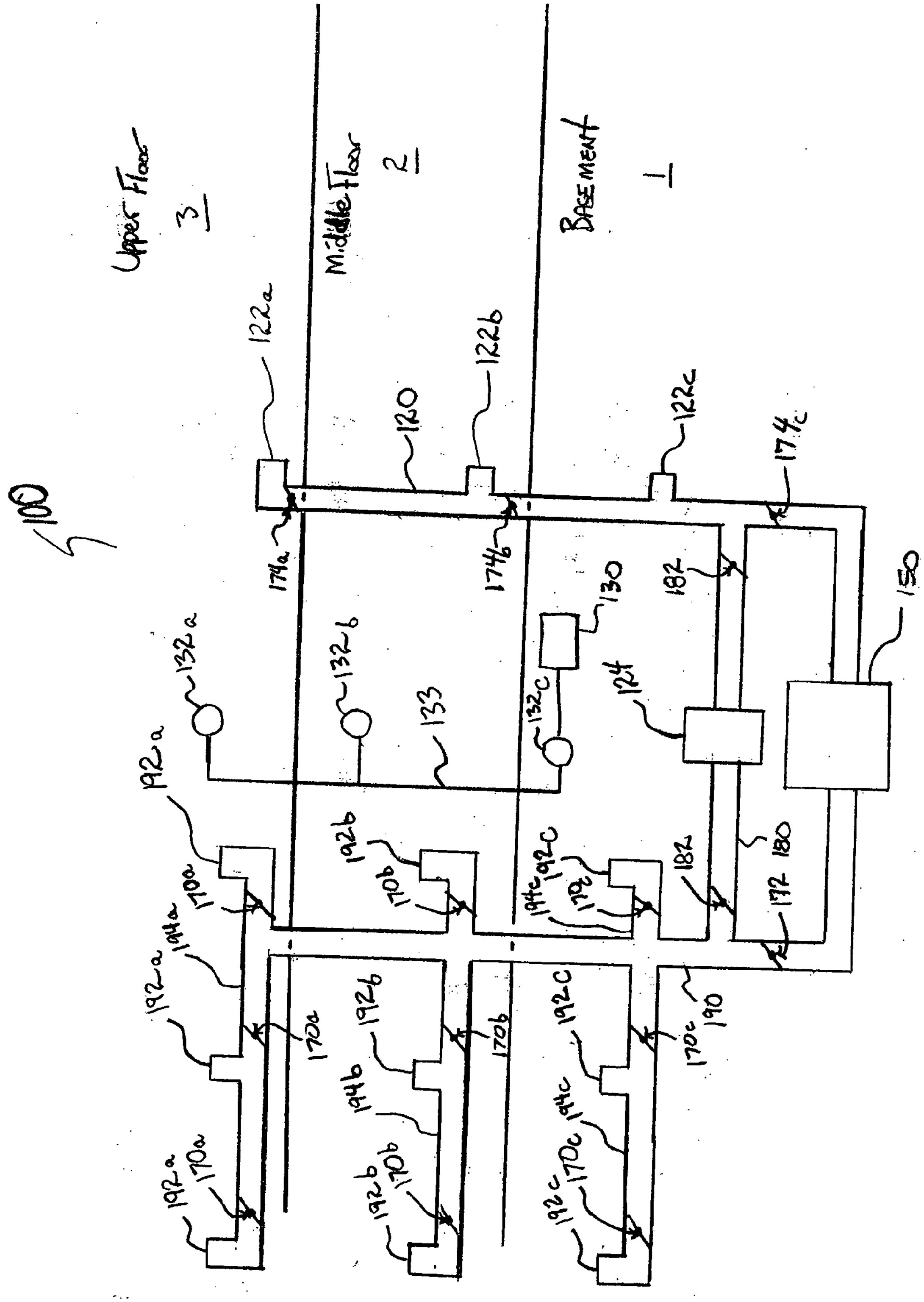

100
Upper Floor
3
Middle Floor
2
Basement
1
122a
122b
122c
120
174a
174b
174c
182
130
150
124
132a
132b
132c
133
192a
192b
192c
170a
170b
170c
194a
194b
194c
172
180
190

Fig. 4

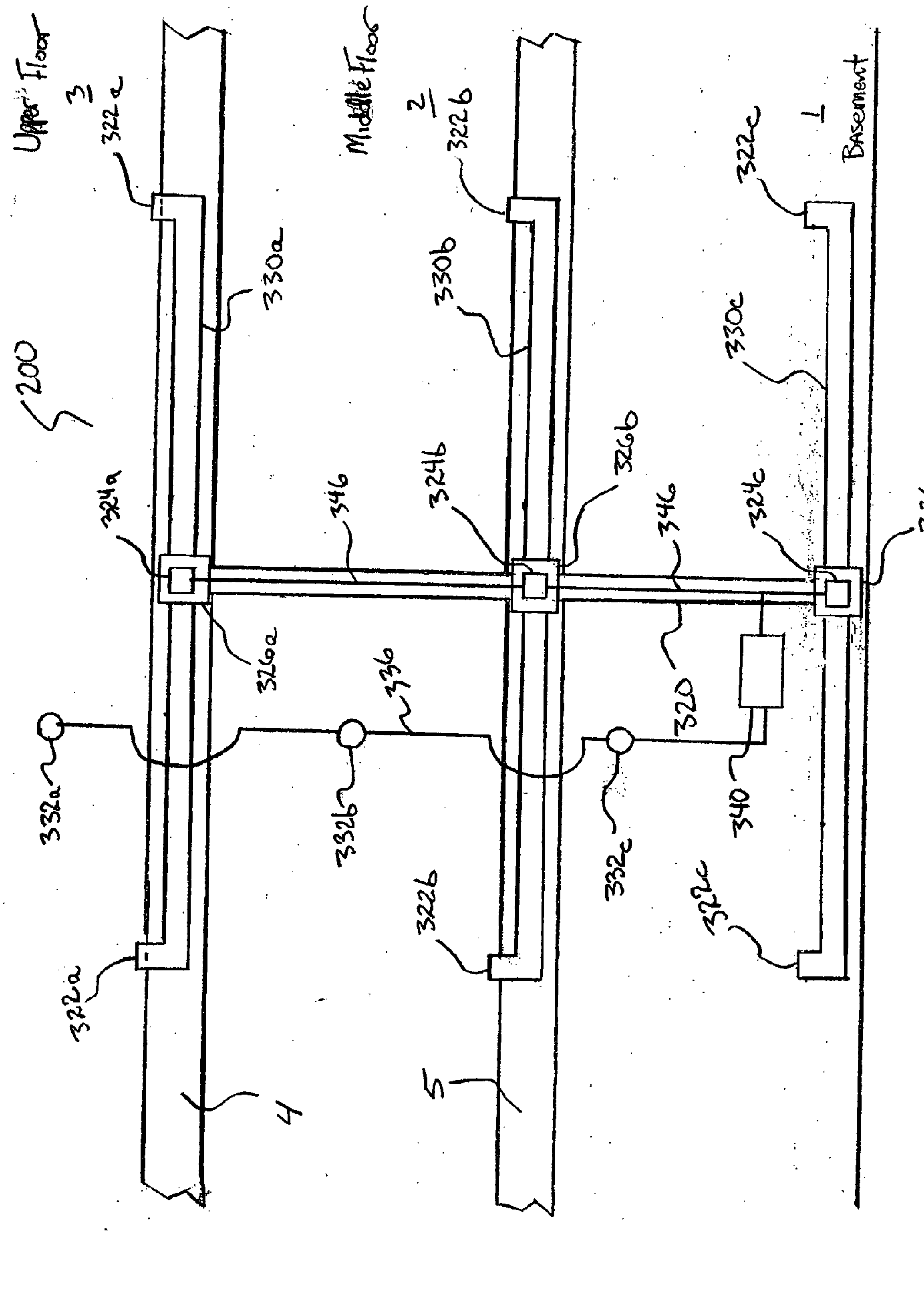

Upper Floor
3
Middle Floor
2
Basement
1
200
322a
322b
322c
330a
330b
330c
324a
324b
324c
326a
326b
326c
346
346
320
336
340
332a
332b
332c
4
5

Fig. 5

INDOOR ENVIRONMENTAL PARAMETER BALANCING APPARATUS AND METHOD TO DO THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of prior-filed U.S. Provisional Patent Application Ser. No. 60/626,849, filed Nov. 10, 2004, the subject matter of which is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention is direction to an apparatus and method that balances thermal load and other indoor environmental differentials between floors, rooms, and/or other spaces of a structure. More particularly, the present invention is directed to an apparatus and method that provides an apparatus that balances indoor environmental parameters such as temperatures and/or humidity between floors or rooms of a structure such as a home or commercial facility.

BACKGROUND OF THE INVENTION

[0003] A common climate control problem in multi-story or multi-room structures is the noticeable temperature differential between floors or rooms of the structure. For example, many are familiar with the effect of outside weather on a residential home having an upstairs, wherein the upstairs too warm in summer and/or too warm in the winter because the all the heat rises and accumulates in the upper level of the home. In addition, the multi-level home may have a downstairs that is too cold in winter. Various heating, ventilation, and air conditioning ("HVAC") system solutions have been implemented to attempt to solve this temperature imbalance between multiple floors or rooms.

[0004] For example, in the residential home market, some have attempted to solve this issue by installing dual power plants, e.g., placing one on each floor or zone. However, this solution is not only relatively expensive, but also requires sufficient space to install two HVAC units within the structure (e.g., a home). Others have attempted to solve this issue by using sophisticated, zoned HVAC systems. However, the complexity of these systems also makes them relatively expensive. Both attempted solutions, due to the relatively high implementation costs, make them affordable only in the high-end residential home and commercial market.

SUMMARY OF THE INVENTION

[0005] Accordingly, the present invention is intended to address and obviate problems and shortcomings and otherwise improve previous apparatus and methods used in an attempt to try and balance environmental parameters within a structure.

[0006] One exemplary embodiment of the present invention is an indoor environmental balancing apparatus for a structure that includes a plenum, a plurality of openings disposed within the plenum and in communication with a plurality of indoor spaces, a fan in communication with the plenum and the plurality of openings, a plurality of sensors disposed within the plurality of indoor spaces and configured to measure an environmental parameter of the plurality of indoor spaces, and a controller configured to monitor the plurality of sensors and respond to a differential in the measured environmental parameter between two or more of the plurality of indoor spaces by operating the fan to move air between the plurality of indoor spaces to bring the differential into equilibrium.

[0007] Another exemplary embodiment of the present invention is an indoor temperature balancing apparatus for a structure that includes plenum, first and second openings disposed within the plenum and in communication with respective first and second indoor spaces of a structure, a fan in communication with the plenum and the first and second openings, a first sensor disposed within the first indoor space and configured to measure a first temperature of the first indoor space, a second sensor disposed within the second indoor space and configured to measure a second temperature of the second indoor space, and a controller configured to monitor the first and second sensors and respond to a differential between the first and second temperatures by operating the fan to move air between the first and second indoor spaces to bring the differential between the first and second temperatures into equilibrium.

[0008] Still another exemplary embodiment of the present invention is a method of balancing the indoor temperature for a structure that includes monitoring temperatures of a first indoor space and a second indoor space, detecting a differential in the temperatures between the first and second indoor spaces, drawing air into a plenum from the first indoor space, transporting the air within the plenum, exhausting the air from the plenum into the second indoor space, detecting that the differential in the temperatures between the first and second indoor spaces is equalized, and stopping the drawing of the air into the plenum from the first space.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] While the specification concludes with claims particularly pointing out and distinctly claiming the invention, it is believed the same will be better understood from the following description taken in conjunction with the accompanying drawings in which:

[0010] **FIG. 1** is a schematic representation of an exemplary embodiment of the environmental balancing apparatus according to the present invention;

[0011] **FIG. 2** is a perspective view of an exemplary embodiment of a L-Shaped end cap shown in **FIG. 1**;

[0012] **FIG. 3** is a perspective view of an exemplary embodiment of a T-Shaped unit shown in **FIG. 1**;

[0013] **FIG. 4** is a schematic representation of another exemplary embodiment of the environmental balancing apparatus according to the present invention; and

[0014] **FIG. 5** is a schematic representation of another exemplary embodiment of the environmental balancing apparatus according to the present invention.

[0015] The embodiments set forth in the drawings are illustrative in nature and not intended to be limiting of the invention defined by the claims. Moreover, individual features of the drawings and the invention will be more fully apparent and understood in view of the detailed description.

DETAILED DESCRIPTION OF THE INVENTION

[0016] The apparatus and method of the present invention provides an environmental parameter balancing apparatus and method of using the same that is configured to measure and monitor an environmental parameter such as the temperature of multiple indoor spaces of a structure, to detect and/or determine that there is a differential in the environmental parameter between the multiple indoor spaces, and to operate a fan to transport air between the multiple indoor spaces in order to equalize the differential between the multiple indoor spaces. The environmental parameter balancing apparatus may be designed for any type of structure, including but not limited to residential structures (e.g., homes, garages, etc.), commercial structures, and/or industrial structures. In addition, the indoor spaces within such structures may be rooms, entire levels such as floors, and any other type of indoor spaces as known to one of ordinary skill in the art.

[0017] The environmental parameter balancing apparatus may be installed as a supplemental system, either separate from or interconnected to, the structure's heating, ventilation, and cooling ("HVAC") system. Supplemental ventilation system, as used herein, is defined as a ventilation system that may operate independently from a structure's HVAC system. It is also understood that the environmental parameter balancing apparatus may also be an integral part of a structure's HVAC system without departing from the spirit and scope of the present invention.

[0018] An exemplary embodiment of the environmental parameter balancing apparatus is shown in **FIGS. 1-3** as **10**. For illustration purposes only, and not limitation, the exemplary embodiment of environmental parameter balancing apparatus **10** (hereinafter "balancing apparatus **10**") is shown configured for a three-level structure such as a home having three floors of conditioned space: a basement **1**, a ground level floor **2**, and an upper level floor **3**. Balancing apparatus **10** may be configured for structures having more than three levels, including unconditioned space such as an attic. Balancing apparatus **10** may include a plenum **20** running between floors of a multi-level home and having one or more register openings **22** at each level of the home, a fan unit **24** installed such that it is in communication with plenum **20** and each register opening **22**, a sensor **32** located at each level, and a controller **30** in communication with each of sensors **32** and fan unit **24**. Sensors **32** are configured to measure an environmental parameter, including but not limited to temperature, humidity, pressure, combinations thereof, and/or any other environmental parameter as known to one of ordinary skill in the art, at each indoor space or level of the structure.

[0019] Controller **30** is configured to monitor sensors **32** in order to detect and/or determine whether there is a difference (a differential) between the environmental parameter measured on each level of the structure. For example, whether the temperature of basement **1** is greater than or less than the temperature of upper level **3**. If controller **30** determines that a differential exists between the environmental parameters of two or more levels, controller **30** is configured to operate fan unit **24** in response to this differential in order to equalize the environmental parameter between the two or more levels such that the environmental parameter of the two or more levels is equalized or balanced (brought into equilibrium). For example, basement **1** is the same temperature as upper level **3**.

[0020] The exemplary embodiment of balancing apparatus **10** will be describe with reference to a balancing apparatus configured to balance temperature between the multi-levels of the structure. However, it is understood that other environmental parameters may be measured, monitored, and equalized by the balancing apparatus **10** of the present invention without departing from the spirit and scope of the present invention. As such, sensors **32** comprise first temperature sensor **32***c*, second temperature sensor **32***b*, and third temperature sensor **32***a* disposed at the basement level **1**, middle level **2**, and upper level **3** of the structure, respectively, and configured to measure the temperature at each of these levels independently. First, second, and third temperature sensors **32***c*, **32***b*, and **32***a*, respectively, are connected to controller **30** via electrical wires **36** as known to one of ordinary skill in the art. It is understood that sesnors **32** and controller **30** may communicate with each other using wireless (e.g., WIFI, BLUETOOTH, etc.) technology. In an exemplary embodiment, temperature sensors **32** may comprise solid state thermister technology as manufactured by ANDIGILOG. Individual sensor components may be mounted to a custom manufactured circuit board (not shown) as manufactured by EQUATHERM with terminal screws (not shown) for lead connectors. Both the controller assembly and sensor assembly may be fabricated in any variety of methods such as in a custom manufactured plastic injection molded packages.

[0021] In an alternative embodiment, sensors **32** may comprise two or more sensors that are configured to monitor multiple environmental parameters, including but not limited to temperature and humidity, temperature and pressure, humidity and pressure, etc., as known to one of ordinary skill in the art without departing from the spirit and scope of the present invention. Sensors **32** (e.g., temperature and humidity sensors) may be connected to controller **30** such that balancing apparatus **10** may operate fan unit **24** and/or other equipment such as dampers in response to the measured and monitored data received by both sensors **32** to balance or equalize the differentials in one or more of these parameters between the levels.

[0022] Plenum **20** in this exemplary embodiment is made optionally from a standard 12"×3¼" duct, which fits between two vertical studs of a standard 2×4 stud wall. Plenum **20** and any other ductwork may be made of any commonly used materials in the art such as sheet metal, plastic, insulation, composite materials, etc. For example, plenum **20** and any other ductwork of the present invention may be made from conventional sheet metal ductwork, flexible ductwork, or combinations thereof as known to one of ordinary skill in the art. In this exemplary embodiment, plenum **20** comprises rectangular, sheet metal ductwork that forms a continuous vertical travel between basement fan unit **24***c*, middle level fan unit **24***b*, and upper level fan unit **24***a*. Plenum **20** may be fabricated from off-the-shelf components, custom made, or combinations thereof without departing from the spirit and scope of the present invention. In addition, plenum **20** may be fabricated at the job site by HVAC installers just prior to the installation.

[0023] At each level of the structure, plenum **20** may comprise a register opening **22** (e.g., upper level opening **22***c*, middle level opening **22***b*, and basement opening **22***c*). Plenum **20** may be constructed such that the register openings are integral to the ductwork or that the register openings may be cut into the ductwork during or after installation. Register openings **22** may be located anywhere on each floor such as, for example, near the ceiling or near the floor. As shown in **FIG. 1**, in this exemplary embodiment, register openings **22** are positioned low on the wall, near the floor.

[0024] At each of its ends, plenum **20** may be configured to include or connect to an L-shaped end cap **28**. Each L-shaped end cap **28** (e.g., upper level L-Shaped end cap **28***a* and basement L-Shaped end cap **28***c*) may include a register opening **22** (e.g., upper level register outlet **22***a* and basement register opening **22***c*, respectively) and a fan unit **24** (e.g., upper level fan unit **24***a* and basement fan unit **24***c*, respectively) installed within register opening **22** (e.g., upper level register opening **22***a* and basement register opening **22***c*, respectively) as shown in **FIGS. 1 and 2**. L-Shaped end cap **28** is configured to mate with terminal ends of plenum **20**. For example, L-Shaped end cap **28***a* connects with plenum **20** such that upper level opening **22***a* is disposed at upper level **3** of the structure, placing plenum **20** in communication with upper level **3**, and L-Shaped end cap **28***c* connects with plenum **20** such that basement opening **22***c* is disposed at basement level **1**, placing plenum **20** in communication with basement **1**.

[0025] In addition, a T-Shaped unit **26** may be positioned along plenum **20** at any middle floor (e.g., middle level **2**) as shown in **FIGS. 1 and 3**. It is understood that more than one T-Shaped unit **26** may be used, particularly, if the structure includes more than three floors that are in communication with balancing apparatus **10**. This T-Shaped unit permits a portion of the air to flow passed middle level **2** and thus between basement level **1** and upper level **3**. T-Shaped unit **26** may include a register opening **22***b* and a fan **24***b* installed within opening **22***b*. Both, L-shaped end caps **28***a* and **28***c* and T-Shaped unit **26** may be separate components that are connected to plenum **20**, or they may be constructed with plenum **20** as a single or integral unit. Register openings **22***a*, **22***b*, and **22***c* may be configured to extend through a vertical wall (e.g., drywall) and be substantially flush with this wall of the home. Alternatively, register openings **22***a*, **22***b*, and **22***c*, plenum **20**, L-Shaped end caps **28***a* and **28***c*, and/or T-Shaped unit **26** may be configured such that one or more of register openings **22***a*, **22***b*, and **22***c* may extend through the respective floors of the structure such that the openings are flush with the floor.

[0026] Balancing apparatus **10** may include one or more fan units **24**, and such fan units may be positioned in a variety of positions within apparatus **10**. As set forth above, upper level fan unit **24***a* may be installed within upper level register opening **22***a*, middle level fan unit **24***b* may be installed within middle level register opening **22***b*, and basement fan unit **24***c* may be installed within basement register opening **22***c*. Fan units **24***a*, **24***b*, and **24***c* serve as the primary air mover of the apparatus. Fan unit **24** may be configured to be interchangeable such that fan unit **24** may be inserted into either T-shaped unit **28** or L-shaped unit **26**. In other words, fan units **24***a*, **24***b*, and **24***c* may comprise the same dimensions and be the exact same type of fan unit. In one exemplary embodiment, fan units **24***a*, **24***b*, and **24***c* are rectangular-shaped, 6 inch fan units manufactured by JMC Thermal Solutions, wherein each unit includes two bi-directional fans.

[0027] In an alternative embodiment, T-shaped units **28***a* and **28***c* and L-shaped unit **26** are constructed such that fan units **24** may be fabricated directly into them to form an integral unit. In an alternative embodiment, fan unit **24** may optionally have a central divider (not shown) positioned with the fan unit such that it separates the two fans in order to prevent one fan, when blowing air out of plenum **20**, from drawing air through the adjacent fan opening into plenum **20**. A manufactured louver (not shown) covers the fan assembly for aesthetics as known to one of ordinary skill in the art.

[0028] Controller **30** may be any conventional as known to one of ordinary skill in the art without departing from the spirit and scope of the present invention. For example, a simple controller with an LED display and an on/off button may be used. Or, a controller having features, such as On/Off, LCD display of temperature differential settings, unit lock out, and timer, may be used. The apparatus may also include a more advanced controller, wherein the controller includes a LCD display and/or touch screen. The LCD display and/or touch screen may be used to display, enter, and manipulate a variety of parameters such as time, date, temperature, or humidity data. The controller may display usage for review, outdoor temperature, fan unit On/Off, humidity settings, air quality settings, vent attic function settings, and/or house exhaust settings and features. Any of the controllers may be connected to a network interface for home automation. Balancing apparatus **10** may be connected to a desktop, laptop, LAN, WAN, WLAN, Internet, etc. to enable control, data collection, and analysis.

[0029] In one exemplary embodiment, controller **30** may be a digital, micro-controller such as one manufactured by EQUATHERM, Inc. In another exemplary embodiment, controller **30** may comprise a HITACHI micro-controller chip mounted to a custom circuit board. Also, controller **30** may comprise a LCD screen for system status and user input buttons mounted to the circuit board for inputting control instructions and parameters. In another exemplary embodiment, the entire assembly may be housed in a custom plastic injection molded package.

[0030] As shown in **FIG. 1**, controller **30** is connected to sensors **32***a*, **32***b*, and **32***c* and fans units **24***a*, **24***b*, and **24***c*. In addition, controller **30** is configured such that the fan units may be controlled and operated by signals received from controller **30**. For example, an attached electrical junction box **42** may enclose relays (not shown) used to switch supplied 110V AC current to fan units **24***a*, **24***b*, **24***c*. Relay control may be provided by 5 volt, TTL signaling from controller **30**.

[0031] In one exemplary embodiment, controller **30** is configured or operable to continuously sample the air temperature of each of the three levels (e.g, upper level **3**, middle level **2**, and basement level **1**) via sensors **32***a*, **32***b*, and **32***c*. When controller **30** detects or determines a differential or imbalance in the measured temperature between the different levels, it responds to such temperature differential by operating one or more of fan units **24***a*, **24***b*, and/or **24***c* to move air between the levels of the structure in order to equalize the temperature between the levels. Once controller **30** detects or determines that the differential between the temperatures of the different levels is equalized or in equilibrium (in balance), the controller stops the operation of fan units **24***a*, **24***b*, **24***c*. This equalization process yields a more uniformly comfortable home, with the added benefit of reduced heating and cooling costs. Balancing apparatus **10** may also be wired to the thermostat, furnace, and/or air conditioner ("HVAC") of the structure so that the system knows when the HVAC system is running and what mode it is in, either the heating mode or cooling mode. The apparatus of the present invention may share a common controller, temperature sensors, fan(s), and/or ductwork (e.g, a plenum) with the structure's HVAC system or it may have independent controller, temperature sensors, fan(s), and/or ductwork (e.g, a plenum).

[0032] The three floor apparatus described above will be used an example. In summer, upper level **3** of the home is typically warmer than middle level **2** and/or basement **1**. The temperature balancing apparatus's controller **30** would detect this differential in temperature between upper level **3** and the lower levels (e.g, middle level **2** and basement **1**) via sensors **32***a*, **32***b*, and **32***c*, determine that the HVAC system is in cooling mode, and then respond by operating the upper fan unit **24***a* to exhaust air from plenum **20** at register opening **22***a* into the warmer upper level **3** and middle fan unit **24***b* to draw air into plenum **20** at register opening **22***b* from the cooler middle level **2**. This would effectively move the cooler air from the lower level(s) (e.g, middle level **2** and/or basement **1**) to the upper level **3** until the temperatures between the upper level and the lower level(s) are equalized or balanced. Once equalized, balancing apparatus **10** would shut off fan unit **24***a* and **24***b* and continue to monitor the temperatures of the different levels for future balancing. In this example, it is assumed that the temperatures of basement **1** and middle level **2** are in a state of equilibrium (equalized/balanced); therefore, basement fan **24***c* is currently off. It is, however, possible that a differential exists between all three floors, in which case all three fans could run simultaneously, as coordinated by controller **30**. Balancing apparatus **10** may also include 2-speed fans that can be operated at different speeds depending upon the temperature differential between the levels.

[0033] In the winter, all the heat from the HVAC system may rise to the upper floors of the structure and thus leave the lower levels cool and uncomfortable. Again, balancing apparatus **10** via controller **30** and sensors **32***a*, **32***b*, and **32***c* detect this temperature imbalance and move air between the levels of the structure in order to equalize or balance the temperatures between the floors. For example, balancing apparatus **10** will continuously measure and monitor the temperatures of basement level **1**, middle level **2**, and upper level **3** via sensors **32***c*, **32***b*, and **32***a*, respectively, and controller **30**. Assuming, for this example, controller **30** detects a temperature imbalance between upper level **3** and middle level **2** such that the temperature of upper level **3** is greater than middle level **2**, controller **30** would determine that the HVAC system is in the heating mode and then switch the fans **24** direction of operation in order to move warm air from the warmer level to the cooler level. In other words, controller **30** would operate fan **24***a* to draw the warmer air into plenum **20** from upper level **3** and operate fan **24***b* to exhaust this warmer air from plenum **20** into the cooler middle level **2**. Controller **30** will continue to move this warmer air from upper level **3** to middle level **2** until it detects that the temperatures of the two levels are in equilibrium, at which point, controller **30** will shut off the fans. As can be seen, the operation of balancing apparatus **10**, during heating season, is opposite of what is performed, during cooling season, in order to exhaust warm air and not cold air into a level during the heating season.

[0034] When moving air between levels in this manner, a natural pressure differential will occur between the levels. This pressure may be relieved in order to permit efficient air movement by the balancing apparatus' fan units **24**. In this exemplary embodiment, balancing apparatus **10** works under the premise that the natural open spaces of the structure itself (e.g, hallways & stairwells) will serve as a return air plenum for balancing apparatus **10**. This design will allow air to be moved in one direction by temperature balancing apparatus **10**, and in the opposite direction, by natural flow through these common spaces. With this approach, placement of balancing apparatus **10** must be considered to ensure efficient operation of the apparatus. For large structures without adequate open circulation spaces, a second temperature balancing apparatus **10** may be installed at the opposite end of the structure to serve as the return plenum (not shown). Controller **30**, as a single controller, may still manage both systems, with one temperature balancing apparatus moving air upward, and the second temperature balancing apparatus moving air downward, effectively serving as a powered return air system or just a return air duct.

[0035] Balancing apparatus **10** the present invention may also include fresh air intake and home exhaust capabilities. The plenum may be connected via lateral ducts to either an outside air intake that places the plenum in communication with ambient air and permits balancing apparatus **10** to draw ambient (outside) air into plenum **20**. This air intake may be located in a crawl space and/or along a side wall of a crawl space, basement, or any middle or upper levels. In addition, this ambient air intake may comprise the windows of the structure. In such a configuration and method, the windows of the structure on the levels wherein ambient air is desired to be drawn into apparatus **10** are opened to permit ambient air to enter via openings **22** into plenum **20**. This method introduces fresh, warm or cool air into the apparatus to aid in balancing the temperatures between the floors. Alternatively, plenum **20** may run vertically up into an attic and include an opening in communication with the attic space, wherein the air is forced to exhaust into the attic itself or through roof vents, which may pressurize the attic. In still yet another exemplary embodiment, plenum **20** may also be configured to continue to run vertically up through the attic and through the roof to the outside, wherein the apparatus may vent to the outside. The apparatus may alternatively be configured to simultaneously vent to both the attic and the outside.

[0036] Balancing apparatus **10** may also, optionally, include an air cleaner (not shown) connected to plenum **20**. The cleaner may be any conventional air cleaner as known to one of ordinary skill in the art such as electrostatic or filter air cleaner. It may operate when balancing apparatus **10** operates, or it may be programmed to operate on a timer or on a periodic time schedule. In addition, balancing apparatus **10** may optionally include a humidifier and/or dehumidifier (not shown), which is connected to the apparatus. The humidity and temperature of a space make up the "comfort zone" as defined in ASHRE. Sensors **32** of the present invention may monitor both parameters and the apparatus may turn on fans **24**, the humidifier, dehumidifier, or any combination of the three when controller **30** detects a temperature imbalance or a variation from the set humidity.

[0037] Balancing apparatus **10** may also include a smoke detector (not shown) connected to controller **30** and positioned within plenum **20** such that if the detector detects smoke it may shut down the balancing apparatus **10** via stopping operation of fans **24** to prevent the distribution of smoke and fumes during a fire throughout the structure.

[0038] **FIG. 4** shows an alternative embodiment of the indoor environmental parameter balancing apparatus **100** interconnected with a structure's new or existing HVAC system. As with the first exemplary embodiment shown in **FIGS. 1-3**, environmental balancing apparatus **100** will be described for illustration purposes only, and not limitation, as an environmental parameter balancing apparatus configured to balance temperature between different levels of a structure. However, it should be understood that it could be configured to measure, monitor, and balance other environmental parameters such as humidity, pressure, air quality, etc., between levels, indoor spaces, or rooms of a variety of structures. The HVAC system may comprise an air return plenum **120** connected to a furnace **150** and a supply plenum **190** also connected to furnace **150** as shown in **FIG. 4**. Return plenum **120** may include a plurality of inlets **122** such as one inlet on each level of the structure (e.g, upper inlet **122*a***, middle level inlet **122*b***, and basement inlet **122*c***). HVAC system may also include lateral ducts **194** (e.g, upper lateral duct **194*a***, middle lateral duct **194*b***, and basement lateral duct **194*c***) in communication with a plurality of outlets **192** (e.g, upper level outlets **192*a***, middle level outlets **192*b***, and basement outlets **192*c***) disposed in each room of each level of the structure and with supply duct **190** as found with many conventional HVAC systems.

[0039] Temperature balancing apparatus **100** comprises connecting return plenum **120** to supply plenum **190** with a bypass duct **180**, which provides a flow path for the air to bypass furnace **150**. Bypass duct **180** may include dampers **182** positioned at both ends of the bypass duct and a single direction fan **124** positioned between the two bypass ducts and in communication with bypass duct **180**. However, the fan **124** may also be bi-directional without departing from the spirit and scope of the invention. In addition, balancing apparatus **100** may include a damper **174** after each return inlet **122** when traveling from inlet **122** a toward furnace **150**. For example, balancing apparatus **100** may include a first damper **174*a*** disposed within return plenum **120** between upper level inlet **122*a*** and middle level inlet **122*b***, a second damper **174*b*** disposed within return plenum **120** between middle level inlet **122*b*** and basement inlet **122*c***, and a third damper **174*c*** disposed within return plenum **120** between basement inlet **122*b*** and furnace **150**.

[0040] In addition, supply plenum **190** may include a first supply damper **172** disposed within it between furnace **150** and bypass duct **180**. Also, lateral ducts **194*a***, **194*b***, and **194*c*** all include dampers **170*a***, **170*b***, and **170*c***, respectively, disposed within the ducts before each supply outlet **192*a***, **192*b***, and **192*c***, respectively. Such dampers permit balancing apparatus **100** to close off any of the supply outlets **192**. All the dampers **170**, **172**, **174**, and **182** are connected to a controller **130**. In one exemplary embodiment, controller **130** is a micro-controller as described above in the first exemplary embodiment. Balancing apparatus **100** also includes an upper level sensor **132*a*** disposed on upper level **3**, a middle level sensor **132*b*** disposed on middle level **2**, and basement sensor **132*c*** disposed on basement level **1**. The sensors are connected to controller **130** using electrical control wire **133**.

[0041] Sensors **132** continuously measure the temperature of each level, and controller **130** continuously receives and monitors this data in its CPU (not shown). When controller **130** detects or determines that an imbalance in the temperatures between the levels exists, it opens bypass duct **180** via opening dampers **182** and opens and closes the appropriate dampers **170** to balance the temperature between the floors. For example, if basement **1** is cool and middle floor **2** is hot, balancing apparatus **100** will close middle level inlet **122*b*** via the damper **174*b***, close basement supply outlets **192*c*** via corresponding dampers **170*c***, open middle level outlets **192*b*** via corresponding dampers **170*b***, open the bypass duct **180** via opening dampers **182** to bypass furnace **150**, and turn on fan **124**. This will draw cool air from the basement via inlet **122*c***, transport the air to the middle level supply outlets **192*b***, and exhaust this cool air from the lateral duct **194*b*** into middle level **2** via supply outlets **192*b***. Balancing apparatus **100** will continue moving air from basement **1** to middle level **2** until controller **130** monitors that the two levels are at an equilibrium, i.e, the temperatures are in balance or equalized. This example only described balancing between to floors but it is understood that the apparatus may balance temperature differentials between multiple floors. It is also understood that balancing apparatus **100** may be configured to provide balancing of other environmental parameters besides temperature such as humidity, pressure, air quality, etc. Balancing apparatus **100** may also provide balancing for any number of levels of a structure and/or types of structures.

[0042] In an alternative exemplary embodiment of the balancing apparatus **100** shown in **FIG. 4**, the balancing apparatus is exactly the same as shown if **FIG. 4**, except that it does not include bypass duct **180**, fan unit **124**, and bypass dampers **182**. In this exemplary embodiment, the balancing apparatus uses the fan unit of furnace **150**. When furnace **150** is not operating, temperature sensors **132** continuously measure the temperature of each level of the structure. Controller **130** monitors these temperature readings, and upon detection of a temperature differential between the levels, controller **130** will operate central furnace fan (not shown) and open and close the appropriate dampers **170**, **172**, and/or **174** in order to move air between the levels of the structure until the sensors detect that the temperatures between the levels are balanced.

[0043] **FIG. 5** shows still another alternative embodiment of the temperature balancing apparatus **200**. In this embodiment, balancing apparatus **200** comprises a vertical plenum **320**, lateral ducts **330*a***, **330*b***, and **330*c***, distribution units **326*a***, **326*b***, **326*c*** connecting lateral ducts **330*a***, **330*b***, and **330*c*** to plenum **320**, register openings **322*a***, **322*b***, and **322*c*** disposed within lateral ducts **330*a***, **330*b***, and **330*c***, respectively, and fans **324*a***, **324*b***, and **324*c*** located within respective distribution units **326*a***, **326*b***, and **326*c***, controller **340** connected via conductor **346** to each of fans **324*a***, **324*b***, and **324*c***, sensors **332*a***, **332*b***, and **332*c*** located on each respective level of the structure and connected via conductor **336** to controller **340**. In this embodiment, lateral ducts **330*a***, **330*b***, and **330*c*** may be flexible ductwork (e.g, 3 inch flexible duct) that may be fed through both the upper floor **4** of upper level **3** and middle floor **5** of middle level **2**. The flexible duct may be run through wall, ceiling, or floor cavities, making it great for retrofitting a home. This flexible duct may be run to each level or to each indoor space (e.g, room). Again, as set forth above in the other exemplary embodiments, balancing apparatus **200** may measure and monitor the temperatures on the different levels, and upon controller **340** detecting a differential in temperature between the levels, it will operate one or more of fans **324***a*, **324***b*, and/or **324***c* to balance or equalize the temperature between these levels. Once the controller detects that the temperature between the floors is equalized, it will stop the operation of the fans and continue monitoring the temperatures of the levels. The apparatus of this exemplary embodiment works substantially the same as the embodiment shown in **FIG. 1**.

What is claimed:

1. An indoor environmental balancing apparatus for a structure, comprising:

a plenum;

a plurality of openings disposed within the plenum and in communication with a plurality of indoor spaces;

a fan in communication with the plenum and the plurality of openings;

a plurality of sensors disposed within the plurality of indoor spaces and configured to measure an environmental parameter of the plurality of indoor spaces; and

a controller configured to monitor the plurality of sensors and respond to a differential in the measured environmental parameter between two or more of the plurality of indoor spaces by operating the fan to move air between the plurality of indoor spaces to bring the differential into equilibrium.

2. The indoor environmental balancing apparatus according to claim 1, wherein the fan is a bi-directional fan.

3. The indoor environmental balancing apparatus according to claim 1, wherein the apparatus is a supplemental ventilation system.

4. The indoor environmental balancing apparatus according to claim 1, wherein the plenum comprises a L-Shaped unit disposed within it, wherein the L-Shaped unit includes one of the plurality of openings that are in communication with the plurality of indoor spaces.

5. The indoor environmental balancing apparatus according to claim 4, wherein the plenum comprises a T-Shaped unit having one of the plurality of openings disposed within it, wherein the T-Shaped unit is configured to permit air to both bypass the opening and flow out of the opening into one of the plurality of indoor spaces.

6. The indoor environmental balancing apparatus according to claim 1, wherein the plurality of sensors are configured to measure temperature.

7. The indoor environmental balancing apparatus according to claim 6, wherein the controller is configured to respond to a differential in temperature between two or more of the plurality of indoor spaces by drawing air into the plenum from one of the plurality of indoor spaces having a cooler temperature relative to at least one of the plurality of indoor spaces and exhausting the cooler air from the plenum into the at least one of the plurality of indoor spaces such that the differential in temperature between the two or more of the plurality of indoor spaces is equalized.

8. The indoor environmental balancing apparatus according to claim 7, wherein the controller is configured to determine whether the structure's heating and cooling system is in a heating mode or cooling mode.

9. The indoor environmental balancing apparatus according to claim 8, wherein if the controller determines the structure's heating and cooling system is in the heating mode, the controller will switch the direction of the fan such that when the controller monitors a differential in temperature between two or more of the plurality of indoor spaces, the controller is configured to respond to the differential in temperature by drawing air into the plenum from one of the plurality of indoor spaces having a warmer temperature relative to at least one of the plurality of indoor spaces and exhausting the warmer air from the plenum into the at least one of the plurality of indoor spaces such that the differential in temperature between the two or more of the plurality of indoor spaces is equalized.

10. The indoor environmental balancing apparatus according to claim 1, further comprising a lateral duct connected between the plenum to the plurality of openings.

11. The indoor environmental balancing apparatus according to claim 10, wherein the lateral duct is flexible duct.

12. The indoor environmental balancing apparatus according to claim 1, wherein the plenum comprises a cold air duct and a supply duct of an existing heating and cooling system of the structure.

13. The indoor environmental balancing apparatus according to claim 12, further comprising a bypass duct connecting the cold air duct to the supply duct such that air may bypass the heating and cooling system.

14. The indoor environmental balancing apparatus according to claim 13, wherein the fan is disposed within the bypass duct and the system includes motorized dampers connected to the controller.

15. An indoor temperature balancing apparatus for a structure, comprising:

a plenum;

first and second openings disposed within the plenum and in communication with respective first and second indoor spaces of a structure;

a fan in communication with the plenum and the first and second openings;

a first sensor disposed within the first indoor space and configured to measure a first temperature of the first indoor space;

a second sensor disposed within the second indoor space and configured to measure a second temperature of the second indoor space; and

a controller configured to monitor the first and second sensors and respond to a differential between the first and second temperatures by operating the fan to move air between the first and second indoor spaces to bring the differential between the first and second temperatures into equilibrium.

16. The indoor temperature balancing apparatus for a structure according to claim 15, wherein the first and second indoor spaces comprise a first level of a home and a second level of a home.

17. The indoor temperature balancing apparatus for a structure according to claim 16, wherein the controller is configured such that if the controller determines that the structure's heating and cooling system is in the cooling mode and that the first temperature is less than the second temperature, the controller will operate the fan to draw air into the plenum from the first level, transport the air through the plenum, and exhaust the air from the plenum into the second level.

18. The indoor temperature balancing apparatus for a structure according to claim 16, wherein the controller is configured such that if the controller determines that the structure's heating and cooling system is in the heating mode and that the first temperature is less than the second temperature, the controller will operate the fan to draw air into the plenum from the second level, transport the air through the plenum, and exhaust the air from the plenum into the first level.

19. The indoor temperature balancing apparatus for a structure according to claim 15, further comprising:

a third opening disposed within the plenum and in communication with the fan and a third indoor space of the structure; and

a third sensor disposed within the third indoor space and configured to measure a third temperature of the third space;

wherein the controller is configured to monitor the first, second, and third sensors and respond to a differential between one or more of the temperatures measured by the first, second, and third sensors by operating the fan to move air between the first, second, and third indoor spaces to bring the differential between the one or more temperatures into equilibrium.

20. A method of balancing the indoor temperature for a structure, comprising:

monitoring temperatures of a first indoor space and a second indoor space;

detecting a differential in the temperatures between the first and second indoor spaces;

drawing air into a plenum from the first indoor space;

transporting the air within the plenum;

exhausting the air from the plenum into the second indoor space;

detecting that the differential in the temperatures between the first and second indoor spaces is equalized; and

stopping the drawing of the air into the plenum from the first space.

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