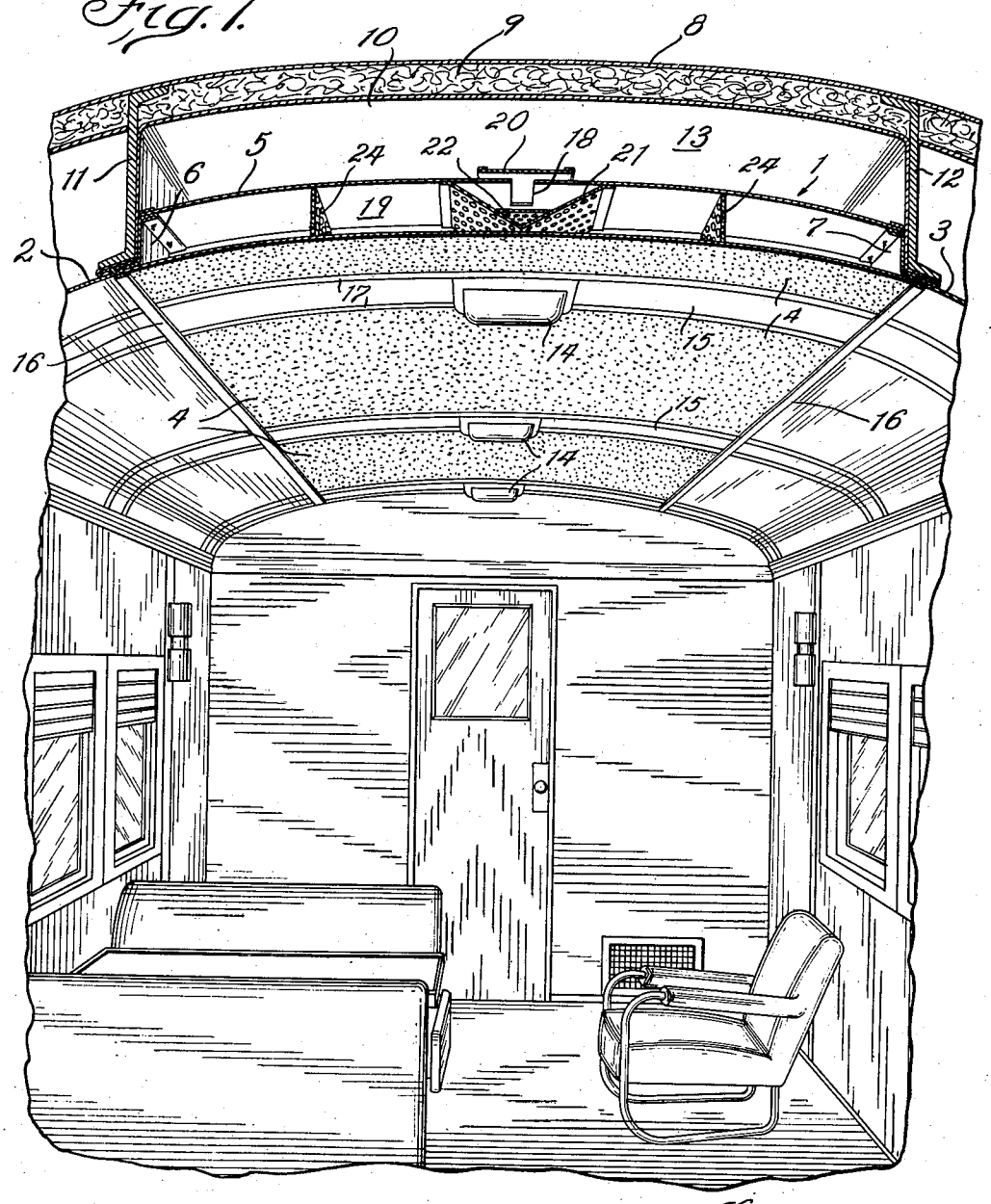
Aug. 5, 1941. R. L. LEADBETTER 2,251,682

VENTILATING CONSTRUCTION

Filed May 2, 1938 4 Sheets-Sheet 1

Fig. 1.



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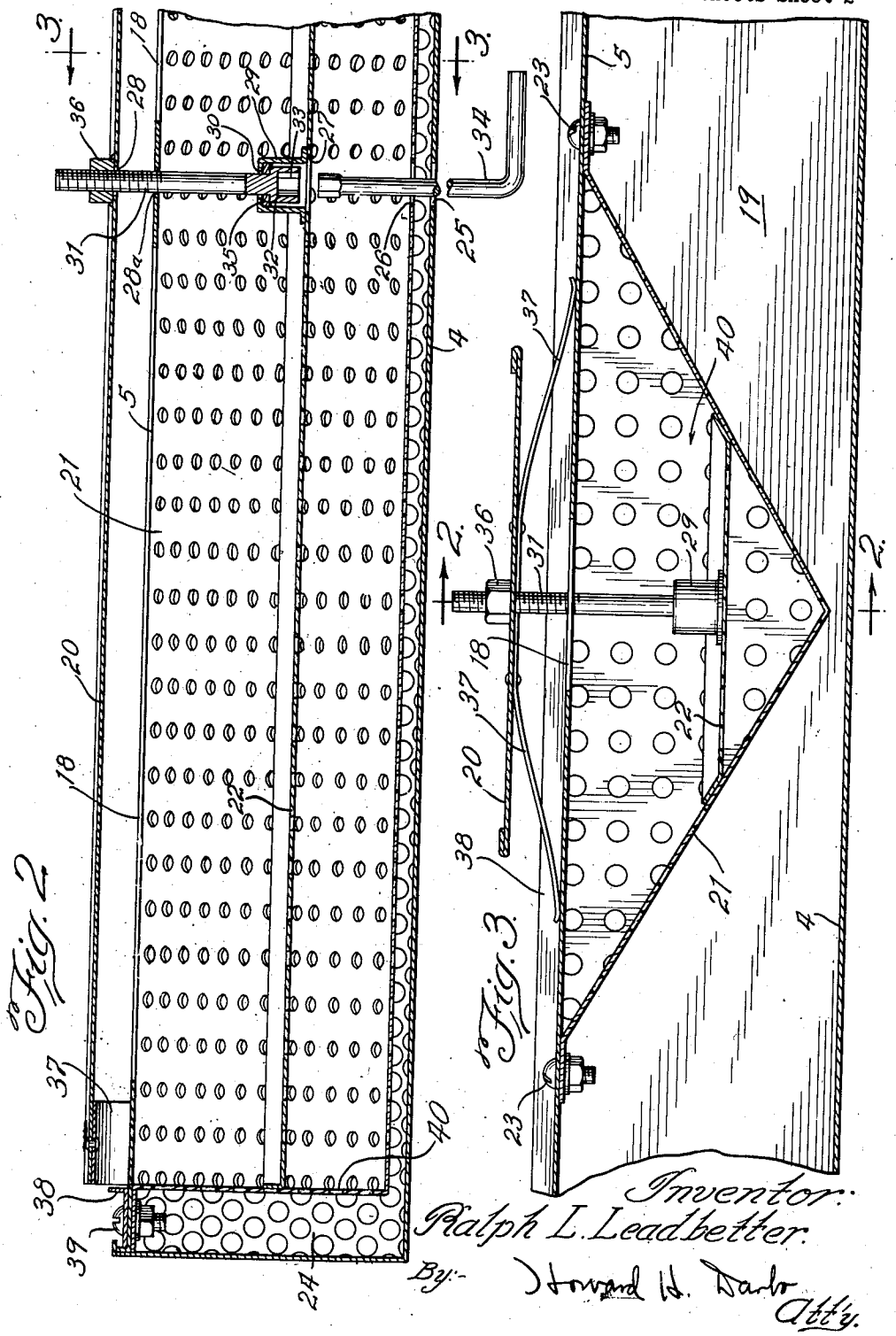


Fig. 2

Fig. 3.

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VENTILATING CONSTRUCTION

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Fig. 4.

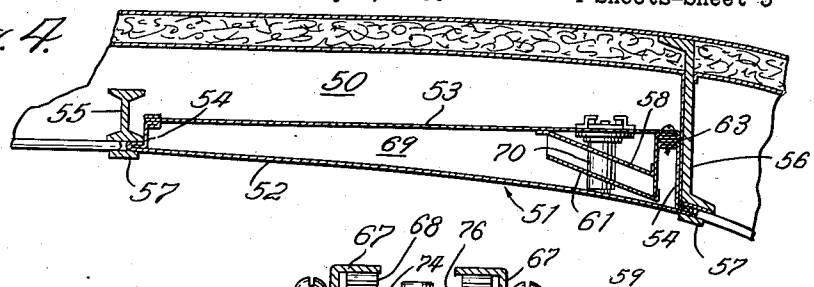


Fig. 6.

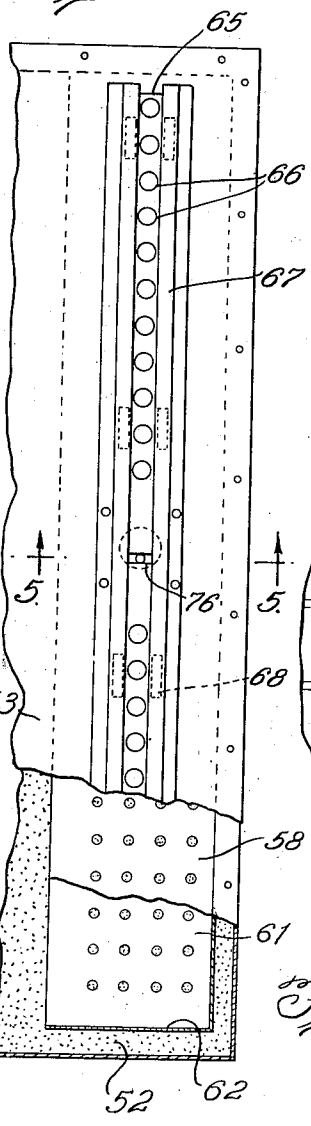
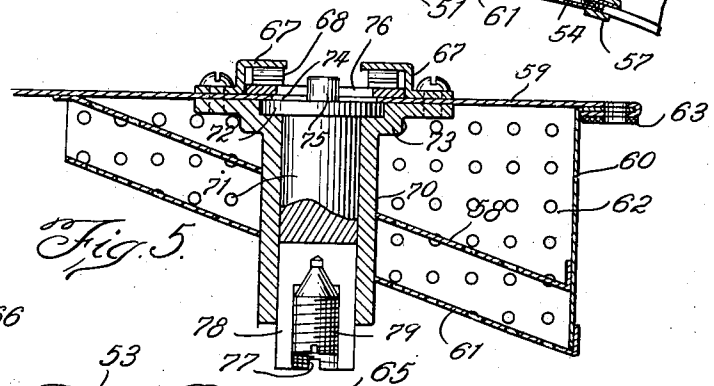


Fig. 5.



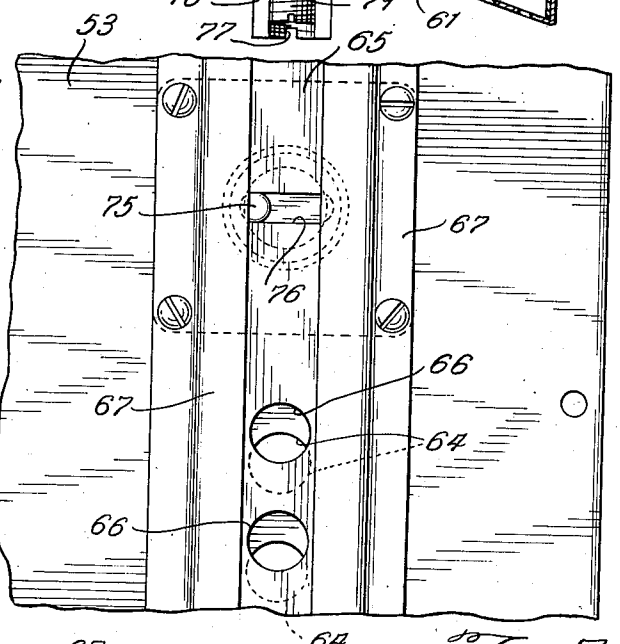


Fig. 7.

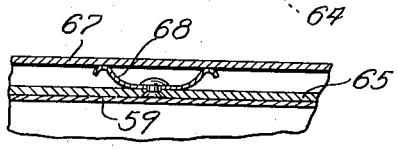


Fig. 8.

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VENTILATING CONSTRUCTION

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Fig. 9.

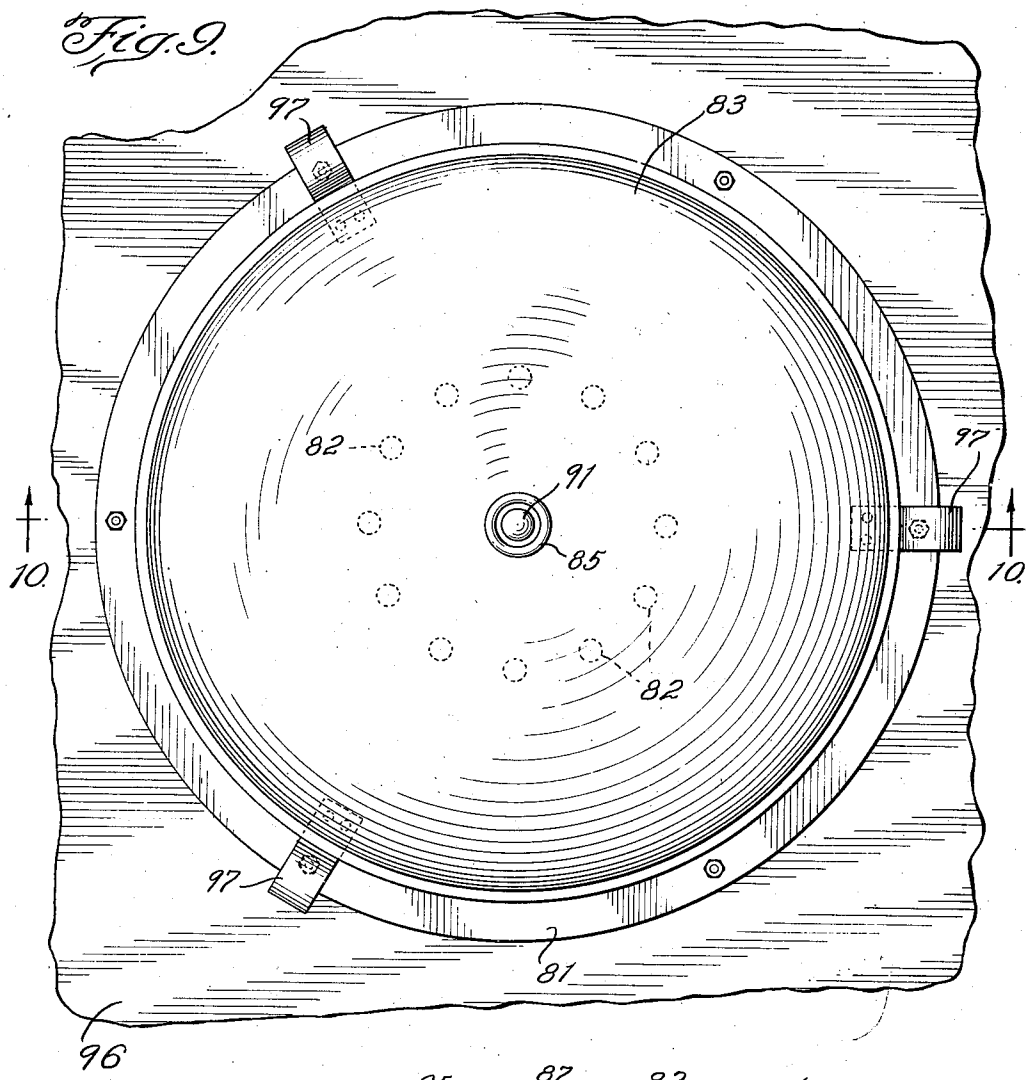
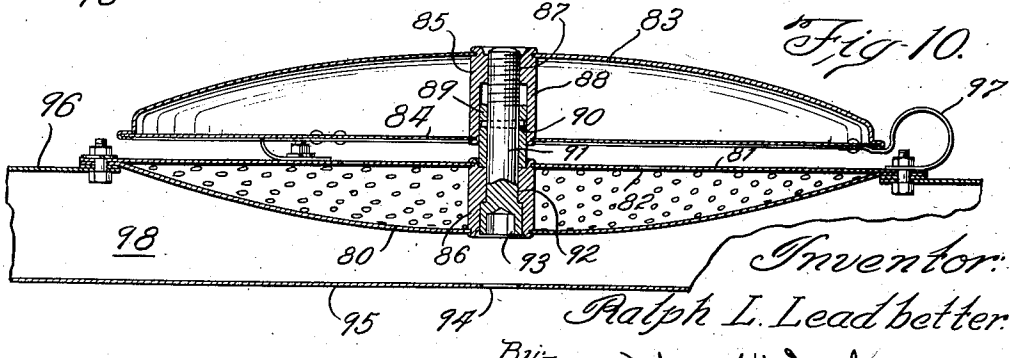


Fig. 10.



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Patented Aug. 5, 1941 2,251,682

UNITED STATES PATENT OFFICE

2,251,682

VENTILATING CONSTRUCTION

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Application May 2, 1938, Serial No. 205,403

8 Claims. (Cl. 98—14)

This invention relates to improvements in air-distributing apparatus for ventilating systems, and pertains particularly to that type of air-distributing apparatus in which the ventilating air is introduced into an enclosure through a perforated or otherwise apertured panel of large area in comparison with the ordinary ventilating grille.

Air-distributing apparatus of the above type in which a plenum chamber is separated from the enclosure to be ventilated by a double panel of sheet-like apertured members in spaced parallel relation with each other has recently been commercially adopted and is now widely used for distributing conditioned air in closed vehicles, especially in railway coaches and motor buses. The plenum chamber is generally located overhead and the double panel air-distributor forms at least a portion of the ceiling of the enclosure. The upper panel, which is not visible from below, is usually provided with a relatively small number of holes and is known as the control panel since it functions, due to the limited proportion of open area, to restrict the flow of air from the plenum chamber into the enclosure below, thus maintaining an appreciable super-atmospheric pressure substantially uniform throughout the volume of the plenum chamber. Under such conditions it is possible to distribute the air from the plenum chamber into the enclosure in accordance with predetermined specifications by varying the number and/or size of openings in any zone of the control panel. A perforated facing member, usually provided with a large number of small openings and generally referred to as the distributing panel, forms the ceiling of the enclosure as well as a final distributing outlet of the air distributor, serving to screen the control panel which is generally unsightly. The purpose of the construction is to distribute ventilating air into an enclosure in desired quantities at different parts thereof and without draft formation.

Experience has shown that the air streams passing through the openings in the control panel do not spread sufficiently to prevent their impingement at high velocity against the perforated distributing member. A portion of the foreign materials borne by the ventilating air is deposited on the distributing panel and, since the amount of the accumulation at any point is roughly proportional to the volume of air passing through the panel at that point, the result of uneven flow through the panel is an undesirable appearance due to the localized dirty areas. This appearance may be due to deposits on the upper surface of the panel due to direct impingement or on the under surface due, in part, to deposits from eddy currents created by the high velocity air streams.

These streams pass through the openings in the adjacent areas of the distributing panel and in vehicles having very low ceilings the discrete streams may cause drafts sensible to persons in the enclosure. For these reasons it is desirable to diffuse the air passing through the control panel as efficiently as possible before the air reaches the facing for final distribution.

The object of this invention is to provide means for diffusing the air passing through the openings of the control member of an air distributor whereby each opening provides a uniformly distributed air supply to that area of the distributing member which such opening is intended to serve. A further object is to provide means for regulating the rate of flow of air through the openings in the control panel to thereby supply the ventilating air to the different parts of the enclosure to be ventilated according to predetermined specifications.

In practicing the invention, adjustable shutters are arranged to regulate the rate of flow of air from the plenum chamber through the openings in the control panel. An impedance is provided at each plenum chamber outlet which operates to reduce the velocity of the air and diffuse the stream as a step in the distribution of the air supplied to the enclosure. A device operating to maintain an air cushion in the path of the air stream is employed for this purpose. The succeeding and final step in the air-distribution process is accomplished by the apertured distributing panel which is fed by the diffusers. The diffusing devices are fully described hereinafter.

In the drawings:

Fig. 1 is a perspective view, partly in section, showing the air-distributing construction installed in a railway car;

Fig. 2 is a sectional view of the preferred form of the air diffuser taken at line 2—2 of Fig. 3;

Fig. 3 is a sectional view taken at line 3—3 of Fig. 2;

Fig. 4 is a sectional view of the roof portion of a railway car showing a modified embodiment of the invention;

Fig. 5 is a detailed sectional view of the air control and diffuser of Fig. 4 at line 5—5 of Fig. 6;

Fig. 6 is a fragmentary plan view, partly in section, of the apparatus of Fig. 4;

Fig. 7 is a detailed view showing the operating mechanism of Fig. 6;

Fig. 8 is a sectional view of a detail of the construction of Fig. 4;

Fig. 9 is a fragmentary plan view of a further modification of the invention; and

Fig. 10 is a sectional view taken on the line 10—10 of Fig. 9.

The general arrangement of a preferred embodiment of the invention is shown, installed, in Fig. 1. The air-distributing construction, designated generally by the numeral 1, forms a ceiling extending between half-decks 2 and 3 of a railway car. This construction consists of a perforated or otherwise apertured distributing panel 4 which forms the ceiling presented to view from within the passenger compartment, control panel 5, frame members 6 and 7 and the air flow control and diffusing means hereinafter described. This construction may be pre-fabricated and installed as a unit in the process of construction of the car. The distributing and control panels may be made of any suitable self-sustaining material. I prefer to use perforated sheet metal for the former and a hard pressed-wood material, such as Masonite, for the latter. The panels may be welded to frames 6 and 7, if metal, or rivets or screws may be used to fasten the various members together.

In preparing the car for installation of the air-distributing equipment, the roof 8 is lined with insulation 9 and a suitable surfacing membrane 10 applied to the insulation and preferably extending downwardly along the inside surfaces of carlines 11 and 12 to form plenum chamber 13. Membrane 10 should be air-impervious to prevent accumulation of odors or the penetration of moisture into insulating material 9. The individual air-distributing units may then be inserted between lighting fixtures 14 in the particular design shown. Suitable panels 15 may be used to carry out the architectural motif. Moldings 16 are used to conceal the joints along the sides of the distributing panels 4 and moldings 17 conceal the joints between adjacent ceiling panels. Any suitable air conditioning and impelling equipment may be used to continuously supply ventilating air to plenum chamber 13 from which the air is distributed into the passenger compartment in accordance with predetermined specifications.

As shown in Fig. 1, a slot 18, or, in the alternative, a series of holes, is provided in the control panel for passage of air from the plenum chamber 13 to a secondary plenum chamber 19 and thence through the perforations of distributing panels 4 into the passenger compartment. It is desirable to have approximately the same amount of air flowing through the control panel opening in each air-distributing unit throughout the length of the car, in some cases, while in other installations it is desirable to provide varying quantities of air to different parts of the passenger compartment. In order to provide means for controlling the flow of air through each control panel opening 18, an adjustable shutter 20 is arranged to overlap opening 18 and to be adjustable from below. This control mechanism will be described more fully below.

If air were permitted to pass from plenum chamber 13 through opening 18 directly into secondary chamber 19 without being diffused, it would pass through distributing panels 4 at a localized area or areas thereof, while substantially no air would pass through portions or may pass in reverse direction through portions of the panel. In order to prevent localized drafts and suction of air upwardly through the distributing panel due to the action of the high velocity streams means are provided for spreading the stream of air passing through opening 18 to thereby supply air evenly to all parts of distributing panel 4. Although a large number of different forms of diffuser may be used in carrying out the invention, a preferred construction from the standpoint of performance and economy in manufacture is that shown in Figs. 1 to 3. This device comprises a trough-shaped member 21 which extends lengthwise of the car in the embodiment shown. This trough member may be formed of perforated sheet metal, the total effective open area being such that its resistance to air flow is not more, and preferably is less, than that of opening 18, a satisfactory range being from a resistance equal to that of opening 18 to one-half that much. The extent of perforation of this diffuser element is not critical, but best results are obtained within the range indicated. Insufficient open area would result in high velocity jets from the perforations. The perforations are preferably fairly large, say, one-quarter inch, to obviate danger of plugging by dirt. A perforated baffle 22 is arranged beneath opening 18 and above the middle portion of trough 21 to assist in the diffusing function.

The air-diffuser composed of trough member 21 and cross baffle 22 may be mounted on the underside of control panel 5 by means of screws or bolts 23, or may be welded if sheet metal is used for the control panel. In order to overcome the tendency of the air to flow in disproportionate quantities horizontally sideways from the diffuser and to obviate the undesirable suction effects of high velocities, vertical apertured baffles 24 are disposed between the control and distributing panels between the diffusing member and the side frames 6 and 7. These baffles are not an essential part of the apparatus and are unnecessary where a short unit is used. They should be approximately 50% open, but this is not critical. In addition to their function as secondary air diffusers, these members also serve to brace the panel construction.

In providing means for adjusting shutter 20 to control the flow of air through opening 18, openings 25, 26, 27, 28 and 28a are provided in register with each other in distributing panel 4 trough 21, baffle 22, shutter 20 and control panel 5, respectively. A hollow dome 29 is mounted on baffle 22 and has an opening 30 to accommodate bolt 31. The head 32 of the bolt is retained between the dome and the surface of baffle 22. A polygonal keyway 33 is provided in bolt head 32 to receive a key 34 adapted to engage the walls of the keyway in turning bolt 31 between the bearing surfaces provided. A washer spring 35 is provided between the head of the bolt and the dome. A nut 36 may be welded to shutter 20 in register with opening 28 to engage the threaded portion of bolt 31. Turning of the bolt adjusts the spacing between shutter 20 and control panel 5. It will be seen that a very simple mechanism is here provided for adjusting the flow of air from the plenum chamber into the diffusing device from below the distributing panel since key 34 may be inserted through opening 25 in this panel and the key again removed after the adjustment has been made.

Leaf springs 37 are shown riveted to shutter plate 20. These springs serve to stabilize the

shutter and also cooperate with channel guides 38 (Fig. 2) to prevent rotation of shutter 20 when an adjustment is made by turning bolt 31. In the particular design shown bolts 39 are employed to hold guide 38 in position and also to hold the assembly of the entire distributing unit together.

The shutter arrangement described has peculiar advantage as a part of this invention. While a substantial pressure head must be maintained in the plenum chamber to effect the desired primary distribution to the openings in the control panel, it is desirable to supply air to the diffuser at as low a velocity as possible. The passageway provided between shutter plate 20 and control panel 5 offers substantial resistance. The result is a reduced pressure at opening 18 as compared with the plenum chamber pressure and consequently the velocity of the air passing through this opening is proportionately reduced.

Although the diffusing unit is shown disposed longitudinally of the railway car in Fig. 1, it may also be arranged crosswise. The arrangement shown is more convenient with a curved ceiling design. The trough member may extend between the opposed sides of the secondary chamber, in which case the ends of the trough diffuser need not be closed, or a comparatively short unit may be used, perforated end members, such as 40, being provided to prevent excessive flow of air from the ends of the unit.

A slightly modified embodiment of the invention is shown in Figs. 4 to 8. In the general arrangement shown in Fig. 4, plenum chamber 50 is provided superjacent the passenger compartment of the vehicle. The air-distributing unit, designated generally by the numeral 51, is composed of perforated distributing panel 52, control panel 53 and frame members 54, and is designed to be inserted between central supporting beam 55 and carline 56. Moldings 57 are used to support the unit and cover the joints. The air-distributing units are preferably assembled and installed in such a way that they may conveniently be removed and opened for cleaning and inspection.

The diffusing elements used in this structure include perforated diffusing plate 58 angularly disposed between imperforate supporting members 59 (which, in the embodiment shown, is a portion of control panel 53) and 60 and secondary perforated diffusing plate 61 spaced below primary element 58 and supported by the back member 60 and the ends 62 of the diffusing unit. As shown, the upper edge of plate 61 is spaced from supporting member 59. A strip of felt 63 may be used as a gasket to prevent vibration between the metallic parts.

Although the air flow control mechanism described above may be used with this modified form of the invention, I have shown a further construction suitable for this purpose. The details are shown in Figs. 5 to 8. A series of holes 64 are provided in a row in control panel 53. A strip shutter 65 having a corresponding series of holes 66 is arranged to slide between guides 67 and bear against the upper surface of control panel 53. Spring members 68 (Fig. 8) are riveted to shutter 65 and bear against a surface of guide member 67 to insure close contact between the shutter and the control panel. It will be seen that adjustment of shutter 65 with respect to the control panel will uncover a greater or less area of holes 64 and thus control the flow of air between plenum chamber 50 and secondary chamber 69. The mechanism for controlling the adjustment of the shutter include a downwardly projecting thimble 70, preferably of brass, and a spindle 71 having a collar 72 journaled in the annular space provided between shoulder 73 of thimble 70 and the portion of the control panel adjacent the periphery of opening 74 provided in the control panel. Openings are provided in the elements of the diffuser to accommodate the thimble 70. An eccentric pin 75 extending upwardly from spindle 71 is adapted to engage transverse slot 76 in shutter 65 to move the latter longitudinally upon rotation of the spindle. Suitable means, such as a slot 77, are provided to manipulate spindle 71 from below. The end portion of spindle 71 may be split longitudinally, as indicated at 78, and internally threaded to receive set screw 79 as a locking device acting to prevent rotation of spindle 71, after adjustment thereof, by expanding the split portion of the spindle inside thimble 70. A screw driver or other suitable instrument is used to rotate the spindle and adjust the shutter. An opening is provided for this purpose in the distributing panel 52.

If desired, the air-diffusing unit shown in Fig. 5 may be fabricated apart from the entire air-distributing unit and inserted after complete assembly. Instead of using the control panel as an integral part of the device to support the mechanism, as shown, a separate horizontal supporting member may be provided and the finished unit inserted bodily into secondary chamber 69 by lowering it into a suitable opening along the edge of the control panel.

In the operation of this embodiment of the invention, air is supplied to the diffuser from the plenum chamber. The momentum of the flowing air is reduced by the air cushions created by baffle members 58 and 61 and it is permitted to flow into the secondary chamber 69 for final distribution into the enclosure by distributing panel 52. The larger portion of the air leaves the diffuser via the opening between the edge of baffle 61 and the control panel or supporting member 59, the remainder passing downwardly through the perforations of baffle 61 or sidewise through the perforations of end members 62. Obviously the total effective area available for egress of air from the diffuser must be considerably greater than the effective open area of openings 64 to permit air to flow into secondary chamber at low velocity.

A further modified diffusing unit is shown in Figs. 9 and 10. A generally conical or bowl-shaped diffusing element 80 is used in place of the trough-like diffusing element 21. This element is disposed adjacent to disc 81 which is provided with a number of openings 82. A cover formed by plates 83 and 84 is disposed above disc 81, as shown. Central openings are provided to receive the reduced end portions of sleeves 85 and 86, the ends of which are swaged over the peripheral portions of the openings. Sleeve 85 is interiorly threaded at 87 and is provided with an enlarged bore at 88 to receive bushing 89. Bolt 91 passes through sleeve 86 and bushing 89 and is threaded into sleeve 85 at 87, bushing 89 being pinned at 90 to the bolt. Thrust bearings are thus formed by the upper and lower shoulders of diminished bore portion 92 of sleeve 86 which cooperate with the head of the bolt and with the bushing 89. A suitable socket 93 is provided in the head of bolt 91 to

receive a key inserted through perforation 94 in distributing panel 95 to adjust the cover with respect to disc 81. This diffusing and control unit is mounted in an opening provided in control panel 96, leaf springs 97 serving to stabilize the cover and prevent vibration. When the air-distributing unit is installed, air from the plenum chamber passes through openings 82 of plate 81 and the perforations of diffusing element 80 into secondary chamber 98 and thence through the perforations of distributing panel 95 into the space to be ventilated. The quantity of air is controlled by the size of the space between the cover and the plate 81.

The operation of this device is similar to that of the forms of diffusers above-described. Diffusing element 80 is perforated sufficiently to permit air entering the device from the plenum chamber to flow into the secondary chamber at low velocity. The high velocity air stream passing through openings 82 is broken up and supplied in diffused condition to the distributing panel for introduction into the space below.

A ventilating system constructed in accordance with the present invention operates as a combined pressure and displacement system. Air is supplied to the plenum chamber in quantities sufficient to maintain a positive pressure therein whereby to cause air to pass through the control panel openings under substantially the same pressure head for all parts of the control panel. Control over the flow of air from the plenum chamber is necessarily accomplished by restriction of the effective open area of the control panel, and the air passes through such openings at a relatively high velocity. These high velocity air streams are arrested and the air is diffused, and admitted to the secondary chamber at low velocity and with only slight inertia. Thus the air passing from the diffusing element displaces the air immediately preceding as a result of the force applied by the moving air streams passing through the openings of the control panel. Turbulence of the air leaving the diffusing element occurs only to a very limited extent and the air is neither forced through the distributing panel at such high velocities as to cause drafts nor is it projected horizontally in the secondary chamber at a sufficiently high velocity to cause suction of air from the enclosure below into the secondary chamber. Thus it is seen that the air diffusing and control unit constitutes the heart of the ventilating system.

Although the invention is illustrated and described as associated with a ventilating system for vehicles, it is equally suitable for architectural uses. Similarly, the distributors may be used vertically at a wall of the enclosure although the illustrations and description exemplify them as installed overhead. The specific embodiments are shown and described by way of example and the invention is not limited other than as defined by the appended claims.

I claim:

1. In an air distributor for a ventilating system for an enclosure having a ceiling, a sheet-form control member of substantially air impervious material having a slot therein and spaced below said ceiling to form a plenum chamber, means for continuously supplying ventilating air to said plenum chamber, and a diffusing device without said plenum chamber in association with said slot in said control member adapted to spread the stream of air passing through said slot, said diffusing device comprising an apertured trough-like member arranged with the edges thereof contiguous to said control member on opposed sides of said slot, end members for said trough-like member, and an apertured baffle member spaced under said slot and arranged substantially horizontally within said trough-like member.

2. In an air distributor for a ventilating system for an enclosure having a ceiling, a sheet-form control member of substantially air-impervious material having a slot therein and spaced below said ceiling, a perforated sheet-form air-distributing member spaced below said control member, means for continuously supplying ventilating air to the space between said ceiling and said control member, and a diffusing device between said control member and said air-distributing member adapted to spread the stream of air passing through said slot to thereby maintain a supply of air to substantially all portions of said air-distributing member, said diffusing device comprising an apertured trough-like member arranged with the edges thereof contiguous to said control member on opposed sides of said slot, end members for said trough-like member, and an apertured baffle member disposed horizontally under said slot and within said trough-like member.

3. In a ventilating system, the combination with an enclosure having a wall or ceiling, of a sheet-like control member spaced inwardly from said wall or ceiling to form a plenum chamber, means for continuously supplying ventilating air to said chamber, said control member having a slot therein, means for regulating the rate of flow of air through said slot, an apertured sheet-form distributing member spaced inwardly from said control member with respect to said enclosure, and a diffusing element between said control member and said distributing member adapted to spread the stream of air passing through said slot to thereby maintain a supply of air to substantially all portions of said distributing member, said diffusing element comprising an elongated trough-like member arranged with the edges thereof abutting said control member on opposed sides of said slot and a baffle member disposed within said trough-like member between the sides thereof, said trough-like member and said baffle member having a multiplicity of apertures distributed therein.

4. The construction of claim 3 in which said means for regulating the rate of flow of air through said slot comprising a shutter plate disposed parallel to and spaced from said control panel at said slot on the side of said panel opposite to said diffusing element, and means for adjusting the distance of said plate from said control panel to thereby regulate the rate of flow of air through said slot, said plate overlapping a substantial portion of said control panel surrounding said slot.

5. The construction of claim 3 and including apertured partitions extending between said control panel and said air-distributing member, said partitions being disposed intermediate said diffusing element and an edge of said air-distributing member in substantially parallel relation with said diffusing element.

6. In a ventilating air distributing system, in combination, a plenum chamber superjacent an enclosure to be ventilated, means for continuously supplying ventilating air to said chamber, a control panel having one or more openings near an edge thereof and forming the floor of

said chamber, means for controlling the rate of flow of air through said openings, a perforated distributing panel spaced below said control panel, and means for diffusing the air passing through said openings, said diffusing means comprising an imperforate supporting and enclosing member depending from said control panel between an opening therein and the near edge of said control panel, a perforated sheet-form baffle inclined between said supporting and enclosing member and said control panel under said opening, a second perforated sheet-form baffle spaced in substantially parallel relation below said first baffle, one edge of said second baffle abutting said supporting and enclosing member and the opposed edge being spaced below said control panel, and end members abutting said supporting and enclosing member and enclosing the space between said second baffle and said control panel.

7. The combination of claim 6 in which the end members are perforated.

8. In a ventilating system, the combination with an enclosure having a wall or ceiling, of a sheet-like control panel spaced inwardly from said wall or ceiling to form a plenum chamber, means for continuously supplying ventilating air to said chamber, said control panel being of substantially air-impervious material and having an opening therein, means for regulating the rate of flow of air through said opening comprising a valve plate adjustably spaced from and overlapping said control panel a considerable extent beyond said opening, a perforated sheet-form distributing panel spaced inwardly from said control panel with respect to said enclosure, and a diffusing member between said control panel and said distributing panel adapted to spread and diffuse the stream of air passing through said opening to thereby maintain a supply of air to substantially all portions of said distributing panel, said diffusing member comprising an apertured conical member of sheet material arranged with the base thereof adjoining said control panel and surrounding said opening.

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