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3,368,752

DUAL DUCT AIR CONDITIONING WITH SEASONAL CHANGEOVER MEANS

Filed Feb. 28, 1966

3 Sheets-Sheet 1

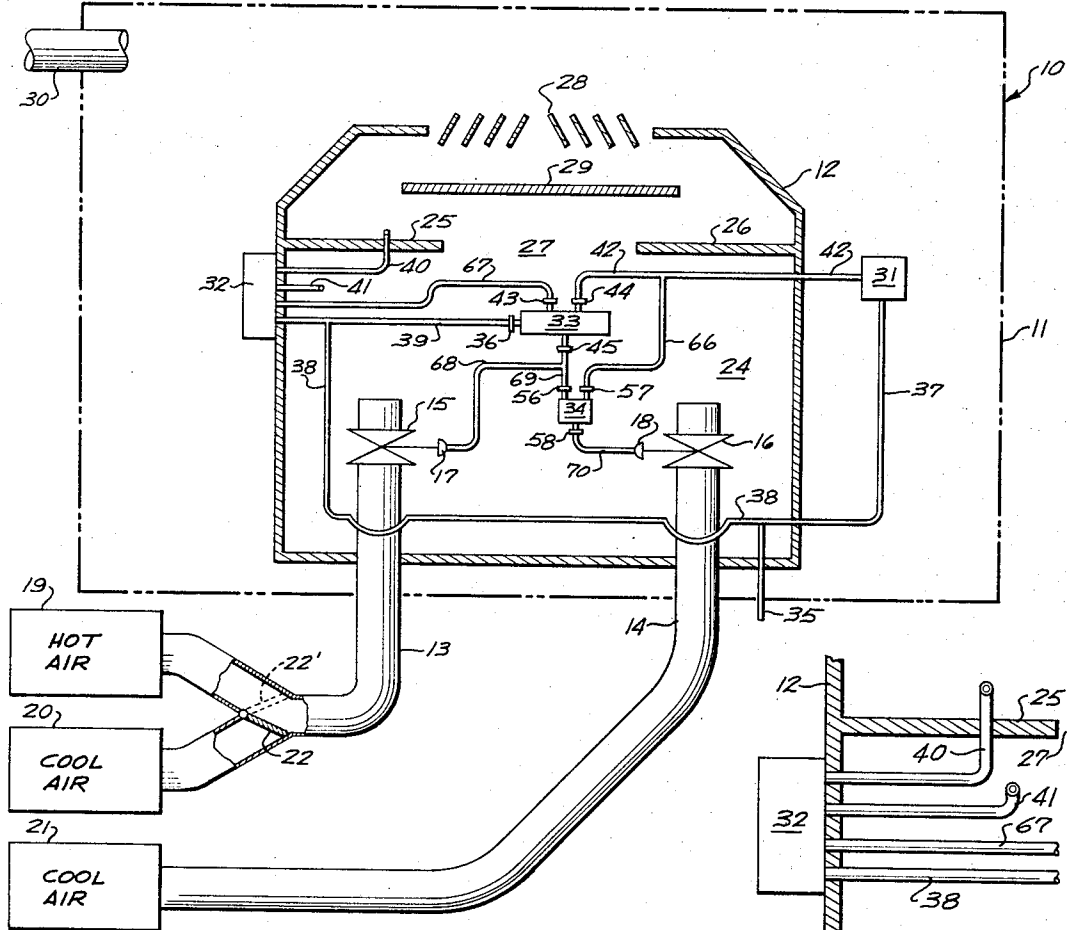


Fig. 1

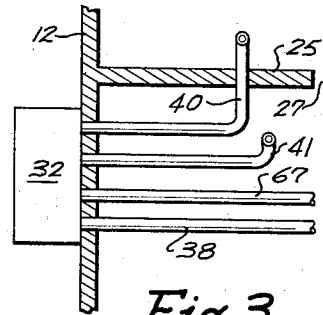


Fig. 3

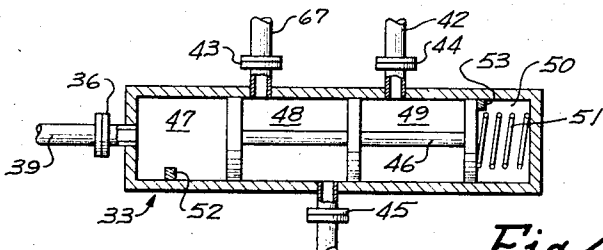


Fig. 4

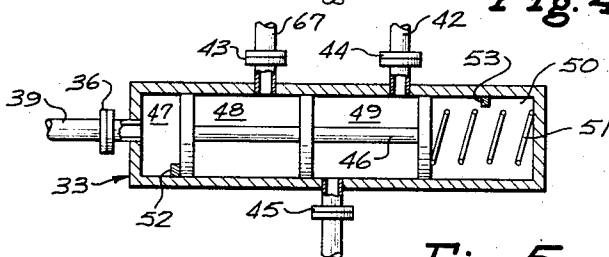


Fig. 5

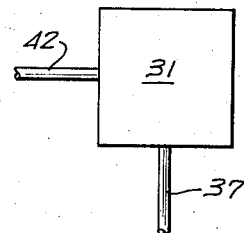


Fig. 2

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3 Sheets-Sheet 2

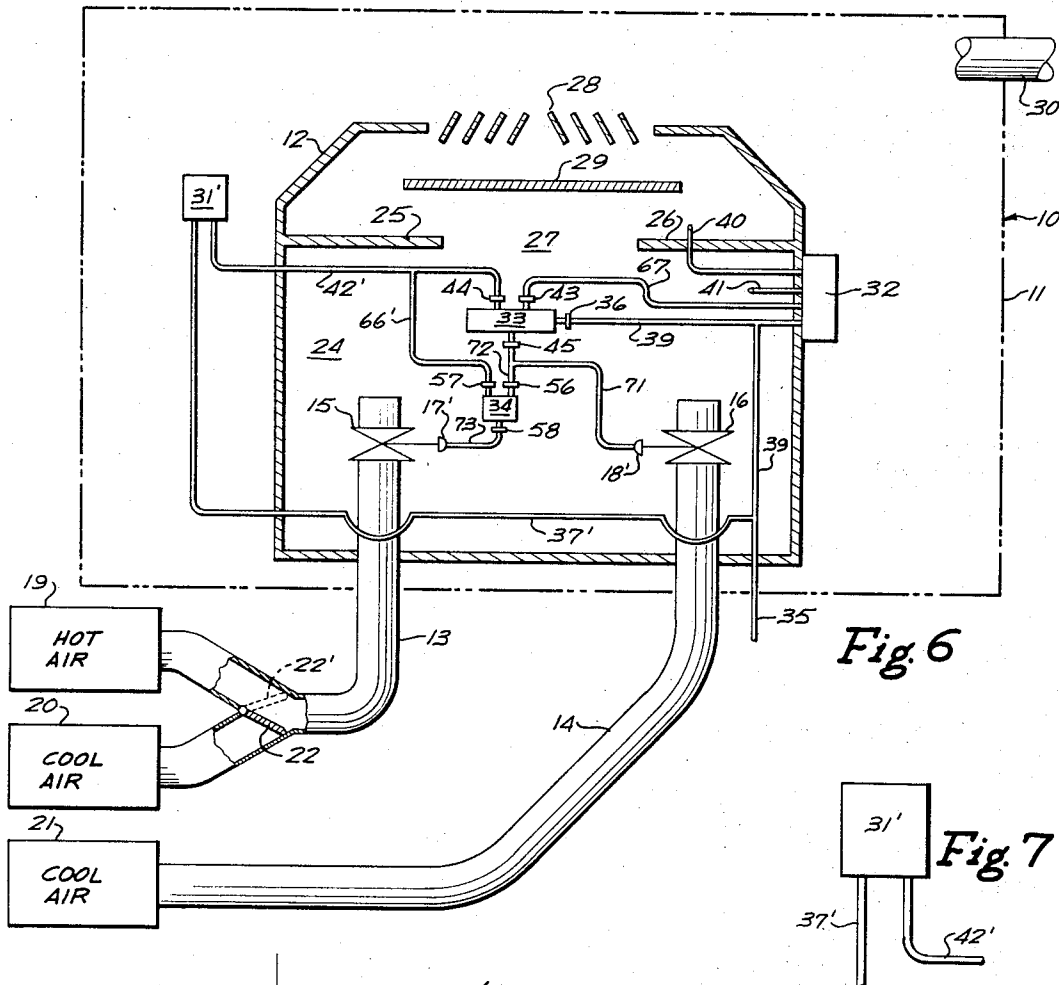


Fig. 6

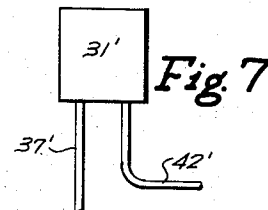


Fig. 7

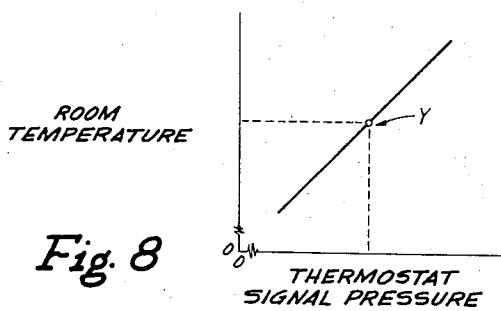


Fig. 8

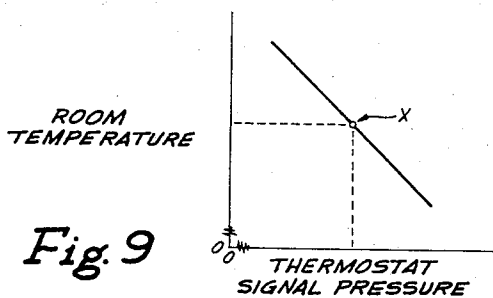


Fig. 9

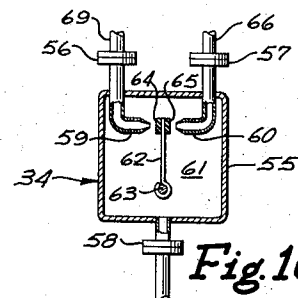


Fig. 10

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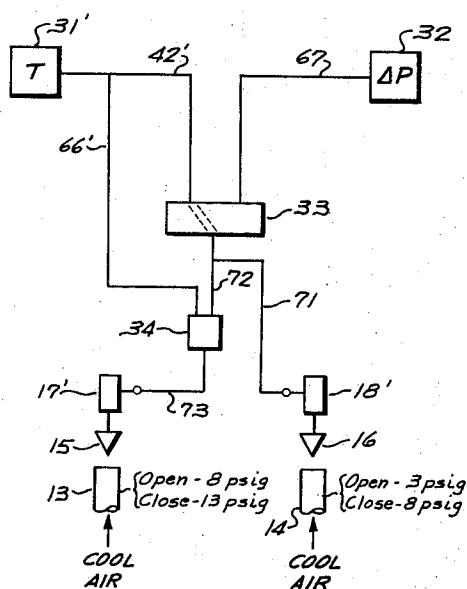
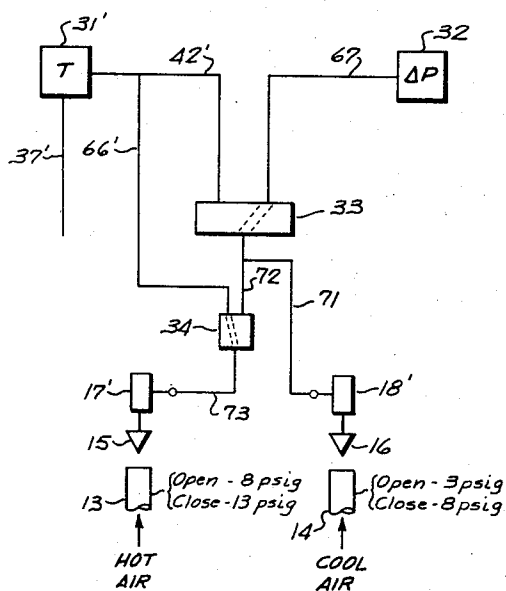
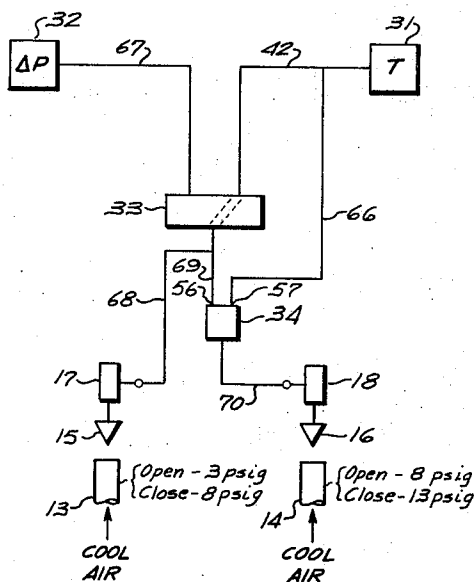
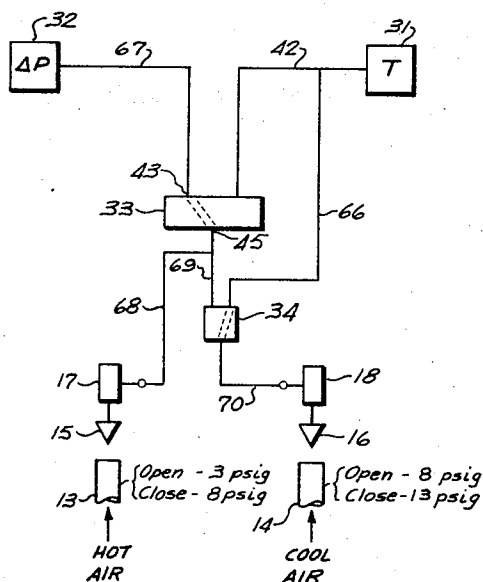
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DUAL DUCT AIR CONDITIONING WITH SEASONAL CHANGEOVER MEANS

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3 Sheets-Sheet 3



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DUAL DUCT AIR CONDITIONING WITH SEASONAL CHANGEOVER MEANS

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6 Claims. (Cl. 236—1)

The present invention relates to dual duct air conditioning systems and more particularly to an improved seasonal changeover assembly for such systems.

Prior art

Dual duct air conditioning systems utilize separate streams of conditioned air for ventilation and temperature control within a building. A typical dual duct air conditioning system is illustrated in Goemann, U.S. Patent 2,729,429. A substantially constant volume of ventilation air has been provided in such systems by reciprocally blending two separate streams of air, one hot and one cool, in accordance with the temperature requirements of an individual room, whereby an increase in the flow rate of hot air is accompanied by a decrease in the flow rate of cool air, and vice versa. During the winter months, i.e., when the building requires heating, these substantially constant volume air distribution systems are satisfactory. During the summer months, i.e., when the cooling requirements greatly exceed the ventilation requirements of the building, such constant volume air distributing systems can become unsatisfactory. The seasonal problem is described in Goemann, U.S. Patent 3,019,987, wherein it is proposed to provide cool air in both air supply ducts in a sufficient volume to satisfy the thermal requirements of the building during the summer season, regardless of the fact that the total air flow may exceed the optimum ventilation requirements, i.e., the total air flow will not be maintained at a substantially constant value but instead will fluctuate according to the temperature maintenance requirement in each individual room of the building. Various mechanical changeover apparatus has been presented in Curran et al. 2,883,111 and Curran et al. 2,898,044 involving mechanical changes within the reciprocal valving apparatus itself. Means for avoiding the seasonal changeover reciprocal valving problem are shown in Curran 2,957,628 and 2,957,629, which utilize excess cool air duct capacity.

A seasonal changeover system

A seasonal changeover distribution system which does not involve duplicate cool air capacity (such as 2,957,628, and 2,957,629) and which does not involve mechanical changes within the reciprocal valving (such as 2,883,111 and 2,898,044) has been described in Jentoft Patent 3,237,860 issued Mar. 1, 1966, from patent application S.N. 369,145, now Patent No. 3,237,860, filed May 21, 1964 and assigned to the assignee of the present invention. The Jentoft patent describes an air distribution system involving separate, mechanically independent, air flow control valves, each operable over the identical range of pressures.

Statement of invention

The present invention provides a dual duct air distribution system which can be adapted to seasonal changeover installations. Air flow is regulated by two different valves which operate in response to differing actuating pneumatic pressures. During the winter heating season, one of the valves is normally responsive to a thermostat signal and the other of the valves is responsive to a flow controlling signal which maintains a substantially constant volume of air input into each individual room of the building. During the summer season, the flow controlling signal is inoperative and the thermostat signal controls the

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flow of air from both of the dual ducts which both contain, during the changeover conditions cool air. The thermostat signal operates one of the valves from full-closed to full-open position while the other valve is maintained in a full-closed position. Sequentially the thermostat signal operates the other valve from a full-closed position to a full-open position only when the first-mentioned valve is in a full-open position. Thus the two air inlet valves do not operate concurrently (as in Jentoft 3,237,860) but instead operate in sequence with the one valve being fully-closed while the other valve is less than fully-open; and that other valve must be fully-open before the remaining valve moves from its fully-closed state. The seasonal changeover occurs by means of a significant change in the pneumatic supply pressure which is provided within the building. A signal switching device is responsive to the pneumatic supply pressure. Under normal circumstances, e.g., in the winter heating season, the thermostat signal controls the flow of air from only one of the two air carrying ducts; during seasonal changeover conditions, the thermostat signal controls the flow of air from both of the air carrying ducts. The thermostat signal can be normally applied to either of the two air carrying ducts, i.e., to the hot air carrying duct or to the cold air carrying duct as will be hereinafter described in detail. The thermostat signal corresponds to the difference between (a) the air temperature within the said room and (b) a predetermined temperature for the said room which may be manually regulated by the occupant of the room.

The use of sequential pressure range valves as provided in the present invention permits inclusion of a signal selector device which prevents overblowing of the air distribution system in two circumstances. This protective device prevents runaway conditions from developing in certain circumstances as will be hereinafter described.

Objects

The objects of this invention include:

Providing seasonal changeover features in a dual duct air conditioning system which normally employs thermostatic regulation of the air from one of the dual ducts and flow compensating regulation of the flow of air from the other of the dual ducts, whereby a substantially constant volume of ventilation air flow is normally maintained;

Providing a dual duct air conditioning control system which accommodates seasonal changeover requirements regardless of whether the temperature responsive signal is applied to the normally hot air stream valve or to the normally cool air stream valve;

Providing a dual duct air conditioning control system operable with two valves which are responsive to actuating pneumatic pressures at different pressure ranges;

Providing a dual duct air conditioning control system which can be adapted to prevent overblowing of hot air or cold air during circumstances when extreme demands for temperature correction are presented.

With these objects in view, the invention will be described in detail by reference to the accompanying drawings in which:

FIGURE 1 is a schematic illustration of a typical building room utilizing a seasonal changeover air distributing apparatus according to this invention;

FIGURE 2 is a schematic illustration of a thermostat of the type utilized in FIGURE 1;

FIGURE 3 is a schematic illustration of a flow regulating device of the type illustrated in FIGURE 1;

FIGURES 4 and 5 are cross-sectional views of a typical switching valve in two alternative positions;

FIGURE 6 is a schematic illustration, similar to FIGURE 1, showing an alternative embodiment of the present apparatus;

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FIGURE 7 is an enlarged illustration of a thermostat of the type utilized in FIGURE 6;

FIGURES 8 and 9 are graphical representations of the theoretical performance characteristics of commercially available thermostats;

FIGURE 10 is a cross-sectional view of a typical signal selector device as provided in FIGURE 1 and in FIGURE 6;

FIGURE 11 is a schematic illustration of the normal operation of the apparatus of FIGURE 1 under usual conditions;

FIGURE 12 is a schematic illustration of the operation of the apparatus of FIGURE 1 in its alternative conditions, i.e., during seasonal changeover;

FIGURE 13 is a schematic illustration of the apparatus of FIGURE 6 under usual conditions;

FIGURE 14 is a schematic illustration of the apparatus of FIGURE 6 in its alternative condition, i.e., during seasonal changeover.

Referring to FIGURE 1 there is illustrated a typical building room 10 indicated by a broken line 11 and containing an air distributing outlet unit 12. Ventilation air is introduced into the room 10 through a pair of air inlet conduits 13, 14 which terminate within the air distributing outlet unit 12. The air inlet conduits 13, 14 are equipped with valves 15, 16, respectively, which have pneumatic operators 17, 18, respectively.

The air inlet conduit 13 is connected to a source 19 of hot air and also connected to a source 20 of cool air. The air inlet conduit 14 is connected to a source 21 of cool air at all times. A flapper valve 22 normally (i.e., during the winter heating season) is in the illustrated position with the air inlet conduit 13 directly connected to the source 19 of hot air. The flapper valve 22 may be moved during the alternate seasonal changeover condition to the dotted line position 22' whereby the air inlet conduit 13 will be connected to the source 20 of cool air.

The air distributing outlet unit 12 includes an interior chamber 24. Baffles 25, 26 each extend partially across the interior chamber 24 defining an orifice 27 through which air is discharged from the interior chamber 24. A suitable grille 28 is provided in the casing of the air distributing outlet 12 for discharging air into the interior of the room 10. A baffle member 29 may be provided between the orifice 27 and the grille 28 to promote mixing of inlet air from the two air inlet conduits 13, 14 prior to introduction into the room 10. An air outlet conduit 30 is provided to discharge a quantity of air from the interior of the room 10 corresponding to the amount which is introduced through the grille 28.

In order to control the air discharge, a thermostat 31 (FIGURE 2) is provided in the interior of the room 10, remote from the air distributing outlet unit 12.

A flow regulating device 32 (FIGURE 3) is provided, preferably within or secured to the casing of the air distributing outlet unit 12 for measuring the instantaneous rate of air flow through the orifice 27. A switching valve 33 (FIGURES 4, 5) is provided for the selective connection of pneumatic impulse conduits in a manner to be described. A pressure selector device 34 (FIGURE 10) likewise is provided for connecting pressure impulse conduits in a manner to be described. A source 35 of pneumatic pressure is provided from which pneumatic pressure is delivered to thermostat 31, the flow regulating device 32, and the operating port 36 of the switching valve 33. A pneumatic conduit 37 delivers the pneumatic impulse to the thermostat 31. A pneumatic conduit 38 delivers the pneumatic impulse to the flow regulating device 32. A pneumatic conduit 39 delivers the pneumatic impulse from the conduit 38 to the operating port 36 of the switching valve 33.

The flow regulating device 32 contains a pair of pneumatic impulse conduits 40, 41. The conduit 40 has an

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opening outside the orifice 27; the conduit 41 has an opening on the opposite side of the orifice 27. The differential pressure between the orifice openings of the conduits 40, 41 is a measure of the instantaneous rate of air flow through the orifice 27.

The thermostat 31 as shown in FIGURES 1, 2 is of the reverse-acting type. The performance characteristic is illustrated in FIGURE 9. As the observed temperature in the interior of the room 10 increases, the thermostatic signal pressure produced in the thermostatic signal conduit 42 decreases; conversely, as the observed temperature in the interior of the room 10 decreases, the pressure in the thermostatic signal conduit 42 increases.

Switching valve

The switching valve 33 may be constructed in a variety of ways. It includes a pair of inlet ports 43, 44, an outlet port 45, and an operating port 36 all of which are connected to a common chamber which is formed by the housing of the switching valve 33. A spool 46 contains three pistons which divide the interior of the valve housing into four distinct chambers 47, 48, 49, 50. The operating port 36 at all times communicates with chamber 47. The inlet port 43 at all times communicates with chamber 48. The inlet port 44 at all times communicates with chamber 49. The chamber 50 contains a compressible spring 51. A stop member 52 is provided in the chamber 47 to limit travel of the spool 46 in one direction. A stop member 53 is provided in the chamber 50 to limit the travel of the spool in the opposite direction. The outlet port 45 is connected with the chamber 48 in FIGURE 4 when the spring 51 is tightly compressed and the spool 46 abuts the stop member 53. Alternatively, the outlet port 45 communicates with the chamber 49 as shown in FIGURE 5 when the spool 46 abuts the stop member 52 with the spring 51 extended.

The spool 46 is caused to move from the right position, FIGURE 4, to the left position FIGURE 5 as the pressure applied to the operating port 36 is altered. So long as the pressure maintained within the chamber 47 is sufficient to overcome the resistance of the spring 51, the spool will appear in abutment with the stop member 53 as shown in FIGURE 4. When the pressure in the chamber 47 decreases, the resistance of the spring 51 causes the spool 46 to advance to the left in abutment with the stop member 52 as shown in FIGURE 5.

Pressure selector device

The pressure selector device 34 is illustrated in FIGURE 10 and typically includes a housing 55 having two inlet ports 56, 57 and one outlet port 58. The inlet ports 56, 57 communicate with a pair of opposed nozzles 59, 60 respectively, which are positioned in the interior 61 of the housing 55. Mounted within the housing 61 is a flapper element 62 which is pivotal about a pin member 63. Resilient pads 64, 65 are secured to the opposite end of the flapper element 62 confronting the nozzles 59, 60. When the pressure impulse at the nozzle 59 exceeds the pressure impulse at the nozzle 60, the resilient pad 65 will be forced against the nozzle 60 and the pressure impulse of the nozzle 59 will be delivered to the interior chamber 61 and hence through the outlet port 58. Alternatively, when the pressure impulse at the nozzle 59 is less than the pressure impulse at the nozzle 60, the resilient pad 64 will be forced against the nozzle 59 and the pressure impulse of the nozzle 60 will be delivered to the interior chamber 61 and hence through the outlet port 58. Thus the function of the pressure selector device 34 is to deliver the higher of the two applied pressure impulses at the inlet ports 56, 57 to the outlet port 58.

Additional pneumatic connections

The thermostat 31 delivers a thermostat signal through a thermostatic signal conduit 42 which is connected to the inlet port 44 of the switching valve 33. The same thermo-

static signal impulse is delivered from the conduit 42 through a conduit 66 to the inlet port 57 of the pressure selector device 34. The flow controlling signal is delivered from the flow controller 32 through a signal conduit 67 to the inlet port 43 of the switching valve 33. The output pressure impulse from the switching valve 33 is delivered from the outlet port 45 through an impulse conduit 68 to the operator 17 of the valve 15. The same outlet pressure impulse is delivered from the conduit 68 through impulse conduit 69 to the inlet port 56 of the pressure selector device 34. A pressure impulse conduit 70 delivers the output signal from the signal selector device 34 through outlet port 58 to the operator 18 of the valve 16.

Operation of the device of FIGURE 1

The apparatus of FIGURE 1 performs under usual conditions and also performs under alternative conditions. The operation under usual conditions is schematically illustrated in FIGURE 11 and the operation under the alternative conditions or seasonal changeover conditions is illustrated in FIGURE 12.

During the winter heating season, hot air is provided in the conduit 13 and cool air is provided in the conduit 14. The hot air valve 15 has an operator 17 which is adapted to open the valve 15 fully at a first pressure value and to close the valve 15 fully at a second pressure value. For example, the closing may commence at an applied pressure of 3 p.s.i.g. and the closing may be completed at an applied pressure of 8 p.s.i.g., whereby the range of operation for the valve operator 17 is from 3 to 8 p.s.i.g. At applied pressures less than 3 p.s.i.g., the operator 17 opens the valve 15 fully; at applied pressures above 8 p.s.i.g., the operator 17 will close the valve 15 fully. Under usual conditions, i.e., during the winter heating season, the switching valve 33 is maintained in whatever position is necessary to connect the flow regulating device 32 directly with the valve operator 17 through the conduits 67, 68 and the switching valve ports 43, 45. Concurrently the thermostat signal is delivered through the thermostatic signal conduit 42, through the impulse conduit 66, through the pressure selector device 34 and the impulse conduit 70 to the valve operator 18. The valve operator 18 is adapted to provide a full open valve 16 at a third pressure value and a full-closed valve 16 at a fourth pressure value. That is, the valve operator 18 is responsive over a pressure range extending from a third value to a fourth value. The pressure range for the operator 18 in a typical case is from 8 p.s.i.g. to 13 p.s.i.g. Note that the range for the operator 18 is higher than the range for the operator 17. Thus the range of the operator 18 consists essentially of pressure values which are higher than those in the range of the operator 17. In this example the operator 17 has a range which terminates at the precise value, 8 p.s.i.g., where the range of the operator 18 commences. This is an ideal situation. Some gap or overlap between the two ranges is permissible. A gap between the two ranges is preferable to an overlap, but a small overlap in the two ranges can be sustained. The thermostat 31 controls inlet flow of cool air through duct 14 via valve 16, whereas the flow regulator 32 controls the flow of hot air through the duct 13 via valve 15.

When the room 10 is cooler than the predetermined temperature, the thermostat (FIGURE 9) develops a higher pressure which is applied to the operator 18 causing the valve 16 to move in a closing direction and deliver less cool air from the duct 14. The change in inlet flow from the cool air duct 14 tends to decrease the total flow of air through the orifice 27. The flow regulator senses the reduced flow and lowers the flow regulating signal which is applied to the operator 17. Accordingly the valve 15 moves in an opening direction to allow more hot air discharge from the duct 13 to maintain constant volume output flow at a higher average temperature. The reverse sequence occurs when the temperature in the

room rises above a preset value. Then the thermostat 31 senses the increased temperature and generates a lower thermostatic signal pressure which is delivered to the operator 18 causing the valve 16 to open and admit more cool air. The flow regulator signal increases causing a closing movement of the hot air valve 15.

Function of the pressure selector 34

It will be observed that under normal operating conditions, the thermostatic signal pressure in the thermostatic signal conduit 42 normally is in a range of about 8 to 13 p.s.i.g., i.e., above the pressure presented in the flow regulating impulse conduit 67. Hence normally the selector device 34 receives inlet impulses of 3-8 p.s.i.g. at one inlet port 56 and of 8-13 p.s.i.g. at the other inlet port 57. The higher of the two inlet pressures is delivered through the impulse conduit 66 and is applied to the operator 18 through the impulse conduit 70—except in a peculiar circumstance where a building room is over heated (that is, exhibits a temperature well above the predetermined temperature set for the thermostat 31 by the room occupant). In this circumstance the thermostat 31 observes the excessive room temperature and generates a very low output pressure in the thermostat signal conduit 42 which is delivered to the valve operator 18 causing the valve 16 to open fully or nearly full. For example, suppose that the pressure applied to the valve operator 18 is 8.3 p.s.i.g. which causes the flow of cool air into the room to exceed the constant volume which is desired. The flow regulator device 32 senses that excess air is being delivered and increases the pressure in the flow regulating impulse conduit 67 until the flow of hot air through the conduit 13 is completely terminated by closing the valve 15 at an applied pressure of about 8 p.s.i.g. The pressure in impulse conduit 68 continues to increase until a pressure, for example 8.9 p.s.i.g., is developed. That pressure of 8.9 p.s.i.g. is delivered through the impulse conduit 69 to the selector device 34 causing the higher pressure, namely, 8.9 p.s.i.g., to be presented at the outlet port 58 and thence at the valve operator 18 whereby the flow regulator 32 commences closing the valve 16 to limit the quantity of cool air emanating from the conduit 14 to the desired constant volume rate of flow for the entire system. Thus the pressure selector device 34 prevents over blowing of the room with cool air in excess of the desired constant volume ventilation air requirement.

Seasonal changeover—FIGURE 1

When the summer cooling season arrives, the apparatus of FIGURE 1 is transferred to seasonal changeover condition by shifting the flapper valve 22 to its alternative position 22' whereby both the air inlet conduits 13, 14 received cool air. Similarly the pressure level of the pneumatic signal supply source 35 is shifted in a direction which allows the switching valve 33 to move to its alternative position. It should be observed that the pressures in the pneumatic supply conduit 35 both during the usual conditions and during seasonal changeover conditions must exceed the maximum operating pressure of the system which is, in these examples, 13 p.s.i.g. Typically the pneumatic pressure supply will change from a level of about 20 p.s.i.g. in one condition to a level of about 15 p.s.i.g. in the other condition. That simple change in pneumatic supply pressure results in a switching of the switching valve 33 from its one alternative position to the other alternative position.

Referring to FIGURE 12, the switching valve 33 is shown in its alternative position for seasonal changeover and both of the air inlet conduits 13, 14 are provided with cool air. The thermostatic signal is delivered through the thermostat signal conduit 42 through the switching valve 33 to the impulse conduit 68 and hence to the valve operator 17. Likewise the thermostatic signal is delivered through the thermostatic signal conduit 42 through the

impulse conduit 66, through the selector device 34 and the impulse conduit 70 to the valve operator 18. The flow controller 32 is totally disconnected from the system during seasonal changeover. Similarly the pressure selector device 34 is functionless during seasonal changeover since the same pressure impulse is applied to both of its inlet ports 56, 57.

The thermostat 31 has the performance characteristic illustrated in FIGURE 9, i.e., as the observed temperature in the room increases, the thermostat signal pressure decreases. At the operating point X (FIGURE 9) the thermostatic pressure developed in the thermostatic signal conduit 42 might be 9.1 p.s.i.g. At this value, the valve operator 18 locates the valves 16 somewhere between its open and closed position, more nearly open. At this pressure level the valve operator 17 maintains the valve 15 fully closed. As the temperature in the room rises above a predetermined value X, the pressure of the thermostatic signal conduit 42 decreases until, at a level of 8 p.s.i.g., the valve 16 is fully opened and the valve 15 remains fully closed. If the pressure of the thermostatic signal conduit 42 decreases further, the valve 16 remains in its fully open position and the valve 15 commences to open as a result of application of a pressure less than 8 p.s.i.g. to valve operator 17. When the temperature drops below the predetermined value X, the pressure in the thermostat signal conduit 42 increases and the valve 15 is fully closed as the pressure rises to a value of 8 p.s.i.g. That valve 15 remains fully closed and the valve 16 commences to close as the pressure continues to rise above 8 p.s.i.g. until a level of 13 p.s.i.g. is reached at which point both of the valves 15, 16 are fully closed.

Alternative embodiment—FIGURE 6

The essential apparatus shown in FIGURE 6 corresponds with that shown in FIGURE 1. Identical numerals are employed to identify identical elements. The valving and conduit arrangements are somewhat different as will be hereinafter described. Each of the elements shown in FIGURE 6 is identical with the element shown in FIGURE 1 except for the thermostat 31' of FIGURE 6. The thermostat 31' is illustrated in FIGURE 7 and is a dual acting thermostat, sometimes identified as a heating-cooling thermostat which is adapted to operate with a direct characteristic when a pneumatic impulse of a first value is applied to the unit and is adapted to operate inversely when a different pneumatic impulse is applied to the unit. For example, the thermostat 31' has the performance characteristic of FIGURE 8, direct acting, during the winter heating season in the usual condition, and has the performance characteristic of FIGURE 9, reverse acting, during the seasonal changeover conditions. The other differences between FIGURE 6 and FIGURE 1 are:

- a thermostatic impulse conduit 42' connecting the thermostat 31' and the inlet port 44 of the switching valve 33;
- a thermostatic impulse conduit 66' connects the conduit 42' with the inlet port 57 of the selector device 34;
- a pneumatic supply impulse is delivered from a pneumatic supply source 35 to a pneumatic impulse conduit 37' to the thermostat 31';

- the outlet port 45 of the switching valve 33 is connected by a conduit 71 to the operator 18' of the valve 16; the inlet port 56 of the selector device 34 is connected by an impulse conduit 72 to the conduit 71;

- the outlet port 58 of the selector device 34 is connected by an impulse conduit 73 to the valve operator 17' of the valve 15;

- the valve operator 17' is operable over a higher pressure range than the valve operator 18', e.g., the operator 18' moves from a pressure of 3 p.s.i.g. (open) to 8 p.s.i.g. (closed) and the operator 17' moves from a pressure of 8 p.s.i.g. (open) to 13 p.s.i.g. (closed). In all other respects the device shown in FIGURE 6 is identical with that shown in FIGURE 1.

The essential difference between the apparatus of

FIGURE 6 and the apparatus of FIGURE 1 is that the thermostat 31' controls the hot air inlet valve 15, under usual conditions, i.e., during the winter heating season. In so doing the thermostat 31' has a direct-acting characteristic of the type shown in FIGURE 8 whereby increased observed room temperatures are accompanied by increased thermostat signal pressures.

The performance of the apparatus shown in FIGURE 6 will be described by reference to FIGURES 13 and 14.

Under the usual conditions, shown in FIGURE 13, the switching valve 33 directly connects the flow regulator pressure conduit 67 to the valve operator 18' through the switching valve 33 and the impulse conduit 71. The thermostat signal is delivered through the thermostatic signal conduit 42', through the impulse conduit 66', through the pressure selector device 34 and the impulse conduit 73 to the valve operator 17'. In this instance the thermostat 31', receiving a usual pneumatic supply through the conduit 37' is direct acting and has the characteristics shown in FIGURE 8. Accordingly when the thermostat 31' observes that the room has a temperature above the desired value Y, an increased pressure is developed in the thermostat signal conduit 42' and delivered as described to the valve operator 17' causing the valve 15 to be moved in a closing direction. Decrease in total air flow is instantaneously sensed by the flow controller 32 which generates a decreased pressure through the switching valve 33 and the impulse conduits 71 to the valve operator 18' causing the valve 16 to open and allow additional quantities of cool air to flow through the cool air duct 14.

Operation of the pressure selector device 34

When the thermostat 31' observes, under usual conditions, that the room is colder than the predetermined value Y, the thermostat signal pressure decreases in the thermostat signal conduit 42' until the valve 15 reaches a full open condition. If, in that full open condition of the valve 15, the amount of hot air flowing through the duct 13 exceeds the constant volume amount which is desired, the flow regulator device 32 will instantaneously observe the increased flow rate and develop an increased pressure in the flow regulator conduit 67 which will eventually close the valve 16 as that pressure rises to a value of 8 p.s.i.g. If the air flow from the hot air duct continues at its high rate, the pressure in the flow controller conduit 67 will continue to rise until it exceeds the lowering pressure in the thermostatic signal conduit 42' and impulse conduit 66' at which event the pressure selector device 34 will deliver the higher flow regulator pressure to the impulse conduit 73 resulting in a partial closing of the valve 15 until the net flow rate of conditioned air delivered by the system is restricted to its preselected constant value. Thus on excess demands for heating, the apparatus self-limits the output to the desired constant volume and overblowing of heated air is prevented.

Seasonal changeover—FIGURE 6

The operation of the apparatus of FIGURE 6 during the seasonal changeover conditions is illustrated schematically in FIGURE 14. Both the air inlet ducts 13, 14 are provided with cool air during the seasonal changeover conditions. The switching valve 33 is disposed in its alternative position with the thermostat signal conduit 42' connected to the impulse conduit 71. The flow regulator 32 is inoperative under these conditions. The thermostat 31', during seasonal changeover conditions, performs in its alternative characteristic as shown in FIGURE 9 whereby an increase in observed temperature results in a decrease of thermostat signal pressure delivered to the thermostat signal conduit 42'. Thus, during seasonal changeover conditions, when the temperature in the room exceeds the predetermined value X, a relatively low thermostat signal pressure is applied to the thermostat signal conduit 42', for example, 7 p.s.i.g., at which pressure the valve 15 is

fully open and the valve 16 is partially open. When the temperature is colder than the predetermined value X, the thermostat signal pressure increases in the thermostat signal conduit 42' and the valve 16 becomes fully closed when that pressure exceeds 8 p.s.i.g. and the valve 15 becomes partially closed as the pressure exceeds 8 p.s.i.g.

We claim:

1. In an air distributing system for a building room including separate conduit means each providing a separate stream of conditioned air to said room, one said separate stream being identified as a first stream and being always relatively cool and the other said separate stream being identified as a second stream and being in a usual condition, relatively hot, and in an alternative condition, being relatively cool;

a first valve means for regulating the flow of air from said first stream through a first outlet into said room; a second valve means for regulating the flow of air from said second stream through a second outlet into said room;

a thermostatic means responsive to the temperature within the said room for providing a thermostatic signal corresponding to the air temperature within said room;

a flow regulating means for providing a flow regulating signal directly corresponding to the cumulative flow rate of air from both said first outlet and said second outlet;

the improvement comprising:

signal switching means adapted in said usual condition to deliver as an output signal said flow regulating signal to a selected one of the said first and second valve means, and adapted in said alternative condition to deliver as an output signal the said thermostatic signal to the said selected one of said first and second valve means;

signal delivery means for delivering the said thermostatic signal to the non-selected one of the said first and second valve means;

said selected valve means being operable between a full-open and a full-closed position in response to actuating signals over a first range of pressures;

the said non-selected valve means being operable between a full-open and a full-closed position in response to actuating signals over a second range pressure;

the said first pressure range consisting essentially of pressures which are lower than the pressures of the said second pressure range;

whereby in said usual condition, the said cumulative flow rate of air from said outlets is substantially constant as a result of increase of air flow from one said outlet being accompanied with decrease of air flow from the other said outlet and vice versa; and

whereby in said alternative condition, the said cumulative flow rate may vary as a result of increase in flow of air from said non-selected valve means while the selected valve means is closed and sequential increase in flow of air from said selected valve means only while the valve of said non-selected valve means is fully open, according to the said thermostatic signal which is applied, in said alternative condition, to both said first and second valve means.

2. The improvement of claim 1 including:

a signal selector means having two inlet ports and one outlet port which is at all times connected to the said non-selected valve means;

the said signal delivery means including means for delivering the said thermostatic signal to one inlet port of said signal selector means and for delivering said output signal from said signal switching means to the other inlet port, said signal selector means being adapted to deliver the higher of the two inlet pressure signals through the said outlet to the said non-selected valve means;

whereby in the said usual condition, the said thermostatic signal is applied to the said non-selected valve means except where the pressure of the said flow regulating signal exceeds the pressure of the said thermostatic signal in which circumstance the said flow regulating signal is delivered through the said signal selector means to the said non-selected valve means.

3. The improvement of claim 1 wherein the said selected valve means is the said second valve means and the said output signal from the said signal switching means is applied to said second valve means;

said thermostatic signal is applied to said first valve means;

said thermostatic signal having a pressure inversely related to the observed room temperature at all times;

said second valve means being operable between its full-open and its full-closed positions in response to actuating signals over a first range of pressures;

said first valve means being operable between a full-open and a full-closed position in response to actuating signals over a second range pressure;

the said first pressure range consisting essentially of pressures which are lower than the pressures of the said second pressure range;

whereby in said usual condition, the said cumulative flow rate of air from said outlets is substantially constant as a result of increase of air flow from one said outlet being accompanied with decrease of air flow from the other said outlet and vice versa; and

whereby in said alternative condition, the said cumulative flow rate may vary as a result of increase in flow of air from said first valve means while the said second valve means is closed and sequential increase in flow of air from said second valve means only while the said first valve means is fully open, according to the said thermostatic applied, in said alternative condition, to both said first and second valve means.

4. The improvement of claim 3 including:

a signal selector means having two inlet ports and one outlet port which is at all times connected to the said first valve means;

the said signal delivery means including means for delivering the said thermostatic signal to one inlet port of said signal selector means and for delivering said output signal from said signal switching means to the other inlet port, said signal selector means being adapted to deliver the higher of the two inlet pressure signals through the said outlet to the said first valve means;

whereby in the said usual condition, the said thermostatic signal is applied to the said first valve means except when the pressure of the said flow-regulating signal exceeds the pressure of the said thermostatic signal in which circumstance the said flow-regulating signal is delivered through the said signal selector means to the said first valve means.

5. The improvement of claim 1 wherein the said selected valve means is the said first valve means and the said output signal from the said signal switching means is applied to the said first valve means;

said thermostatic signal is applied to said second valve means;

said thermostatic signal having a pressure directly related to the observed room temperature during said usual conditions and inversely related to the observed room temperature during said alternative conditions;

said first valve means being operable between its full-open and its full-closed positions in response to actuating signals over a first range of pressures;

the said second valve means being operable between a full-open and a full-closed position in response to actuating signals over a second range pressure;

the said first pressure range consisting essentially of

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pressures which are lower than the pressures of the said second pressure range;
 whereby in said usual condition, the said cumulative flow rate of air from said outlets is substantially constant as a result of increase of air flow from one said outlet being accompanied with decrease of air flow from the other said outlet and vice versa; and
 whereby in said alternative condition, the said cumulative flow rate may vary as a result of increase in flow of air from said second valve means while the said first valve means is closed and sequential increase in flow of air from said first valve means only while the said second valve means is fully open, according to the said thermostatic applied, in said alternative condition, to both said first and second valve means.
 6. The improvement of claim 5 including:
 a signal selector means having two inlet ports and one outlet port which is at all times connected to the said second valve means;
 the said signal delivery means including means for delivering the said thermostatic signal to one inlet port of said signal selector means and for delivering said

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output signal from said signal switching means to the other inlet port, said signal selector means being adapted to deliver the higher of the two inlet pressure signals through the said outlet to the said second valve means;
 whereby in the said usual condition, the said thermostatic signal is applied to the said second valve means except when the pressure of the said flow-regulating signal exceeds the pressure of the said thermostatic signal in which circumstance the said flow-regulating signal is delivered through the said signal selector means to the said second valve means.

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