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3,082,676

## AIR DISTRIBUTING UNIT

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This invention relates to air distributing units, and more particularly to improved air distributing units incorporating damper means therein. This invention also relates to a method of controlling a damper in an air distributing unit.

It is usual in normal air conditioning practice to attempt to separate variable and constant loads. The variable loads usually consist of transmission losses through the exterior walls of the area to be treated and also solar radiation losses through these walls. The constant loads usually consist of the illumination load, the people occupying the area, and also the equipment located within the area to be treated. In more refined systems the areas to be conditioned are arbitrarily divided into interior zones and exterior zones. An exterior zone usually encompasses the peripheral area of the building to a depth of about fifteen feet. Usually special air conditioning units, such as induction units of the type described in Carrier Patent 2,363,294, granted November 21, 1944, are utilized in these exterior zones to accommodate the variable and constant loads.

An interior zone is usually considered to have substantially a constant load and it is normal to utilize outlets or units with no, or possibly only manual control means to accommodate the area. It has always been known that the interior zone is not truly a constant load area and the assumption that it is such is a compromise measure. Very often an interior area will be vacant for long periods of time, lights may be extinguished and equipment may not be used. Under such circumstances the temperature of the room will approach the temperature of the air discharged in the area which may be below 60° F., resulting in uncomfortable conditions within the room. In other instances, as a result of the relocation of equipment such as calculating, accounting and other electrical equipment, the load of the area may be increased and remain at a new higher level which cannot be met by the existing outlet arrangement. Under these circumstances it can easily be seen that the interior zone is not truly a constant load zone but rather one wherein the load may change within limits. Under such circumstances the constant output air conditioning devices utilized to condition such areas will not function properly to provide satisfactory conditions within the area.

The chief object of the present invention is to provide an improved air distributing unit including damper means for accommodating change in load conditions.

Another object of the invention is to provide an improved air distributing unit including damper means which may be actuated by the pressure of the fluid being supplied to the unit.

A still further object of the invention is to provide an improved bladder damper.

A still further object is to provide an air distributing unit including a bladder damper which is actuated by the pressure of the air being supplied to the air distributing unit.

A further object is to provide a method for operating a bladder damper in an air distributing unit. Other objects will be readily perceived from the following description.

This invention relates to an air distributing unit for discharging air into an area to be treated comprising the

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combination of a conduit, at least one plenum chamber, means for supplying conditioned air from the conduit to the plenum chamber, means defining a longitudinal slot-like discharge outlet in said chamber, said means including a wall of the chamber defining one longitudinal peripheral portion of the slot and a bladder damper defining the opposite longitudinal peripheral portion of the slot, and means for inflating the damper to cooperate with the opposite peripheral portion of the slot to regulate passage of air from the chamber to the area being treated.

This invention also relates to a method of regulating the discharge of air from an air conditioning unit having a plenum chamber, the steps which consist in supplying conditioned air to the plenum chamber at a predetermined pressure, maintaining air pressure in a bladder at a predetermined pressure less than the pressure within the plenum chamber thereby deflating a portion of the bladder extending into the plenum chamber, expanding the air discharged from the plenum chamber causing the air in the bladder located adjacent the discharge side of the outlet from the plenum chamber to expand to regulate the passage of air from the plenum chamber and controlling the pressure within the bladder in response to conditions within the area being treated.

The attached drawings illustrate a preferred embodiment of the invention, in which

FIGURE 1 is a sectional view illustrating the air distributing unit of the present invention;

FIGURE 2 is an enlarged sectional view of the bladder damper with a diagrammatic showing of a control system to be used with the damper, and

FIGURE 3 is an enlarged perspective view, partly diagrammatic, partly in section, showing the use of a plurality of units to condition an area to be treated, said units being operatively associated with a source of conditioned air.

Referring to the drawings, FIGURE 1 discloses a sectional view of the unit 2. This unit includes a conduit section 3 which is defined by the top wall 4 and the side walls 5 and 6. The conduit section 3 has a lower wall 7 which separates the conduit section from the air distributing section 12.

The air distributing section 12 comprises the plenums 13 and 13' which are located on opposite sides of a bladder damper 15. The plenum 13 is defined by the extension of wall 22, wall 7 and the lower wall 10. Similarly, the plenum 13' is defined by the wall 7, the extension of the wall 23 and lower wall 10'. In order to pass conditioned air from the conduit section 3 into the plenums, suitable openings 8 are spaced along the edges of the wall 7 adjacent the juncture of the wall 7 with the walls 5 and 6. Associated with these openings 8 are a plurality of deflecting vanes 9 which extend into the plenums 13 and 13'. These vanes perform a diffusing action and substantially remove the velocity components from the air in the conduit 3 and convert it substantially to static pressure within the plenums 13 and 13'.

The air discharged from the plenums 13 and 13' through the longitudinal openings defined by the edges of the walls 10 and 10' and the opposite edges defined by the bladder damper 15. This bladder damper will be described more fully hereinafter.

As the air passes from each of the plenums, the air is expanded adjacent the angular walls 26 and 27. These walls may be suitably perforated, placing the discharge side of the longitudinal orifices from the plenums into communication with the silencing chambers 16 and 16'. The chamber 16 is defined by the walls 10, 22, 20, and the perforated section 26. The second silencing chamber 16' is defined by the walls 10', 23, 21, and the perforated

section 27. These chambers may be filled with suitable sound-insulating material such as glass wool.

The bladder damper 15 may be connected to the wall 7 by means of a suitable filler piece 70. A suitable deflector 30 may be suspended from the lower portion of the bladder damper 15 to deflect the air discharged from the respective plenums in a general horizontal direction substantially parallel to the walls 20 and 21. These deflectors normally consist of two surfaces 31 and 32 which perform a turning function and also provide two longitudinal slots. For the purpose of maintaining low noise levels, these surfaces 31 and 32 are normally flocked. The lower portion of the deflector comprises two angularly disposed planar surfaces 33 and 34.

Very often it is desired that these units be continuous throughout the length of an area. In other situations it may be desirable to separate these units. For this reason the conduit section 3 is usually supplied in a three-sided construction with the open lower end being provided with bent sections (not shown). These bends extend toward the interior of the conduit and are intended to either fit closing members or to engage the bent portions of the air distributing sections 12, especially the walls 22 and 23 thereof which have outwardly bent portions 24 and 25 adapted to engage the conduit section 3.

Referring to FIGURE 2, there is shown an enlarged view of the damper with a control which may be utilized therewith. It will be noted that the walls 10 and 10' which define the lower portion of the plenum extend beyond the juncture point with the walls 26 and 27. These edges form sealing edges adapted to coact with the bladder damper to throttle the air passing from the plenum. The bladder damper includes a chamber 40 which has a generally parallelepiped shape defined by the walls 41, 42, 43 and 44. Covering these walls which form the chamber 40 is a suitable fabric envelope 50 which comprises the bladder of the damper. The fabric may consist of a cloth impregnated with a suitable elastomer material such as nylon fabric coated or impregnated with neoprene or a polymerized butadiene.

To actuate the bladder to cooperate with the edges of the walls 10 and 10', suitable openings 45 and 46 are spaced in the walls 41 and 42. These openings are located in the upper portion of the chamber 40, specifically in the portion of the bladder damper which extends into and at least partially define wall portions of the plenums 13 and 13'. It is intended that a control pressure be introduced into the control chamber 40, this control pressure being a pressure less than the pressure existing within the conduit 3 and the plenums 13 and 13'. It is intended that this lesser pressure exists in the control chamber so that the control fluid will pass through the openings 45 and 46 and be metered between the bladder 50 and the surfaces 41 and 42 adjacent the openings 45 and 46.

In physically providing the ports 45 and 46, it should be done in a manner so as not to provide positive sealing surfaces between the wall sections 41 and 42 which lie adjacent these ports, for it is intended that the fluid passing from the chamber 40 be able to pass toward the lower portion of the damper in such a manner as to permit inflation of the lower portion of the damper in a manner to be described hereinafter.

Because the plenum is at a higher pressure than the pressure within the chamber 40, the upper portion of the bladder will be urged in substantial surface contact with the surfaces 41 and 42. However, as the air passes through the longitudinal openings defined by the edges of the walls 10 and 10' and the bladder damper, the air will be expanded thereby decreasing its pressure. The lower portion of the bladder damper will be at a higher pressure than the adjacent air causing the lower portion of the bladder to expand. This expanded bladder will coact with the edges of the walls 10 and 10' throttling the air passing from the plenums 13 and 13'.

It will be appreciated that because of the particular construction of the bladder and the inherent metering function performed by the bladder coacting with the area adjacent ports 45 and 46, air may be metered into the lower portion of the bladder providing stability in operation and avoiding the common defect of bladder dampers, namely a fluttering action. This fluttering action which is normally experienced in bladder dampers contributes to poor control and also excessive noise resulting in making the damper inadequate for use.

In order to control the pressure within the chamber 40 there is also disclosed in FIGURE 2 an arrangement for regulating the controlled air pressure within the chamber 40. It will be noted that this damper is of the type which is actuated by the fluid being supplied to the unit. A line 51 extends from the conduit 3 and has located therein an orifice 52 which throttle the air passing there-through. If it is desired, the pressure of the air in the plenums 13 and 13' may be used to actuate the control. On the discharge side of the orifice 52 the line 53 extends into the control chamber 40. Connected to this line 53 is a suitable T-connection having extending therefrom the line 54 which is connected to the pressure-regulating device 55.

This pressure-regulating device 55 comprises a casing 58 having an opening 62 therein. Located within the casing 58 is a suitable piston 60 with a port 61 which by the operation of the piston provides a variable orifice connecting the line 54 and the vent opening 62 in the casing 58. This opening 62 discharges into the area being treated. The piston 60 is acted upon by conduit pressure which is connected to the casing 58 by means of the line 57. This conduit pressure urges the piston downwardly and opposes the bias of the spring member 63. By this means there is provided a conduit pressure-responsive venting arrangement which is in communication with the control chamber 40.

Under certain circumstances it is also desirable to make the bladder damper responsive to temperature conditions within the area to be treated. This is achieved by connecting the conduit 3 to the control chamber 40 through the line 65 and locating within this line 65 a suitable thermostatic valve 66. This thermostatic valve 66 is connected by means of the line 67 to the bulb 68. The bulb responds to temperature conditions in the room and varies the opening in the valve 66 to control the pressure within the control chamber 40 in response to temperature conditions.

It will be appreciated that the pressure within the control chamber 40 will always be less than conduit pressure because the control chamber is always being vented through the action of the volume control member 55.

Referring to FIGURE 3 there is shown a plurality of units 2, 2' and 2'' connected in series which discharge into an area 28. These units are located above the ceiling 80 of the room having the slot portions as defined by the deflector portion 30 extending into the area 28. The upper portions of these units are shown partially in section to disclose the plurality of openings 8 passing through the partition which separates the conduit from the plenum sections of the individual units. These units are connected to a suitable conduit 75 which extends to the central station 90 of the system. The central station normally includes louvers 91 for controlling the mixture of return air and outside air to be conditioned, a pre-heater coil 92, sprays 93, cooling coil 94, heating coil 95 and fan 96.

Considering the operation of the unit, air enters the central station 90, and is suitably heated, cooled and/or humidified and passed by the fan 96 through the conduit 75 into the conduit sections of the one or more units. This air is taken off through the openings 8 and passed into the respective plenums 13 and 13' of the units 2, 2' and 2''. The air because of the vanes 9 is diffused into the plenum substantially converting the

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velocity pressure to static pressure. This static pressure is substantially higher than the pressure within the area to be treated. The air is then passed through the longitudinal openings formed by the bladder damper 15 and the edges of the walls 10 and 10' (FIGURE 1). The air then passes through the discharge side of the openings and because of the flocking on the surfaces 31, 32 and also because of the silencing chambers 16 and 16', the noise level of the air is suitably diminished.

Considering the operation of the bladder damper, the air passes from the conduit 3 (FIGURE 2) through the orifice 52 thereby supplying a pressure less than conduit pressure into the chamber 40. The pressure in the chamber 40 is further varied in response to conduit pressure by the pressure-responsive element 55 which suitably vents the chamber 40 in response to conduit pressure. The pressure within the chamber 40 is further affected by the temperature within the area to be treated in response to the thermostatic-sensing element 68 which controls the thermostatic valve 66. Because of this control arrangement the pressure within the chamber 40 is less than that existing in the plenums 13 and 13', the upper portion of the bladder 50 is urged against the surfaces of the walls 41 and 42. The bladder damper meters the flow of fluid from the chamber 40 into the lower portions of the bladder defined by the bladder itself and the surfaces of the walls 41 and 42. Because the air passing from the plenum is suitably expanded as it passes through the longitudinal discharge openings from the plenums, the pressure on the discharge sides of the openings is less than within the bladder extending adjacent thereto permitting the bladder to expand. This expansion is controlled by the pressure within the control chamber in such a manner as to enable the bladder to coact with the edges of the walls 10 and 10' so as to throttle the discharge from these plenums in response to the aforementioned volume and temperature controls.

It will be understood, if desired, that plenums 13, 13' may be formed as a single plenum; in such case, of course, filler piece 70 may be omitted. Damper 15 cooperates with the edges of members 10, 10' to meter the discharge of air into the area being treated.

The present invention presents an inexpensive, self-powered bladder damper control especially adapted for units utilized in interior zone applications in air conditioning systems. This unit is not only competitive in cost to existing units which have no provision for controlling the discharge of the unit but has suitable versatility which permits it to respond to slight changes in load conditions within the area to be treated so that changes in load are suitably compensated for in a manner to provide continuous satisfactory comfort conditions.

While we have described a preferred embodiment of this invention, it will be understood the invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

We claim:

1. In an air conditioning system for an area to be treated a source of conditioned air, a conduit connected to said source of conditioned air, said conduit having a general rectangular cross-section and including a first wall, a plenum chamber located adjacent said conduit, said first wall at least partially defining the plenum chamber, a plurality of openings extending through said wall placing said conduit and plenum chamber in communication, said openings being located adjacent the juncture of the first wall with an adjacent wall of the conduit, means associated with said openings and extending into said plenum chamber for diffusing the air passing into the plenum chamber, a second wall spaced from and parallel to said first wall and also partially defining said plenum chamber, said second wall having a longitudinal slot-like outlet therein, a third wall spaced from said second wall and being parallel therewith and forming therewith a sound-absorbing chamber, damper means extending from with-

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in the plenum chamber into the area adjacent said sound-absorbing chamber, said longitudinal slot-like outlet in said second wall having a longitudinal peripheral portion, said damper means cooperating with said longitudinal peripheral portion to regulate the passage of air from the plenum chamber into the area being treated.

2. The air conditioning system according to claim 1 in which the damper means comprises a control fluid chamber, a planar member forming a wall of said chamber extending from within the plenum chamber to a point on the discharge side of the longitudinal slot-like outlet, a flexible sheet covering said planar member, at least one opening in the planar member placing the area between the flexible sheet and planar member in communication with the control fluid chamber so that the pressure in said chamber is exerted against said sheet to urge said sheet into cooperation with the longitudinal peripheral portion of the longitudinal slot-like outlet to regulate the air being discharged from the plenum.

3. An air conditioning system according to claim 2 further comprising means for introducing fluid pressure within the control fluid chamber less than the pressure within the conduit.

4. An air conditioning system according to claim 1 in which the damper means comprises a control fluid chamber having a general parallelepiped shape, said control fluid chamber being enveloped by a flexible sheet, said control chamber having at least one planar member extending within the plenum chamber to a point on the discharge side of the longitudinal slot-like outlet at least one opening in said planar member located in a portion of the planar member extending within the plenum placing the area between the flexible sheet and the planar member in communication with the control fluid chamber so that pressure in said chamber is exerted against the sheet to urge said sheet into cooperation with the longitudinal peripheral portion of the longitudinal slot-like outlet to regulate the air being discharged from the plenum.

5. In a method of regulating the discharge of air from an air conditioning unit including a plenum chamber having a slot like outlet and an inflatable member to regulate passage of air from the chamber, the steps which consist in supplying conditioned air to the plenum chamber at a predetermined pressure, maintaining air pressure in said member at a predetermined pressure less than the pressure within the plenum chamber so that the portion of the member exposed to pressure in the plenum chamber is deflated, air discharged from the plenum chamber through the outlet expanding so that pressure in that portion of the member located adjacent the discharge side of the outlet from the plenum chamber is greater than the pressure of the expanding air thereby regulating the passage of air from the plenum chamber and controlling the pressure within the member in response to conditions within the area being treated.

6. In an air distributing unit for supplying conditioned air to an area to be treated, the combination of a conduit, at least one plenum chamber, means for supplying conditioned air from the conduit to the plenum chamber, means defining a longitudinal slot-like discharge outlet in said chamber to discharge conditioned air from the chamber to the area, said means including a wall of the chamber defining one longitudinal peripheral portion of the slot and control means defining a second longitudinal peripheral portion of the slot, said control means including a control fluid chamber having at least a portion thereof disposed adjacent the plenum chamber within the slot, and an inflatable member placed over a wall of the control chamber and having an upper portion within the plenum chamber and a lower portion without the plenum chamber, means for supplying a desired fluid pressure to said fluid control chamber, means placing the space between the control fluid chamber and the inflatable member in communication with the control fluid chamber, pressure in said plenum chamber being

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greater than pressure in said fluid control chamber so that plenum air pressure urges the upper portion of the inflatable member into substantial contact with the wall of the control fluid chamber in the area within the plenum chamber and the lower portion of the inflatable member without the plenum chamber inflates to cooperate with the peripheral portion of the slot formed by the plenum chamber wall to regulate passage of air from the plenum chamber to the area being treated.

7. An air distributing unit according to claim 6 in which means are provide for introducing a fluid pressure within the control fluid chamber less than the pressure within the conduit.

8. An air distributing unit according to claim 7 in which the opening in the wall is located in the portion of the wall extending into the plenum so that plenum air pressure urges the flexible sheet into substantial contact with the wall in the area within the plenum and the portion of the flexible sheet on the discharge side of the longitudinal slot-like discharge outlet inflates to regulate the passage of air from the plenum to discharge air from the plenum into the area.

9. In an air distributing unit for discharging air into an area to be treated, the combination of a plenum chamber, means for passing a supply of air into the plenum chamber, means defining a longitudinal slot-like discharge outlet from the plenum chamber to discharge air from the plenum into the area, said means including a wall of the plenum chamber defining one longitudinal peripheral portion of the slot, and control means defining a second longitudinal peripheral portion of the slot, said control means including a control fluid chamber having at least a portion thereof disposed adjacent the plenum chamber within the slot, and an inflatable member placed over a wall of the control chamber and having an upper portion within the plenum chamber and a lower portion without the plenum chamber, means for supplying a desired fluid pressure to said fluid control chamber, means placing the space between the control fluid chamber and the inflatable member in communication with the control fluid chamber, pressure in said plenum chamber being greater than pressure in said fluid control chamber so that plenum air pressure urges the upper portion of the inflatable member into substantial contact with the wall of the control fluid chamber in the area within the plenum chamber and the lower portion of the inflatable member without the plenum chamber inflates to cooperate with the peripheral portion of the slot formed by the plenum chamber wall to regulate passage of air from the plenum chamber to the area being treated.

10. In an air distributing unit for discharging air into an area to be treated, the combination of a plenum chamber, means for passing a supply of air into the plenum, means for discharging air from the plenum said second means including a wall member defining one longitudinal edge portion of a slot outlet, regulating means including an inflatable member having an upper portion within the plenum and a lower portion without the plenum to cooperate with said slot portion to regulate passage of air from the plenum chamber to the area

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being treated, and means for inflating the lower portion of the inflatable member, said regulating means including a control fluid chamber, a planar member forming a wall of the control fluid chamber extending from within the plenum chamber to a point beyond the discharge side of the slot, the inflatable member comprising a flexible sheet covering said planar member, said planar member having at least one opening therein placing the space between the flexible sheet and the planar member in communication with the control chamber so that pressure in the control chamber is exerted against the sheet to urge said sheet into cooperation with the edge portion of the outlet to regulate the air being discharged from the plenum.

11. An air distributing unit according to claim 9 in which said wall of the plenum chamber slants outwardly from the discharge outlet to permit expansion of air discharged from the plenum chamber through said outlet.

12. In an air distributing unit for discharging air into an area to be treated, the combination of a first plenum chamber, a second plenum chamber, means for supplying air to the plenum chambers, control means disposed between the plenum chambers and cooperating with a wall of each plenum chamber to define a longitudinal slot-like discharge outlet from each chamber, said control means including a control fluid chamber having at least a portion thereof disposed adjacent the plenum chambers within the outlets, and at least one inflatable member disposed about the control fluid chamber over the exterior wall thereof, the inflatable member having upper portions within the plenum chambers and lower portions without the discharge outlets, means for supplying a desired fluid pressure to said fluid control chamber, means placing the spaces between the control fluid chamber and the inflatable member in communication with the control fluid chamber, said communication means being placed in that portion of the walls of the control fluid chamber extending within the outlets, pressure in the plenum chambers being greater than pressure in said fluid control chamber so that plenum air pressure urges the upper portions of the inflatable member into substantial contact with the exterior walls of the fluid control chamber in the areas within the plenum chambers and the lower portions of the inflatable member inflate to cooperate with the peripheral portions of the outlets formed by the plenum chamber walls to regulate passage of air from the plenum chambers through the outlets to the area being treated.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,082,676

March 26, 1963

Richard A. Church et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 34, for "aocommodate" read -- accommodate --; column 2, line 9, for "periphearal" read -- peripheral --; line 59, after "air" insert -- is --; column 4, line 17, for "throttle" read -- throttles --; column 5, line 44, for "adaped" read -- adapted --; column 7, line 11, for "provide" read -- provided --; column 7, line 21, strike out "to discharge air from the plenum into the area"; column 8, line 31, strike out "dis-".

Signed and sealed this 11th day of February 1964.

(SEAL)

Attest:

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Acting Commissioner of Patents