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Osheroff

[11] **3,840,177**

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[54] **FLUIDICALLY-CONTROLLED AIR-CONDITIONING SYSTEM**

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[52] **U.S. Cl.** **236/49,** 137/805, 236/80, 251/61.1

[51] **Int. Cl.** **F24f 11/04**

[58] **Field of Search** 236/49, 80; 137/805; 251/61.1

[56] **References Cited**

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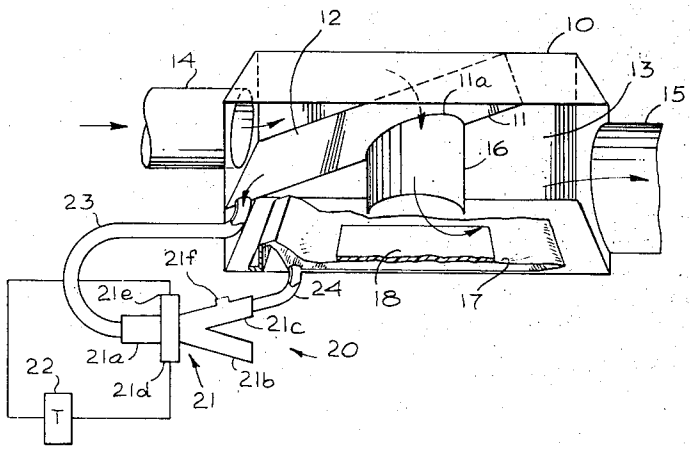
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Attorney, Agent, or Firm—Weinstein, Robbins, Botney, Saltz & Kay

[57] **ABSTRACT**

The present invention involves the use of fluidic principles in an air-conditioning system to provide both temperature and volume control. More particularly, fluidic amplifier apparatus is coupled to an inflatable bag or bellows positioned in the path of the conditioned air and, under the control of a thermovalve, the fluidic apparatus either inflates or deflates the bellows, thereby varying the flow of air to the conditioned space to meet the changing load conditions there. The volume limiter apparatus also affects the state of the bellows and, therefore, also affects the flow of air to the conditioned space.

15 Claims, 5 Drawing Figures



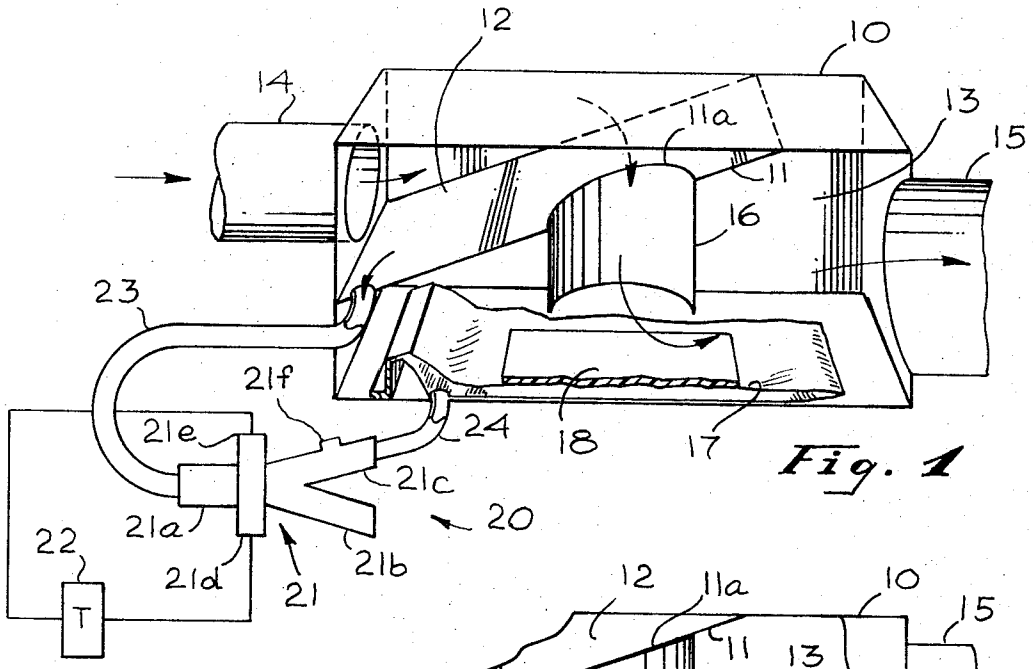


Fig. 1

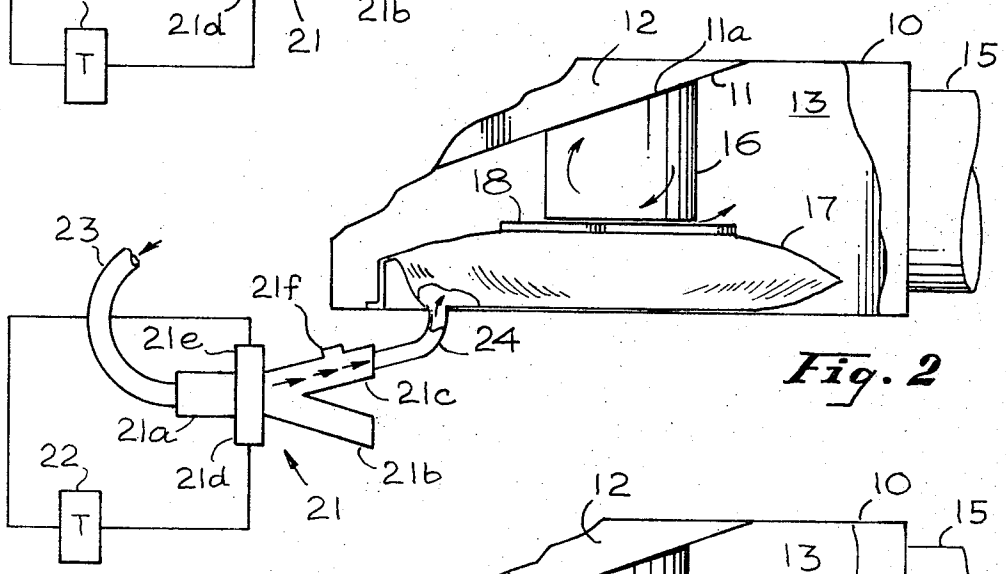


Fig. 2

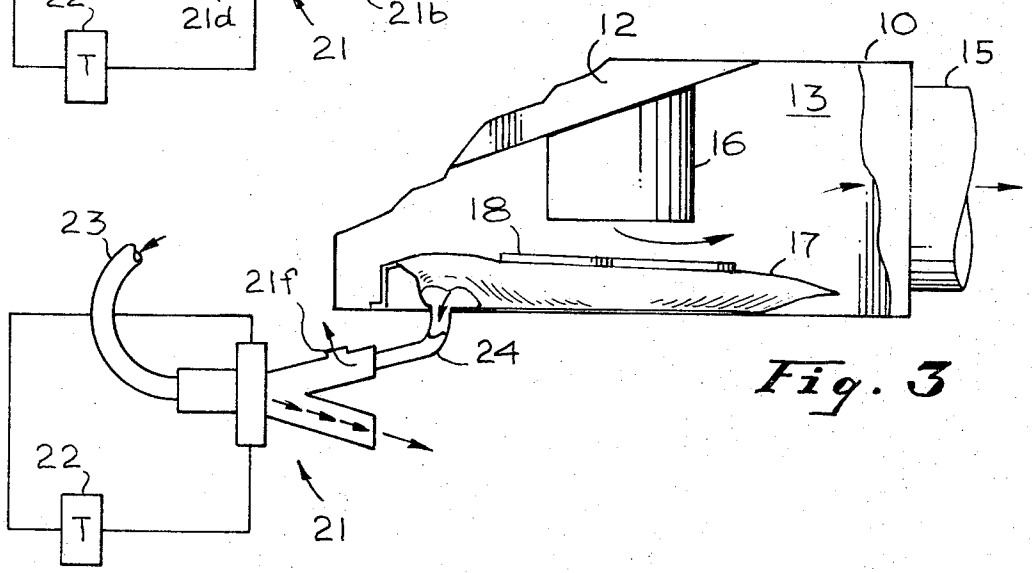


Fig. 3

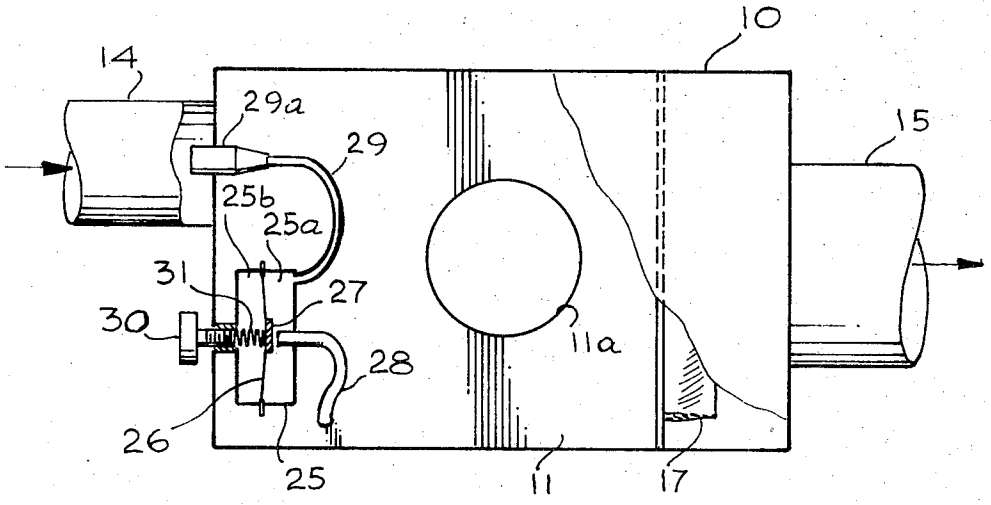

10
14
29a
29
15
25b
25a
31
27
30
28
11a
26
25
11
17

Fig. 4

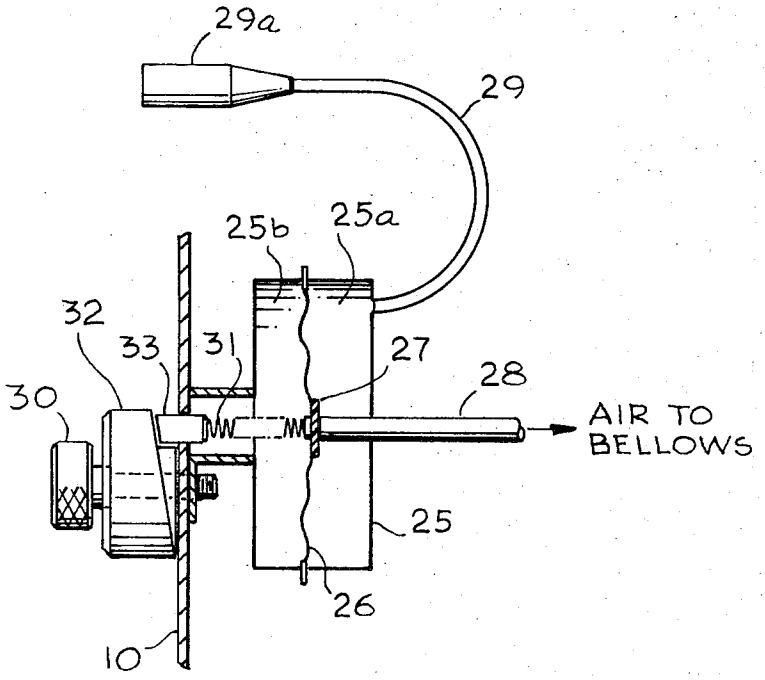

29a
29
25b
25a
32
33
31
27
28
30
AIR TO BELLOWS
25
26
10

Fig. 5

FLUIDICALLY-CONTROLLED AIR-CONDITIONING SYSTEM

The present invention relates to air-conditioning systems in general, and more particularly relates to an air-conditioning system in which fluidic principles are employed to provide volume as well as temperature control.

As everyone knows, the standard air-conditioning system is thermostatically controlled, which is to say that in such a system, the designed flow of conditioned air to a room or zone is a function of temperature differentials. However, in some instances it is also desirable to control the flow of conditioned air to a room or zone as a function of the volume of air flowing therein. This is especially true in large air-conditioned buildings involving many rooms because as the flow of conditioned air is reduced or terminated in one or more areas of the building, the armount or volume of air flowing in other parts of the building is correspondingly increased. Among other things, this surge in the volume has the deleterious effect, first, of increasing the level of noise generated in the system and, second, of increasing the problems of temperature control since more than the designed amount of air is now entering the various rooms being conditioned.

The combination of temperature and volume control in an air-conditioning system can be found in the prior art, but they customarily involve intricate, cumbersome and costly mechanical and electrical arrangements of one sort or another, which, as is well known, necessarily means that considerable maintenance and servicing problems and costs will be incurred. The present invention either eliminates or materially alleviates these and other disadvantages encountered among the prior art systems and it does so by employing fluidic principles to achieve the desired temperature and volume control. More particularly, air-conditioning systems according to the present invention are unique in that fluidic amplifier apparatus is utilized in them which, in combination with simple thermovalve and volume detector devices, provides a simple but effective and inexpensive way to limit the volume of air flowing into a space to be conditioned to within the system's design parameters and thereby helps to achieve accurate and expeditious temperature control.

It is, therefore, an object of the present invention to employ fluidic principles to achieve temperature and volume control in an air-conditioning system.

It is another object of the present invention to prevent the volume of air flowing into a space to be conditioned from exceeding a predetermined limit.

It is a further object of the present invention to improve the effectiveness of an air-conditioning system by applying fluidic principles to the system's temperature and volume control apparatus.

The novel features which are believed to be characteristic of the invention, both as to its organization and method of operation, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawings in which an embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the invention.

FIG. 1 is a frontal view, partially in schematic form, of an air-conditioning system according to the present invention illustrating, primarily, the temperature-control aspects of the system;

FIG. 2 is a partial view of the FIG. 1 system illustrating one operating condition of the system, namely, the condition of temperature in which minimum air is allowed to flow to the conditioned space;

FIG. 3 is another partial view of the FIG. 1 system illustrating another operating condition of the system, namely, the condition of temperature in which an increasing amount of air is allowed to flow to the conditioned space;

FIG. 4 is a plan view of the FIG. 1 system primarily illustrating, in simplified form, the volume-control aspects of the system; and

FIG. 5 is an enlarged and more detailed view of the volume-control apparatus shown in FIG. 4.

For a more complete understanding of the details of the invention, reference is now made to the drawings wherein, in FIG. 1, an embodiment of the invention is shown to include an outer casing or housing structure 10 that includes a diagonally oriented partition 11 that may be said to divide the housing structure into two plenums or chambers 12 and 13. At one end of the housing structure, what shall be referred to as the input end, there is mounted an air input duct 14 that connects with chamber 12. At the other end of the housing structure, namely, at the output end, there is mounted an air output duct 15 that connects with chamber 13. As may be deduced from an examination of FIG. 1, an area of partition 11 is cut away to form an opening 11a therethrough and a small section of duct, hereinafter referred to as nozzle 16, is mounted on the partition beneath said opening and extends downwardly therefrom into chamber 13. Accordingly, unless the mouth of nozzle 16 is somehow closed, and there are times in the operation of this system when this may occur, as will be seen hqreinafter, opening 11a and nozzle 16 provide a path into chamber 13 for the conditioned air entering chamber 12 via input duct 14, and from chamber 13 out through output duct 15 to the room to be conditioned.

Mounted in chamber 13 directly beneath nozzle 16 is a long-life bellows 17 on and to the upper wall of which is mounted a plate 18. The purpose of plate 18 is to provide a flat, solid surface to insure that the mouth of the nozzle will close evenly and firmly when the bellows expands. Accordingly, plate 18 may be made of any material suitable for said purpose, preferably a relatively light material so as not to unnecessarily load the bellows.

Finally, completing the FIG. 1 embodiment, is a fluidic control arrangement, generally designated 20, that comprises fluidic amplifier apparatus 21 and a thermovalve 22. The diagram of fluidic apparatus 21 is in schematic form and, therefore, represents any one of a number of fluidic devices that may be used, such as a fluidic oscillator or a bistable fluid amplifier, but irrespective of the kind of fluidic device used, it will include, as is shown by the schematic, an input channel 21*a*, a pair of output channels 21*b* and 21*c*, a pair of control channels 21*d* and 21*e*, and an air vent 21*f* located in output channel 21*c*. Input channel 21*a* is linked or coupled to chamber 12 by means of a hose or pipe 23, as is shown in the figure, and, therefore, a small portion of the air entering chamber 12 is tapped

off by hose 23 and fed to input channel 21*a*. Similarly, output channel 21*c* is linked or coupled by means of a hose or pipe 24 to bellows 17, which means that air exiting from channel 21*c* flows into the bellows.

As was previously mentioned, fluidic apparatus 21 may be a fluidic oscillator or a bistable fluid amplifier. Since bistable fluid amplifiers are in common use and, therefore, their construction and operating principles well known by those skilled in the art, no further description of a device of this kind that may be used in the present invention is deemed necessary here. With respect to the fluidic oscillator, however, although the construction and operating principles of these devices are also well known, there are so many different species or variations of them and since it is possible that not all of them may be applicable or adaptable for use herein, it is deemed judicious to identify some specific types of fluidic oscillators as examples of those that can definitely be utilized as the fluidic apparatus in the FIG. 1 embodiment. Towards this end, therefore, reference is made to U.S. Pat. No. 3,680,776 entitled "Fluidic Apparatus For Air-Conditioning Systems," by Gene W. Osheroff, issued Aug. 1, 1972, wherein there is shown and described several species of a fluidic oscillator which, under the control of a thermovalve, operates to deliver pulses of conditioned air of variable duration to its output channels. The portions of said patent illustrating and describing said oscillators and their operation are incorporated herein by said reference as though said portions were fully set forth. Suffice it to say at this point, therefore, that a steady stream of conditioned air enters these fluidic oscillators, that is to say, the air entering the oscillator is steady state, but the oscillator converts this steady stream of air to pulses of air that are alternately applied by the oscillator to its two output channels, the duration of the pulses through these channels being generally different from one another and also varying with the passage of time. More specifically, the duration of the pulses through one or the other of these output channels and, therefore, through both of them, is under the control of or, stated differently, regulated by thermovalve 22 which, in turn, means that their duration is a function of the temperature conditions of the room to be conditioned.

As for thermovalve 22, here again, any one of a number of different available thermovalves may be used, but one that has already been used in connection with the present invention and found to be suitable for such use is that shown and described in U.S. Pat. No. 3,730,430 entitled "A Thermovalve" by Gene W. Osheroff, issued May 1, 1973. The pertinent illustrative and descriptive portions of said patent are incorporated herein by this reference as though said portions were fully set forth. It will be recognized that thermovalve 22 is located in the room to be conditioned and, as is shown in FIG. 1, is coupled to control channels 21*d* and 21*e*. Briefly stated, and as will more fully be explained hereinbelow, the thermovalve directs the fluidic apparatus to either inflate or deflate the bellows so as to match the load conditions of the room.

Considering now the operation of the embodiment as thus far described, it will initially be assumed that the thermostat in thermovalve 22 has just been set to the desired room temperature and that a significant difference exists between this temperature and the actual or ambient temperature of the room. Under such conditions, bellows 17 will be almost fully vented or deflated and the space between the bellows and nozzle 16 at about a maximum, with the result that the conditioned air supplied to the room will also be at about a maximum. As previously pointed out, the conditioned air flows into chamber 12 via duct 14, and from chamber 12 it flows through nozzle 16 into chamber 13 from which it flows via duct 15 into the room. Needless to say, the greater the space between bellows 17 and nozzle 16, the less impediment there is to air flow and, therefore, the greater the supply of conditioned air to the room. Of course, the reverse is also true, namely, the smaller the space between the bellows and the nozzle, the greater the impediment and the smaller the supply. Thus, the amount of conditioned air flowing to the room is a function of the space between the nozzle and the bellows which, it will subsequently be seen, is in turn a function of the difference between the ambient room temperature and the temperature setting of the thermostat. Stated differently, and for reasons that will be more fully explained and understood later, fludic apparatus 21, under the control of thermovalve 22, inflates or deflates the bellows and thereby decreases or increases the space between the nozzle and the bellows, respectively, to exactly match the room load conditions.

It will also be initially assumed that fluidic apparatus 21 is of the oscillator type previously identified. Accordingly, the conditioned air entering input channel 21*a* is steady state, but the air emerging from output channels 21*b* and 21*c* is pulsed, with the pulses alternating between the output channels to respectively produce two trains of pulses of conditioned air. The duration of the pulses in one train will generally vary with the passage of time and will generally differ from the duration of the pulses in the other train, but since the total amount of air exiting from apparatus 21 must be equal to the amount of air entering it, the duration of the pulses in one output channel will become smaller as the duration of the pulses in the other train becomes larger, and vice versa. Thus, the duration of the pulses of conditioned air coming out of output channel 21*b* will grow smaller as the duration of the pulses of conditioned air emerging from output channel 21*c* grows larger, and vice versa. As previously mentioned, the relative duration of these pulses is a function of the temperature conditions in the room.

With the initial conditions as assumed, only relatively short pulses of air emerge from output channel 21*c* and flow into bellows 17 whereas rather long pulses of air emerge from output channel 21*b*. In between the short pulses, that is to say, during the time the air is emerging from output channel 21*b*, some portion of the air already in bellows 17 escapes through vent 21*f*. Accordingly, under this mode of operation, bellows 17 is almost fully deflated and the space between the bellows and nozzle 16 at about a maximum, with the result that the maximum amount of conditioned air flows through the path of duct 14, chamber 12, nozzle 16, chamber 13, and duct 15 into the room to be conditioned.

With conditioned air flowing into the room, as described, the temperature of the room gradually approaches the temperature setting of the thermostat and as the difference between these two temperatures decreases, the rate of flow of air into the room correspondingly decreases. This is brought about by the fact that as this temperature differential dimishes, the dura-

tion of the pulses of air emerging from output channel **21***c* and entering bellows **17** increases whereas the duration of those emerging from output channel **21***b* decreases, as previously mentioned. Accordingly, the overall or net amount of air in the bellows increases as the duration of the pulses of air flowing to the bellows increases, with the result that the bellows inflates as the temperature differential decreases, thereby gradually closing the space between the bellows and the nozzle. Stating it differently, as the cooling or heating requirement decreases, the thermovalve directs the fluidic oscillator to fill the bellows and as the bellows fills and inflates, the nozzle opening is reduced, thereby cutting down on the amount of air delivered to the room.

This process continues until the temperature of the room air substantially equals the temperature setting of the thermostat, at which point, as is shown in FIG. **2**, the space between the bellows and the nozzle will have been narrowed to the point where the amount of conditioned air flowing to the room is at a minimum, that is to say, is that required merely to offset room temperature losses and, therefore, that required only to substantially maintain the room temperature at the set temperature. Of course, from a purely technical point of view, it will be recognized by those skilled in the art that the system is constantly hunting to exactly match the room load conditions, and, therefore, that the nozzle spacing will vary slightly as the system attempts to maintain the room temperature at the thermostat set point. One of the advantages of this system over those in the prior art that was not previously mentioned is that this hunting to find the desired temperature is confined to much narrower limits, namely, to about ± 1° from the thermostat set point whereas in prior art systems the hunting often extends over a range of as much as 9°.

If now, additional air-conditioning is required in the room, the thermostat in thermovalve **22** is reset so that a significant temperature differential once again exists between the ambient room temperature and the thermostat temperature. When this occurs, the amount of air flowing out of channel **21***b* increases and, at the same time, the amount of air flowing out of channel **21***c* and into bellows **17** correspondingly decreases, with the result that the bellows now vents and deflates to permit more air to be supplied to the room. More particularly, under the control of the thermovalve, the duration of the pulses of air entering the bellows rapidly decreases so that more air leaves the bellows and escapes through vent **21***f* than enters the bellows, the net result being that the bellows deflates until a new stable point is reached where the amount of air entering and leaving the bellows is substantially the same. Needless to say, as the bellows continues to deflate to this point, the space between the bellows and nozzle also increases, thereby allowing correspondingly more conditioned air to flow to the room.

It will be recognized that with the resetting of the thermostat, the new state or operating condition of the system is very much the same as that initially assumed. Accordingly, as the increased amount of conditioned air continues to flow into the room, the difference between the ambient temperature of the room and the temperature setting of the thermostat gradually diminishes which, in turn, means that the duration of the pulses of the air entering bellows **17** gradually increases, thereby causing the bellows to again inflate and the space between the bellows and the nozzle to again decrease. As was previously explained, this process will continue until the abovesaid temperature differential has been substantially reduced to zero, at which point, it will be remembered, the air flowing to the room is only that required to maintain the room temperature at the thermostat setting, that is to say, to keep the above said temperature differential at zero.

This completes a description of the operation of the system while under temperature control, but a word should be said concerning the pulses of conditioned air emerging from output channel **21***b*. To avoid the loss of this air and the benefits thereof, it is preferable that ouput channel **21***b* either be coupled to a return duct so that the air emerging therefrom can be fed back into the system and used again or else accommodation made so that it can be vented to the room to be conditioned along with the main stream of air out of duct **15.** However, this is a matter of design and it was not deemed necessary to show a connection for output channel **21***b* in order to provide an understanding of the invention. Accordingly, to avoid unnecessarily encumbering the figures, output channel **21***b* has been shown unconnected or uncoupled.

The system thus far described is one subject only to temperature control. However, it was stated at the outset of this application that the fluidic apparatus and principles involved herein may also be employed for system volume control and, therefore, toward this end, attention is now directed to FIGS. **4** and **5** wherein volume limiter apparatus according to the present invention is illustrated. The volume limiter apparatus is mounted in plenum or chamber **12** and, in FIG. **4**, which is a plan view of the housing structure **10,** it is shown to basically include a diaphram case **25** inside which is mounted a diaphram **26** that is fastened to the case in an air-tight manner along its entire periphery. Consequently, diaphram **26** divides case **25** into two compartments **25***a* and **25***b* that are separated from each other in an air-tight manner. Mounted on the underside of diaphram **26,** which is the side facing compartment **25,** is a valve seat **27** that faces and is contiguous to one end of a pipe or hose **28** that couples compartment **25***a* to bellows **17.** In other words, under certain conditions, air will flow from compartment **25***a* into bellows **17** through hose **28.** Also coupled to compartment **25***a* is a pressure probe **29,** one end of the probe coupling to the compartment and the other end, designated **29***a*, coupling to inlet duct **14.**

On the upperside of diaphragm **26,** the volume limiter apparatus includes an adjustment knob and spring mechanism comprising an adjustment knob device **30** that extends through housing structure **10** and a spring member **31,** the spring member being lodged between the knob device and the upperside of the diaphragm, the upperside being the side facing compartment **25***b*.

The volume limiter apparatus is shown in greater detail in FIG. **5** wherein the adjustment knob and spring mechanism is shown to further include a member **32** that resembles a truncated pyramid and a similarly shaped member **33.** Member **32** is mounted on the shaft of knob device **30** between the head of the device and housing structure **10** and it is mounted in such a manner that one edge of the member, designated **32***a*, abuts against the housing structure and thereby acts as a fulcrum or hinge about which member **32** rotates to

move in or out as the adjustment knob is respectively moved in or out. As for member **33**, it is mounted between member **32** and spring **31** and it acts to compress or expand the spring as it respectively moves in or out with member **32**. It will be recognized that the position of adjustment knob **30** determines the pressure that spring **31** brings to bear upon diaphragm **26** and, therefore, the force with which valve seat **27** abuts against and covers the mouth of hose **28**. Accordingly, as will be seen hereinbelow, the position of knob **30** sets the upper limit on the volume of air that can flow to the room to be conditioned, that is to say, it determines the maximum number of cubic feet per minute of conditioned air entering the room.

Considering the operation of the volume limiter apparatus, it should first be mentioned that the total pressure in the system (T_p) is equal to the sum of velocity pressure (V_p) and static pressure (S_p), that is to say:

$$T_p = V_P + S_P \tag{1}$$

Consequently,

$$V_P = T_P - S_P \tag{2}$$

At this point, it should further be mentioned that the essence of the volume limiter apparatus is that diaphragm **26** measures the system's velocity pressure (V_P), as will subsequently be explained, and that the volume of air (cubic feet per minute) flowing through the system is proportional to this velocity pressure. Accordingly, volume can be controlled by controlling the velocity pressure Knob **30** is calibrated in percent of rated CFM (cubic feet per minute) and since this is proportional to velocity pressure, as previously mentioned, velocity pressure can be set by manually adjudting the knob.

With the above in mind and with knob **30** set to the desired value of volume, probe **29** supplies total pressure to compartment **25**a and, therefore, to the underside of diaphragm **26**. At the same time, compartment **25**b and, therefore, the upperside of the diaphragm is exposed to static pressure.

The net amount of pressure on the diaphragm, which is the difference between these two pressures, is exerted against the underside of the diaphragm and, pursuant to equation (2) above, is equal to the velocity pressure. It will be recognized by those skilled in the art that so long as this velocity pressure is less than the value to which knob **30** has been set, the mouth of hose **28** will remain closed and no air will flow into bellows **17** via hose **28**.

However, if the volume of air flowing into duct **14** should increase to the point where the net or velocity pressure exerted against the underside of diaphragm **26** exceeds the value to which knob **30** is set, then in that event diaphragm **26** and, therefore, valve seat **27**, will move away from hose **28** and thereby permit air to flow into the bellows. When this occurs, the bellows will expand and, for the reasons previously explained, reduce the volume of air flowing to the room to within the limit set. Of course, the reverse will occur when the volume of air entering duct **14** falls to a value below the set maximum, that is to say, the mouth of hose **28** will again be covered by valve seat **27** and the excess air in bellows **17** will vent through vent **21***f*. Accordingly, when the volume is within normal limits, the bellows and, therefore, the flow of air to the room, is effected only by the thermovalve.

Summarizing the limiter's operation, when too much air tries to enter the system, the air velocity increases. This increase in velocity is measured as an increase in total pressure under the diaphragm. When the total pressure is higher than the static pressure and the design pressure (spring pressure) on the other side of the diaphragm, the diaphragm moves away from the mouth of the hose leading to the bellows, thereby allowing air to flow to the bellows. The bellows inflates, thus reducing the velocity of the air into the system. In this way, volume is brought back to the desired air quantity.

Although a fluidic oscillator is preferred for fluidic amplifier apparatus **21**, it was mentioned earlier herein that other forms of fluidic devices may also be used, such as a bistable fluid amplifier. Accordingly, if apparatus **21** now represents a bistable amplifier, the same basic operation is involved except that we no longer have an oscillatory type situation in which pulses of air of variable duration emerge from output channels **21***b* and **21***c*. Instead, the air flows through one or the other of these output channels in a steady-state pattern until system conditions are satisfied, at which point it switches over to the other channel.

More particularly, if the thermostat in thermovalve **22** is set so that conditioned air is required in the room, then, under the influence of the thermovalve, the air entering input channel **21***a* emerges from output channel **21***b* and it continues to flow out of this output chanel until the ambient temperature of the room attains the temperature setting of the thermostat, at which point in time it switches to output channel **21***c*. During this entire interval of time, of course, bellows **17** is deflated, the space between nozzle **16** and bellows **17** is at a maximum, and the flow of conditioned air to the room is likewise a maximum. However, when the switch occurs to output channel **21***c*, the air then enters the bellows, which inflates, and continues to inflate, until the nozzle is closed by it, thereby substantially terminating any further flow of conditioned air to the room. Air, of course, will vent through vent **21***f*, but this is offset by the air flowing into the bellows, which continues to flow in this direction until conditioned air is once again required in the room, at which time the air in the amplifier switches back to output channel **21***b*. When this occurs, the bellows fully deflates to once again permit maximum air flow to the room.

It should briefly be mentioned that the operation of the volume limiter apparatus is not affected by the fact that apparatus **21** is now a bistable amplifier device rather than an oscillator and, therefore, continues to operate in the manner previously described.

Although particular arrangements of the invention have been illustrated and described hereinabove, it has been by way of example and is not intended that the invention be limited thereto. Accordingly, the invention should be considered to include any and all modifications, alterations or equivalent arrangements falling within the scope of the annexed claims.

Having thus described the invention, what is claimed is:

1. An air-conditioning system mounted between input and output ducts, the conditioned air entering the system via the input ductand exiting the system for the

room to be conditioned via the output duct, said system comprising: a housing structure partitioned to form first and second chambers that are respectively coupled to the input and output ducts; an inside duct intercoupling said first and second chambers to permit air entering said first chamber to flow into said second chamber; an inflatable device mounted beneath the mouth of said inside duct and operable to control the amount of conditioned air flowing through it to said second chamber, the amount of conditioned air flowing through said inside duct corresponding to the spacing between the mouth of said duct and said inflatable device and, therefore, to the degree to which said device is inflated; and pure fluid amplifier means for inflating and deflating said inflatable device to respectively decrease and increase the amount of conditioned air flowing through said inside duct according to the air-conditioning requirements of the room.

2. The air-conditioning system defined in claim **1** wherein said means includes fluid amplifier apparatus having at least an inlet channel coupled to said first chamber to tap off a portion of the conditioned air flowing therein, a pair of outlet channels, one of said outlet channels being coupled to said inflatable device to feed said tapped off air thereto, said one outlet channel including a vent therein through which air in said device may be vented, and a pair of control channels through which pressures may respectively be exerted against said tapped-off air to switch the flow thereof between said outlet channels; and a thermovalve mounted in the room and coupled to said pair of control channels to produce said pressures as a function of the room's air-conditioning requirements.

3. The air-conditioning system defined in claim **1** wherein said means includes fluidic oscillator apparatus having an inlet channel coupled to receive a portion of the conditioned air entering the system, and a pair of outlet channels to which said portion of air flows, one of said outlet channels being coupled to said inflatable device, said oscillator apparatus including first means to switch the air flowing therein back and forth in an oscillatory manner between said pair of outlet channels to produce pulses of conditioned air that are alternately applied to said pair of outlet channels, said oscillator apparatus including second means to vary the duration of said pulses with changes in the temperature of the room, the duration of the pulses of air flowing through said one outlet channel and into said inflatable device increasing and decreasing, respectively, as the need for conditioned air in the room decreases and increases.

4. The air-conditioning system defined in claim **1** wherein the system further includes apparatus to limit the volume of air flowing to the room to within a predetermined level, said apparatus being coupled to said inflatable device and including additional means to inflate said device in proportion to the extent to which said volume level is exceeded.

5. The air-conditioning system defined in claim **3** wherein the system further includes apparatus to limit the volume of air flowing to the room to within a predetermined level, said apparatus being coupled to said inflatable device and including additional means to inflate said device in proportion to the extent to which said volume level is exceeded.

6. The air-conditioning system defined in claim **1** wherein said fluid amplifier is a bistable fluid amplifier.

7. The air-conditioning system defined in claim **1** wherein said fluid amplifier includes first and second fluidic amplifier devices with each having an inlet channel, a pair of outlet channels, a control chamber between its inlet channel and its outlet channels, and a pair of control channels connecting to said control chamber, the inlet channel of said first device being coupled to receive said portion of the conditioned air entering the system, the inlet channel on said second device connecting to the inlet channel of said first device, one of the outlet channels of said first device being coupled to said inflatable device, and the pair of outlet channels of said second device respectively being connected to the pair of control channels of said first device; and temperature-sensitive means mounted in the room and coupled to said apparatus to control the diversion of said air to said inflatable device in response to temperature conditions in the room, the amount of air entering said device being determined by said conditions; and wherein said temperature-sensitive means includes further means coupled to and between the outlet channels of said first device and the control channels of said second device for selectively applying pressures to the control channels of said second device in response to the flow of conditioned air in the outlet channels of said first device, said further means including thermostatically-controlled pressure devices for respectively applying said pressures to the control channels of said second device in response to temperature variations in the room.

8. The system defined in claim **4** wherein said volume limiting apparatus includes first means for setting said apparatus at a predetermined value of velocity pressure for the conditioned air flowing in the system; second means for comparing the actual velocity pressure in the system with said set value; and third means for inflating said inflatable device when said actual velocity pressure value exceeds said set value thereof until said two values are equalized.

9. The system defined in claim **4** wherein said volume limiting apparatus includes an enclosure; a diaphragm mounted in said enclosure in such a manner as to divide it into two compartments, one of said compartments and, therefore, one of the sides of said diaphragm, being exposed to the static pressure of the system; a probe coupled between the other of said compartments and the input duct to expose said other compartment and, therefore, the other side of said diaphragm, to the total pressure of the system, the difference between total pressure and static pressure being velocity pressure; mechanical means by which a predetermined value of velocity pressure is applied to said one side of the diaphragm; and a conduit intercoupling said other compartment and said inflatable device, the mouth of said conduit being closed by said diaphragm so long as the velocity pressure applied to said one side of the diaphragm is greater than the velocity pressure applied to said other side of the diaphragm.

10. The system defined in claim **5** wherein said volume limiting apparatus includes an enclosure; a diaphragm mounted in said enclosure in such a manner as to divide it into two compartments, one of said compartments and, therefore, one of the sides of said diaphragm, being exposed to the static pressure of the sys-

tem; a probe coupled between the other of said compartments and the input duct to expose said other compartment and, therefore, the other side of said diaphragm, to the total pressure of the system, the difference between total pressure and static pressure being velocity pressure; mechanical means by which a predetermined value of velocity pressure is applied to said one side of the diaphragm; and a conduit intercoupling said other compartment and said inflatable device, the mouth of said conduit being closed by said diaphragm so long as the velocity pressure applied to said one side of the diaphragm is greater than the velocity pressure applied to said other side of the diaphragm.

11. The system defined in claim **5** wherein said volume limiting apparatus includes mechanical means for setting said apparatus at a predetermined value of velocity pressure for the conditioned air flowing in the syste; comparison means for comparing the actual velocity pressure in the system with said set value; and third means for inflating said inflatable device when said actual velocity pressure value exceeds said set value thereof until said two values are equalized.

12. The system defined in claim **7** wherein said further means includes a pair of feedback channels respectively linking the pair of outlet channels of said first device with the control channels of said second device, and wherein said thermostaticallycontrolled pressure devices are also coupled to said feedback channels.

13. The system defined in claim **8** wherein said second means includes a diaphragm on one side of which said actual velocity pressure is exerted and on the other side of which said set value of velocity pressure is exerted.

14. The system defined in claim **11** wherein said comparison means includes a diaphragm on one side of which said actual velocity pressure is exerted and on the other side of which said set value of velocity pressure is exerted.

15. The system defined in claim **12** wherein said further means includes a pair of pressure-producing elements respectively mounted in the pair of outlet channels of said first amplifier device and respectively connected to said pair of feedback channels, said elements respectively producing air pressures in response to the flow of air in said outlet channels.

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