Aug. 29, 1961 B. E. CURRAN ET AL 2,998,194

AIR CONDITIONING AND AIR DISTRIBUTING STRUCTURE

Filed March 29, 1957 4 Sheets-Sheet 1

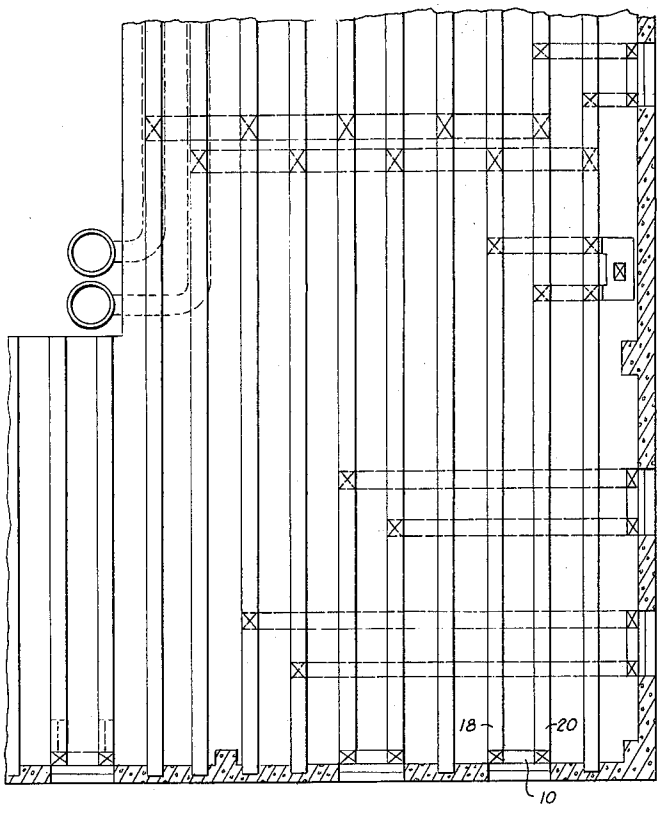


FIG. 1

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AIR CONDITIONING AND AIR DISTRIBUTING STRUCTURE

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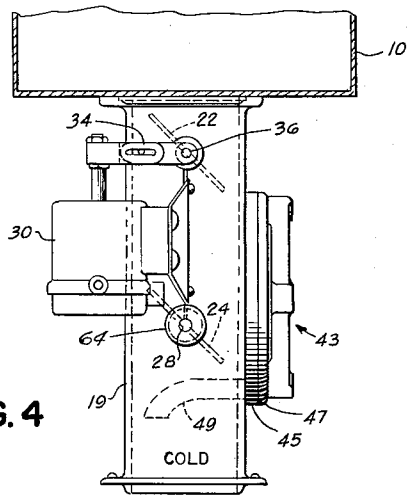


FIG. 4

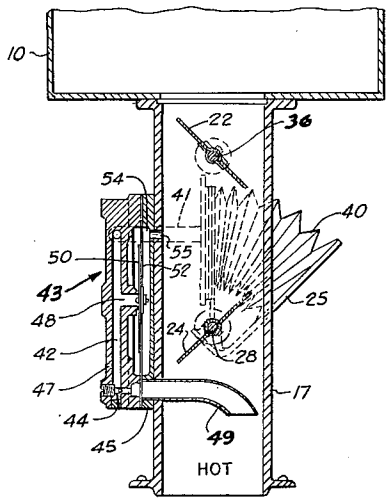


FIG.5

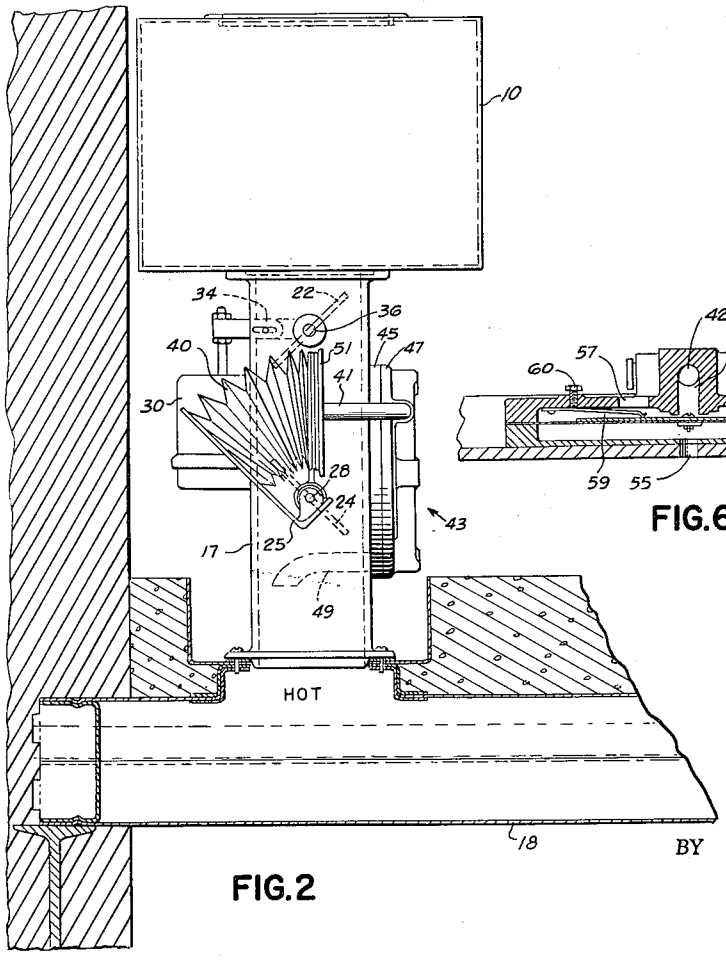


FIG.2

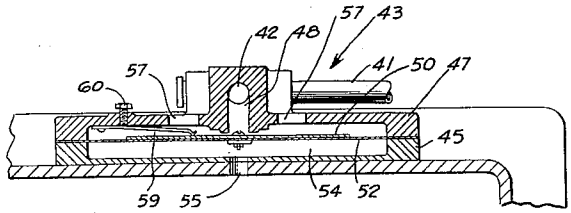


FIG.6

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AIR CONDITIONING AND AIR DISTRIBUTING STRUCTURE

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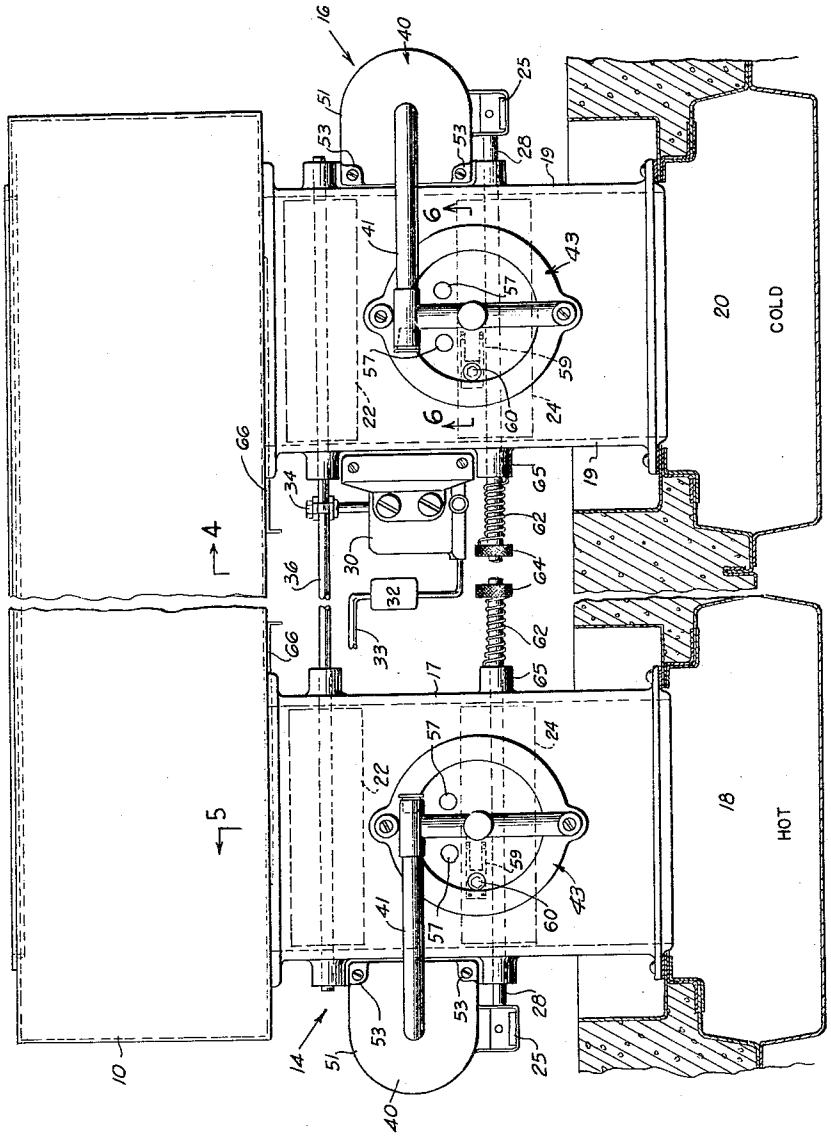


FIG. 3

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AIR CONDITIONING AND AIR DISTRIBUTING STRUCTURE

Filed March 29, 1957 4 Sheets-Sheet 4

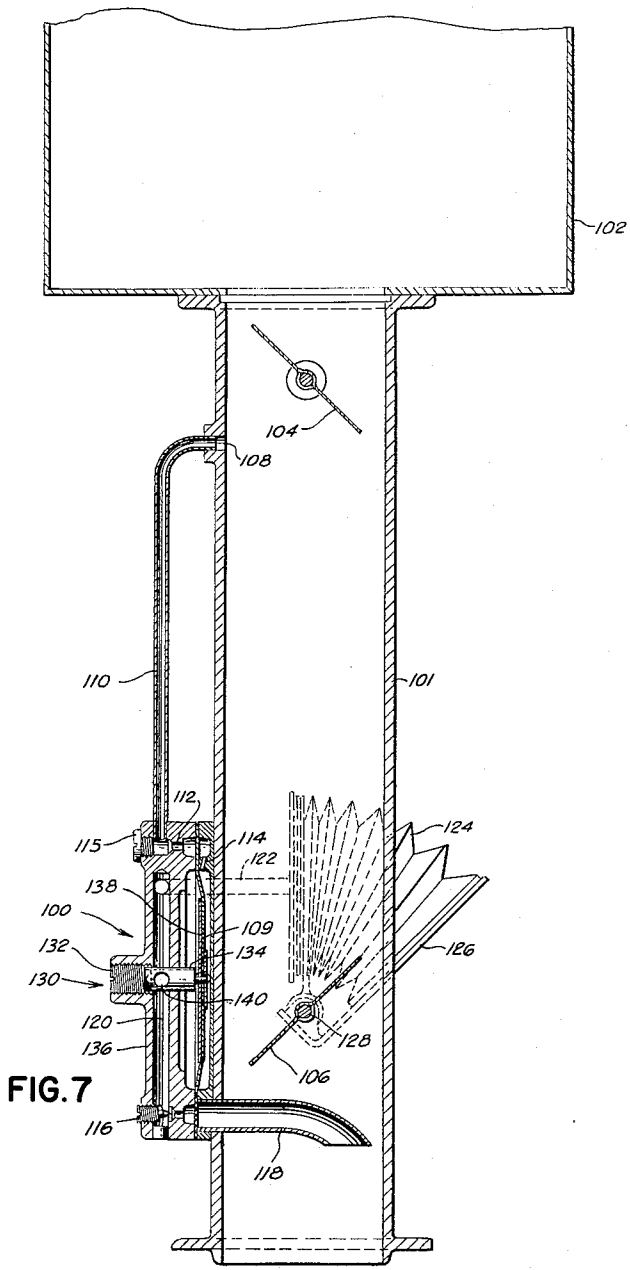


FIG. 7

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2,998,194

AIR CONDITIONING AND AIR DISTRIBUTING STRUCTURE

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3 Claims. (Cl. 236—13)

This invention relates to air conditioning control apparatus for use in an air conditioning system of the dual duct type.

One object of the invention is to provide novel control apparatus for the purpose specified wherein air is supplied to outlets to be discharged into the building and by which the condition of the air in the building may be more accurately controlled in a simplified, economical and practical manner.

A further object of the invention is to provide novel and efficient control apparatus of the type above specified which may be embodied with advantage in the air conditioning apparatus illustrated in the Goemann Patent No. 2,729,429, dated January 3, 1956.

In the drawings:

FIG. 1 is a plan of a portion of one story of a building embodying an air conditioning system having a cellular metal floor as a component thereof and in which the present control apparatus is preferably embodied;

FIG. 2 is a vertical sectional view illustrating a portion of the building and air conditioning system shown in the Goemann patent above referred to and embodying the present control apparatus;

FIG. 3 is a front elevation of the control apparatus shown in FIG. 2;

FIG. 4 is a side elevation partly in cross section as seen from the line 4—4 of FIG. 3;

FIG. 5 is a cross sectional view taken on the line 5—5 of FIG. 3;

FIG. 6 is a cross sectional detail view taken on the line 6—6 of FIG. 3; and

FIG. 7 is a longitudinal cross sectional view similar to FIG. 5 and illustrating a modified form of the present control apparatus.

In general the present invention contemplates novel control apparatus for an air conditioning system of the dual duct type and whose construction enables superior and more accurate control to be maintained of the air conditions within a building. Various forms of dual duct systems have heretofore been proposed wherein air of different condition is supplied through each of a pair of ducts and conveyed to a discharge outlet, such as a sill box, to be discharged into the room. The differently conditioned air under substantial pressure and at high velocity is caused to flow through said dual ducts to each outlet, and the volume as well as the proportions of the differently conditioned air at each outlet are under the control of a thermostat in the room or portion of the building to which the air is being supplied by the outlet. Because of static pressure variations in the air being supplied to each outlet such thermostatic control is ineffective to provide accurate control of the air conditions, and the present invention seeks to provide a novel apparatus for solving this control problem in a simple, economical and practical manner.

In general the present control apparatus contemplates a unit duct assembly connected to the outlet and through which air is caused to flow under pressure by connection of the unit ducts with each of the dual ducts of the dual duct air conditioning system. The unit duct assembly is provided with a pressure reducing damper mounted therein and also with a volume control damper spaced from the pressure reducing damper and disposed between the latter and the outlet. The unit is further provided with pneumatically operated means mounted externally of the duct and preferably to form a unit therewith for substantially restoring the static pressure in the portion of the duct between said dampers to a predetermined value when variations thereof occur upon operation of the volume control damper or upon variations in air pressure on the upstream side of the pressure reducing damper.

Referring to the drawings, the duct unit and control assembly is herein shown as designed to be used with a dual duct system in which hot and cold air is conducted through cells **18**, **20** forming components of the load supporting floor as illustrated in the Goemann patent above referred to. In its preferred form the invention contemplates a structure wherein a single thermostatically controlled air motor is used to operate corresponding pressure reduction and volume control dampers in each of the adjacent ducts of the present duct unit and control assembly. As best shown in FIG. 3, the illustrated apparatus includes an elongated sill box **10** forming a mixing chamber into which hot and cold air is conducted from the cells **18**, **20** through connecting ducts of the duct unit assemblies indicated generally at **14**, **16** and which include stacks **17**, **19** connected to openings in the upper walls of the hot and cold air cells **18**, **20**. Each of the stacks thus connected is provided with a volume control or mixing damper **22** and with a pressure reducing damper **24**. The upper or mixing dampers **22** in each stack are automatically adjusted pneumatically by an air motor **30** actuated by a room thermostat **32** which acts as a valve between a compressed air line **33** and the motor to increase or decrease the air pressure to the motor **30** in accordance with the room temperature. As shown in FIGS. 3 and 4, the air motor **30** is connected by an arm **34** to a shaft **36** extending through both the hot and cold air stacks **17**, **19** and in which are mounted the upper dampers **22**, the dampers **22** being arranged at right angles to each other so that rotation of the shaft in one direction will close the hot air damper and open the cold air damper, and conversely, rotation of the shaft in the opposite direction will open the hot air damper and close the cold air damper. In the drawings FIG. 2 shows the hot air damper in a partially closed position, and FIG. 4 shows the cold air damper in a partially open position so that in operation an increase in temperature in the room to effect an increase in the pressure to the air motor **30** will effect closing of the hot air damper, and opening of the cold air damper in an inverse ratio tending to maintain a constant pressure in the mixing chamber **10**. Conversely, a reduction in room temperature will reduce the air pressure to the motor **30**, and the dampers will be moved to supply more hot air and less cold air to the mixing chamber.

In order to maintain a constant static pressure of air in the portion of each stack between the pressure reducing dampers **24** and the mixing dampers **22** irrespective of variations in the air pressure in the air conducting floor cell, and also irrespective of variations in the settings of the mixing dampers **22**, each stack is provided with its individual pneumatically operated static pressure regulator unit **43** arranged to automatically adjust the lower or pressure reduction dampers **24** in a manner such as to compensate for such variations. As indicated in FIGS. 2 and 3, each pressure reduction damper **24** is mounted on a shaft **28** which is connected by a rigid arm **25** to the movable end of a bellows **40**. The stationary end of the bellows **40** is connected by an air tube **41** to a chamber **42** formed in the regulator unit **43**. As herein shown, each regulator unit includes a base plate **45** attached to the side of its stack and a cover plate **47** secured to the base plate. The air tube **41** communicates with the upper end of the chamber **42**,

the lower end of the chamber being connected through an adjustable needle valve 44 and pickup tube 49 extending into the stack with the main air supply in the stack on the upstream side of the pressure reducing damper 24. The chamber 42 is also provided with an opening comprising a bleeder port 48 arranged to cooperate with a flexible diaphragm 52. As shown in FIG. 5, adjacent faces of the base plate 45 and cover plate 47 are recessed to provide a second chamber 54 across which the flexible diaphragm 52 extends, the diaphragm being provided with a metal contact plate 50 on one side thereof for cooperation with the bleeder port opening 48. One side of the chamber 54 separated by the diaphragm is provided with a static pressure sensing opening 55 in communication with the air supply in the stack at a point between the mixing damper 22 and the pressure reduction damper 24. The other side of the chamber 54 is open to the atmosphere through openings 57 formed in the cover plate 47. As illustrated in FIGS. 3 and 6, the contact plate 50 of the diaphragm is normally resiliently maintained in a position spaced from the bleed port 48 by a flat leaf spring member 59 secured to the inner face of the cover plate 47 and having two legs spaced apart and engaging the contact plate to urge it away from the bleed port. The effective pressure of the leaf spring may be adjusted by a set screw 60 mounted in the cover plate 47 and which engages a portion of the leaf spring as shown. Normally, when the mixing damper 22 is in an open position the pressure of the air from the main air supply passing into the pickup tube 49 and chamber 42 is not sufficient to inflate the bellows 40, and any air passing into the tube may escape through the bleeder port 48 and atmospheric openings 57. Likewise, the pressure between the mixing damper 22 and the pressure reduction damper 24 when the mixing damper is in an open position is not sufficient to expand the diaphragm 52 so that the contact plate 50 will remain in its spaced position to permit escape of air through the bleed port 48. However, when the mixing damper is moved in a closing direction the air pressure in the stack between the two dampers 22, 24 is increased, expanding the diaphragm to move the contact plate 50 in a direction to close the bleed port 48. As a result the air pressure in the chamber 42 is built up to inflate the bellows 40 and effect rocking of the pressure reduction damper in a closing direction, thus effecting a reduction in the pressure between the two dampers and tending to maintain a constant pressure and stable flow of the air being discharged into the mixing chamber and through the outlet grille.

On the other hand, in the event the main air supply pressure should vary such as to increase the flow of air into the pickup tube 49 the air pressure in chamber 42 will also be increased to effect inflation of the bellows and rocking of the lower damper in a closing direction to reduce the pressure, thus also tending to maintain a constant static pressure between the two dampers. The needle valve 44 may be adjusted to regulate the admission of air so that the bleed port 48 can normally exhaust more air than is admitted whereby to permit deflation of the bellows and opening of the pressure reduction damper as described.

As herein shown, the bellows 40 may comprise a pleated structure of relatively thin flexible material connected at one end to a fixed end plate 51 which may be supported from the stack by lugs 53 as shown in FIG. 3. The end plate 51 is provided with an opening therein for receiving the pipe 41 connecting the chamber 42 with the interior of the bellows. The other end of the flexible bellows 40 is connected to the movable arm 25 which is fixed to the damper shaft 28 to effect rotation thereof upon expansion and contraction of the bellows. The coil spring 62 normally holds the bellows in a collapsed position. It will be understood that the operating pressure of the air entering the pickup tube 49 is a measure of the total pressure of the air entering the stack from the main supply ducts. In operation when the bellows 40 is fully inflated the pressure reduction damper is fully closed, and when the bellows 40 is fully collapsed the pressure reduction damper is fully open. In order to effect return of the bellows from an inflated position to a deflated position, upon a reduction of the pressure in the chamber 42 a coil spring 62 is wound about the damper shaft 28, one end of the spring being fixed in a knurled collar 64 adjustably mounted on the shaft, the other end of the spring being fixed in the bearing hub 65 as shown. As shown in FIG. 3, each inlet opening in the sill box 10 may be provided with a manually operated slide damper 66 between the sill box and the individual stacks 17, 19 in order to control the volume of air discharged into the sill box.

The above description includes hot and cold air for winter heating. For summer cooling, both air conducting cells 18, 20 may provide cold air, and both sets of dampers may be set parallel for simultaneous opening and closing so as to vary the amount of cold air being discharged in response to the room temperature.

From the above description it will be observed that the present novel damper control mechanism in a dual duct air conditioning system embodying novel pneumatically operated static pressure regulators is capable of maintaining a substantially constant static pressure of air in the portion of each stack between the pressure reducing dampers 24 and the mixing dampers 22 irrespective of variations in the air pressure in the air conducting floor cells and also irrespective of variations in the settings of the mixing dampers 22 in a novel, superior and highly efficient manner.

Referring now to FIG. 7, illustrating a modified form of damper control mechanism embodying a novel pneumatically operated static pressure regulator, it will be observed that the modified structure includes a pressure regulator unit, indicated generally at 100, which may be similar in construction and mode of operation to that above described except as to novel features as will be hereinafter described. It will also be observed that in the modified structure the stack 101 connecting an air conducting cell and the outlet or sill box 102 is made relatively longer than the connecting stack shown in FIG. 2 whereby to permit an increased spacing between the mixing damper 104 and the pressure reduction damper 106. It will be further observed that the static pressure sensing opening 108 which communicates with the back of the diaphragm 109 of the regulator unit 100 is preferably placed in the upper portion of the stack adjacent the mixing damper 104.

In operation, as a result of such change in the length of the stack 101 and location of the sensing opening 108, the flow of air passing the pressure reduction damper 106 is permitted to spread out and fill the cross sectional area of the stack 101 in the space between the pressure reduction damper and the outlet or mixing damper 104 before the flow reaches the mixing damper to thereby provide at the sensing opening 108 a more stabilized and representative sample of the static pressure all the way across the stream or air flowing through the stack. As illustrated in FIG. 7, this pressure is transmitted from the sensing point or opening 108 through a tube 110 connected to the top of the regulator unit 100 and through communicating openings 112, 114 in the regulator to the back of the diaphragm 109. The numeral 115 indicates a threaded closure plug, and 116 represents an adjustable flow restrictor needle for controlling the flow of air through the upstream pressure pickup tube 118 to the chamber 120 in the regulator unit 100. The chamber 120 communicates through a pipe 122 with the bellows 124 which is connected by an arm 126 to the shaft 128 of the pressure reduction damper 106.

The modified form of pneumatically operated static control pressure unit 100 shown in FIG. 7 is further provided with an adjustable bleed port orifice unit, indicated

generally at **130**, which is arranged to cooperate with the flexible diaphragm **109** to control the escape of air from the chamber **120** through the bleed port orifice and through the atmospheric openings **57**, which openings are not shown in FIG. 7 but which may be similar to those shown in FIG. 6. As shown in FIG. 7, the adjustable bleed port unit **130** includes a threaded plug **132** provided with a tube **134** carried by and extended from the inner end of the plug. The tube **134** extends through a close fitting opening in the cover plate **136**, and the free end of the tube is arranged to cooperate with the contact plate **138** carried by the flexible diaphragm **109**. The tube **134** is provided with radial openings **140** communicating with the chamber **120**. The clearance between the free end of the tube and the contact plate, termed the "seating orifice" or "bleed port clearance," may be adjusted by screwing the threaded plug **132** in or out to vary the clearance and thus change the bleed port capacity. In practice adjustment of the bleed port capacity has the effect of varying the flow capacity of the unit and eliminates the necessity for using the slide damper **66** shown in FIG. 3, as required when a relatively shorter stack **17, 19** is used.

In the operation of the modified form of control regulator, when the outlet damper **104** is wide open so as to give a certain flow capacity, the pressure reduction damper system assumes a certain disposition with respect to the air stream depending on the prevailing upstream pressure and the bleed port clearance. When the upstream pressure varies, the various elements change aspects to compensate for this variance so as to maintain a stable pressure at the sensing point **108** and a stable flow past the outlet damper **104**.

If, on the other hand, the upstream pressure remains constant and the adjustable seating orifice is screwed in or out from its previous position, the aspect of the pressure reduction system elements will rearrange themselves accordingly. If the plug **132** is screwed inwardly the bleed port clearance is reduced, more pickup pressure will flow to the bellows, the bellows will extend slightly, the pressure reduction damper will move in a closing direction, the control pressure will decline slightly, and the rate of flow will be slightly throttled from what it was previously. Conversely, if the plug **132** is screwed outwardly the bleed port clearance is increased, the reverse will take place and the flow will increase. In each instance, after the adjustment has been made, the device will continue to operate with the control pressure and the flow stabilized at the new setting.

Over a wide range of adjustability, the control pressure and the rate of flow with the outlet damper wide open are directly proportional to each other. This can be demonstrated by watching the pressure reduction damper setting change as the seating plug is screwed in or out, and then checking the control pressure and the rate of flow at various settings with the outlet damper wide open. Thus, it will be seen that the adjustable bleed port provides a quick and accurate means for adjusting capacity and for maintaining a stabilized control pressure and flow.

While the preferred embodiment of the invention has been herein illustrated and described, it will be understood that the invention may be embodied in other forms within the scope of the following claims.

Having thus described the invention, what is claimed is:

1. An outlet box having a mixing chamber and a discharge outlet for use in a dual duct air distributing system for discharging air into an individual zone of a building, said outlet box including a pair of side-by-side stacks within said mixing chamber, a pair of shaft mounted damper blades in each stack including an upstream blade and a downstream blade, said downstream blades being mounted on a common shaft and being positioned at right angles to each other whereby when the downstream blade in one stack is in a maximum flow restricting position, the downstream blade in the other stack is in a minimum flow restricting position, said downstream blades being movable in response to movement of said common shaft, means for positioning said common shaft in response to the temperature within said individual zone, said upstream blades being positioned independently of each other in response to the position of their individual shafts, regulating means for positioning each of said individual shafts over substantially a 90-degree range of movement in response to the static pressure existing between said upstream and downstream damper blades in that stack which is associated with each said individual shaft, said regulating means comprising a regulator and a bellows for each stack, said regulator comprising a casing secured to the outer surface of a stack, a movable diaphragm extending across said casing and dividing the interior of said casing into a pressure compartment and an air bleed compartment, a sensing port extending through a wall of said stack and a wall of said casing to communicate between said pressure compartment and the interior of said stack between said upstream and downstream damper blades, a conduit extending through a wall of said stack upstream of said upstream damper blade from a sensing point interior of said stack and further extending to a bleed port in a fixed wall of said air bleed compartment, said movable diaphragm being movable toward and away from said bleed port in response to the pressure within said pressure compartment, an exhaust port in a fixed wall of said air bleed compartment, said bellows having one end fixed at right angles to said stack and having the other end fixed to a pivotal plate attached to the extension of the individual shaft extending outside said stack, said conduit communicating with the interior of said bellows, said damper blade being in a position of minimum flow resistance when said bellows is in a collapsed condition and being in a position of maximum flow resistance when said bellows is in a maximum distended condition, said bellows being resiliently urged toward a collapsed condition.

2. The outlet box of claim 1 wherein the bellows is urged toward a normal collapsed condition by means of a resilient spring associated with the said individual shaft.

3. The outlet box of claim 1 wherein said movable diaphragm is normally urged to a position removed from engagement with said bleed port by means of an adjustable spring within said casing.

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