Nov. 18, 1952 T. C. FITT 2,618,215

VENTILATING DEVICE AND LIKE AIR SUPPLY AND DISTRIBUTING DEVICE

Filed May 3, 1948 4 Sheets-Sheet 1

Fig. 1.

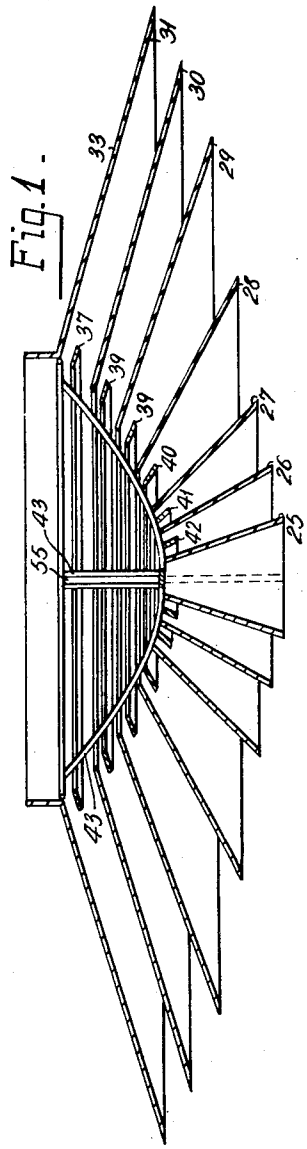
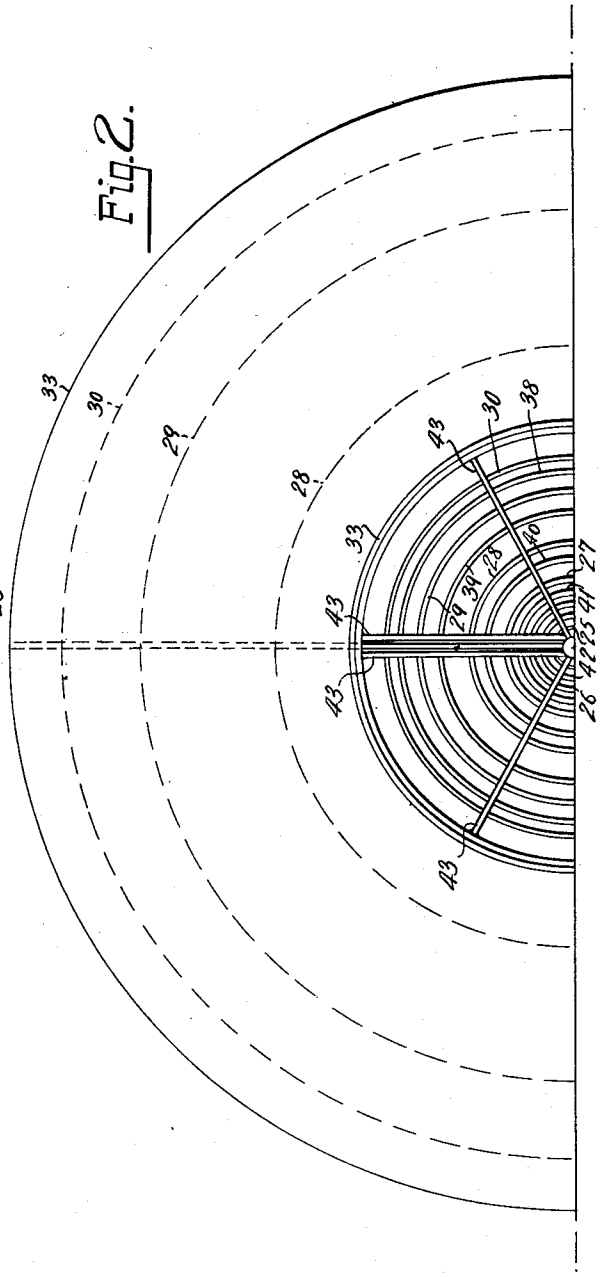


Fig. 2.



INVENTOR
THOMAS C. FITT
By: Young, Emery & Thompson
Att'ys.

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Filed May 3, 1948 4 Sheets-Sheet 2

Fig. 3.

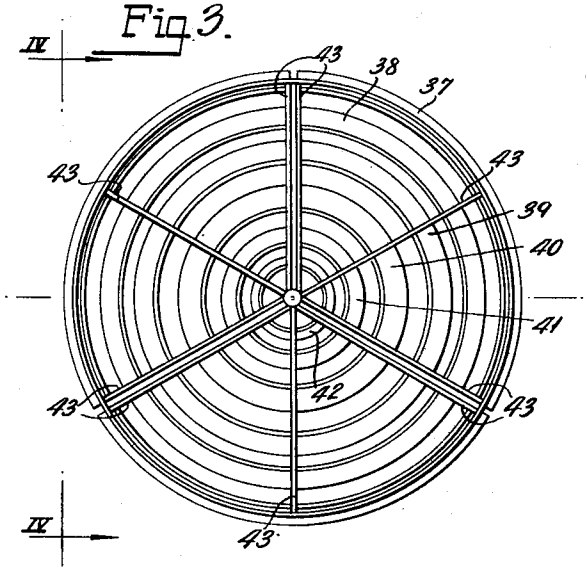


Fig. 4.

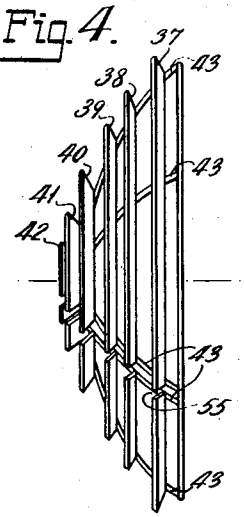


Fig. 5.

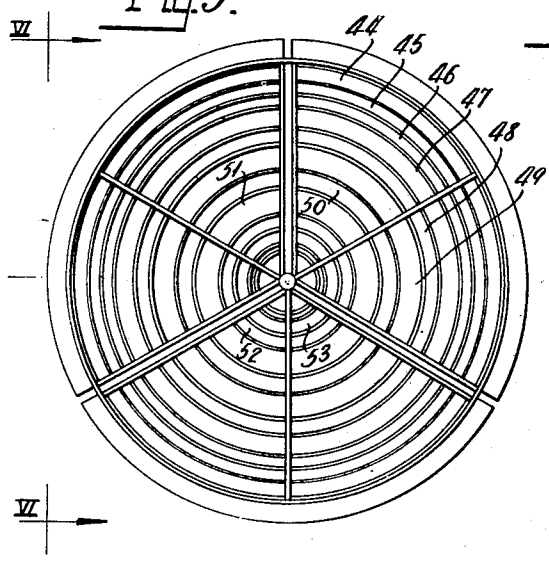
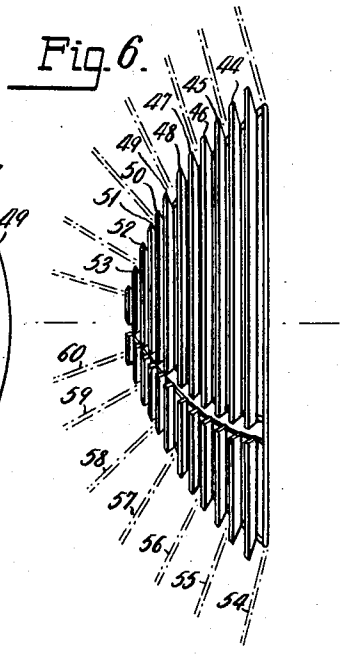


Fig. 6.



INVENTOR
THOMAS C. FITT
By Young, Emery & Thompson Att'ys.

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Filed May 3, 1948 4 Sheets-Sheet 3

Fig. 9.

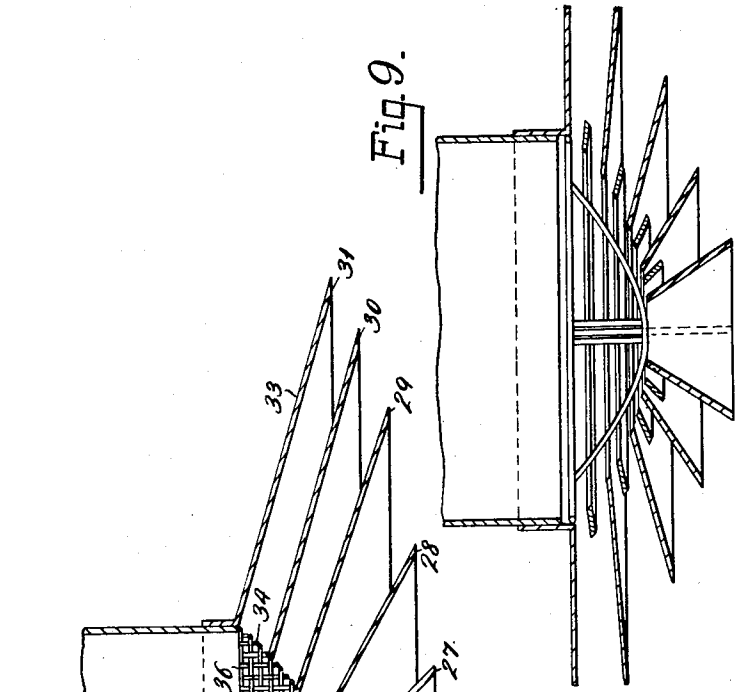

Fig. 7.

INVENTOR
THOMAS C. FITT
By: Young, Emery & Thompson
Attys.

Nov. 18, 1952 T. C. FITT 2,618,215

VENTILATING DEVICE AND LIKE AIR SUPPLY AND DISTRIBUTING DEVICE

Filed May 3, 1948 4 Sheets-Sheet 4

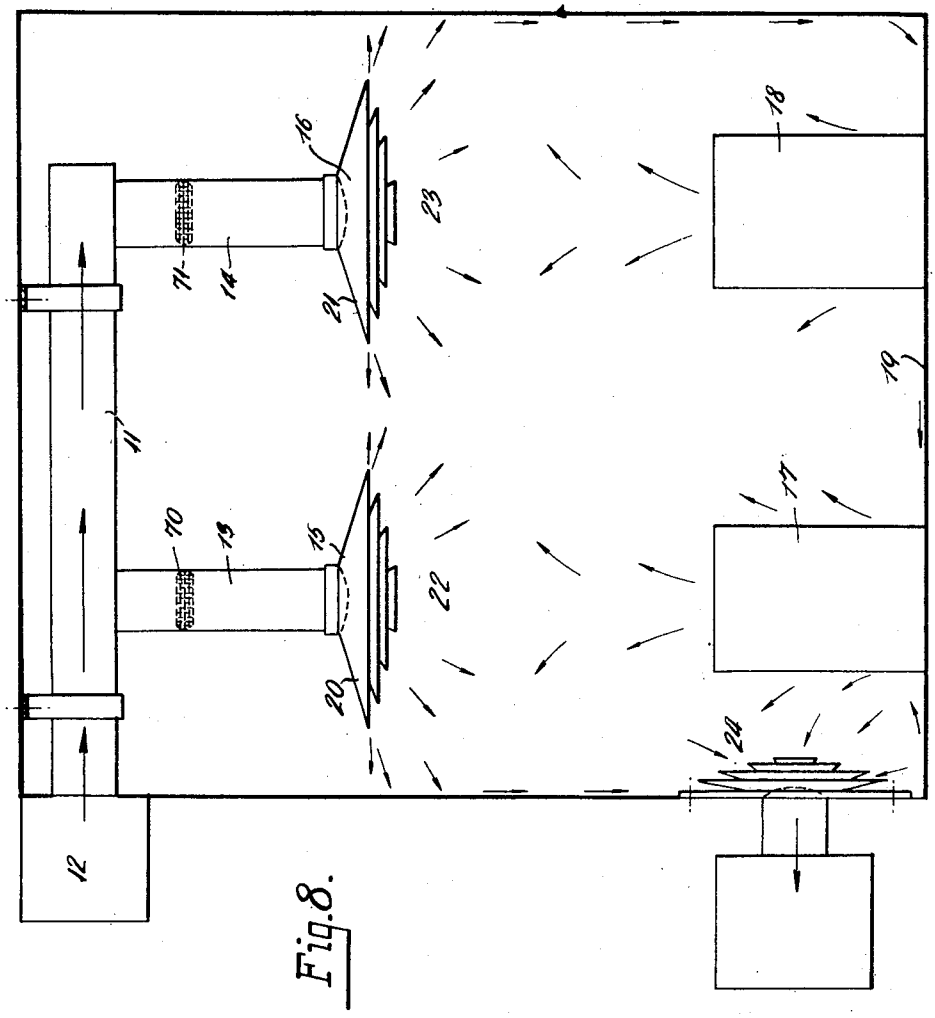

Fig. 8.

INVENTOR
THOMAS C. FITT
By Young, Emery & Thompson
Att'ys.

Patented Nov. 18, 1952 2,618,215

UNITED STATES PATENT OFFICE

2,618,215

VENTILATING DEVICE AND LIKE AIR SUPPLY AND DISTRIBUTING DEVICE

Thomas Charles Fitt, Birmingham, England

Application May 3, 1948, Serial No. 24,797
In Great Britain July 1, 1943

13 Claims. (Cl. 98—40)

1

The present invention concerns improvements in or relating to ventilation for buildings, aircraft, ships and like enclosed spaces.

The object of the invention is to supply air to a room or chamber or to extract it from a room or chamber or both supply and extract air in such a way that no readily perceptible draught is created even though the air in the chamber may be changed several times per hour.

The invention consists essentially in providing a diffuser or like device which so distributes the pressure of air emanating from or drawn to the diffuser that it is substantially uniform at the level of the heads of people working in the room or chamber, if anything with a tendency for the air at such level to move in the opposite direction to that in which the air emerges from or is driven into the diffuser.

One object of the invention is a method of ventilation to bring about the above results while a further object is a diffuser which enables the ventilation to be effected in accordance with the method.

Referring to the drawings:

Figures 1 and 2 illustrate a sectional elevation and half plan of a preferred construction of diffuser in accordance with the invention.

Figures 3 and 4 illustrate a plan and side view of a form of screen device as employed in the diffuser illustrated in Figures 1 and 2, and

Figures 5 and 6 illustrate in plan and side view an alternative form of screen to that illustrated in Figures 3 and 4.

Figure 7 illustrates a section of a diffuser with a different form of screen to that illustrated in Figures 3 to 6.

Figure 8 illustrates by way of example diffusers as used in practice to ventilate a room.

Figure 9 illustrates a diffuser for extracting air from a room.

Referring to Figure 8, 11 represents an air conduit through which air is fed from a blower 12 to conduits 13 and 14 which conduits terminate in diffusers 15 and 16 such as illustrated in Figures 1, 2 and 7 and described more particularly hereinafter. These diffusers are arranged at a convenient height above the floor on which devices such as 17 and 18 are located at which operatives work. Such devices, for instance, in a laundry may be washing or ironing machines from which clouds of steam may emerge when in use. In such a case the height of the diffusers 15 and 16 from the floor 19 might be between 7 and 10 feet while the operatives' heights when standing would be about five to six feet. The

2

diffusers 15 and 16 serve to distribute air from the conduit 11 in such a way that the pressure exerted along surfaces at a constant distance from the outlet end of the diffusers is slightly less at the axes 22 and 23 of the diffusers that it is, for instance, at points lying on extensions of the peripheral walls 20 and 21 of the diffusers.

In diffusers according to the invention as tested by smoke tests although the actual movement of air is practically imperceptible to the operatives, it can be noted that there is a definite upward movement of the air along the axes 22 and 23 about eighteen inches above the floor to within a few inches of the outlet ends of the diffusers where it meets the air from the central part of the diffuser. This has the effect that escaping steam from devices 17 and 18 is drawn upwards and so away from the faces of the users.

The arrows indicate generally the direction of flow of air. It will be noted that this effect is quite contrary to what would be expected and also that what would happer if the diffuser was of the conventional type that is to say not fitted with a special screen such as illustrated in Figures 3 to 6 in detail, or as shown in Figures 1, 2, 7 and 9 in position. It will be obvious that with air continuously flowing into the room there will be a tendency for the pressure in the room to rise unless means are provided for permitting the escape of the air. It of course frequently happens in many cases that the air escapes under doors, chimneys or the like, although special suction means may be provided as illustrated in Figure 9 and shown in position in Figure 8 under the reference 24. The effect of such suction device fitted as illustrated in Figure 8 is to draw air out of the room but at a substantially uniformly distributed pressure over a wide area at a distance of a foot or so from the suction device the actual movement of the air being almost imperceptible. It is therefore possible by means of this invention to effectively ventilate a room and to abstract therefrom steam or noxious gases by driving them away from the faces of the operatives who may be working immediately below the diffusers through which air is fed to the chamber. The diffusers must be such as to permit an adequate flow of air for instance to change the whole of the air in the room five or six times per hour while at the same time ensuring that there is negligible draught effect.

The reference to the movement of the air being "almost imperceptible" is intended to convey that the normal means for testing such movements such as feeling, movement of light solid sub-

stances or deflection of thin paper or the like, does not show any response, but smoke, steam or the like visible means having a specific gravity not appreciably greater than that of air to enable the direction of movement to be observed.

Figure 7 illustrates a construction of the diffuser which was found to give quite satisfactory results. The main part of the diffuser is a well known construction consisting of a series of nested truncated cones 25, 26, 27, 28, 29, 30 and 31 so arranged as to form diverging passages from the axis 32 to the outer peripheral wall 33.

The inner ends of the truncated cones terminate on a surface 34 concave with respect to the conduit through which air is received.

Conveniently the base of the central cone is furthest from the plane 36 in which the conduit 37 to which the diffuser is attached terminates, while the base of the other cone is successively nearer to the plane 36 with the base of the outer cone nearest as shown.

The sloping surfaces of the cones and their dimensions are such as to provide diverging passages of widths more or less equal.

A wire screen 35 formed so as to have a coarse mesh and shaped to conform with the surface 34 is fitted so as to lie on the inner ends of the cones 25 to 31.

It is important that the screen should not unduly restrict the total quantity of air flowing through the diffuser and for that reason the dimensions of the wire preferably lie between the following limits, namely, 18 to 22 S. W. G. wire and 7 to 10 meshes to the inch for the coarseness of the screen. The best results attained for ordinary room ventilation were with a wire mesh screen of 21 S. W. G. woven to provide 7 meshes per linear inch although a wire of 19 S. W. G. woven to provide 9 meshes to the linear inch also serves well.

The apertures in the screen are small in comparison with the gaps between the inner ends of adjacent plates. The mesh of the screen however, is not critical over a wide range but is limited by considerations of efficiency. Thus with an inlet diffuser discharging from a height of 40 feet an average linear velocity of 1000 feet per inch at substantially uniform distribution at head level is attained if the gauze has 6 meshes per linear inch. If the diffuser is arranged at a more normal level of 7 to 10 feet and the rate of discharging has an average velocity of 600 feet per inch then an 8 mesh gauze is satisfactory. For a diffuser discharging at mouth level at a rate of 200 feet per minute for example, for the ventilation of noxious gas, 20 mesh gauze is suitable. In the latter case it is preferable to provide in the diffuser means for cleaning the fine gauze such as a rotary brush acting on that face of the gauze which faces the direction of air flow.

It will be apparent that if a different form of distribution is required this result can be achieved by varying the mesh of the gauze so that the finest gauze may be at the periphery and the mesh becoming coarser at the successive channels until the coarsest mesh is reached at the central channel or vice versa. Naturally the variations in the mesh depend upon the effect it is desired to produce provided that those variations are not sufficient to interfere with the general direction of air streams which is an integral part of the present invention. Instead of the cones 25 to 31 it will be clear that the passages or channels may be formed in other ways. For instance, instead of the cones being of circular

section they might be elliptical or polygonal. Preferably they are symmetrical about a common axis but this is not essential.

Referring to Figures 3 and 4 a different construction of screen is provided in place of the wire mesh screen of Figure 7. This screen consists of a number of frusto-conical strips 37, 38, 39, 40, 41 and 42 formed of metal, plastic or similar material and secured together on curved wires or rods which are substantially radial in plan view.

In Figures 1 and 2 the screen illustrated in Figures 3 and 4 is shown located in a diffuser of similar construction except for the coarse wire screen to that illustrated in Figure 7 from which it will be seen that the frusto-conical strip 37 is arranged to lie between the cones 30 and 31 and to have an inclination intermediate the inclination of the two cones 30 and 31. Similarly, the strips 38, 39, 40, 41 and 42 are arranged to lie intermediate the pairs of cones 30 and 29, 29 and 28, 28 and 27, 27 and 26, 26 and 25, respectively, and in which case the inclination is such as to have an inclination intermediate of the walls of the cones on each side of it so as to offer the smallest dimension, namely, the thickness of the metal of the strip to the flow of air. Preferably the position of the strips is not on the mid-way point between two walls but nearer to the outer wall the distance from the two walls conveniently being in the ratio of 2 to 1. The width of the strips 37 to 42 is a small fraction of the length of the passages between successive cones.

With this arrangement the resistances to air flow is very much reduced compared with the wire screen of 35 but the same general effect as regards the air circulation to that in rooms fitted with the diffuser of Figure 7 is obtained so that there is an upward current below the diffuser when air is being blown into the room from the diffuser at a comparatively short distance from the diffuser.

It will be noted that there is no frusto-conical strip shown in the central passage of cone 25. By reference to the plan view in Figure 2 it will be seen that the radial wires 43 extend into the centre and across the central passage thereby exercising the required screening effect which in respect of the other passages is mainly provided by the frusto-conical strips.

As the diffusers are made in widely differing sizes according the purpose for which they are used being fitted to ducts from as small as 1¾ inches diameter to as large as 5 inches diameter the number and disposition of the frusto-conical strips may be varied to suit circumstances and Figures 5 and 6 illustrate a construction in which as many as 11 frusto-conical strips 43 to 53 may be employed for a diffuser which is assumed to be made up of 7 frusto-cones shown in chain dotted lines 54, 55, 56, 57, 58 and 59 in Figure 6. In this case it will be noted that there are two strips between every pair of cones except cones 59 and 60 where there is only one strip 53. The exact number in any particular case will be adjusted according to circumstances. Generally speaking the spacing of the parts should be such that between adjacent strips or between strips and the adjacent walls of the frusto-cones the maximum spacing should not exceed one inch and as a minimum should be not less than ⅛ of an inch. Actually one or at the most two divisions have been found to give the most satisfactory results in the majority of cases.

In the construction of Figures 3, 4, 5 and 6 the

frusto-conical strips may be secured to radial supports, if of metal, by brazing and the parts illustrated in Figures 3, 4, 5 and 6 may be either loosely fitted in to the diffuser or may be rigidly secured thereto. For simplification in construction as shown in Figure 4, the frusto-conical strips be each made up of a number of parts extending between adjacent radial rods **43** leaving gaps **55** by which the screen may be fitted to a diffuser having radially disposed supporting plates between the cones such as **25** to **30**. Of course as an alternative slots could be provided in these radial plates instead of dividing the strip. As an alternative to a series of frusto-conical strips an equivalent result may be attained by a spirally shaped strip. In either case these strips may be secured by soldering, brazing or like means to the radial spokes **43** which serve to space such parts or strips a desired distance apart. The spacing of the strip may be increased as the size of the duct and the size and spacing of the cones forming the baffles increases while still giving the desired effect of uniform distribution of pressure over a wide area at a short distance from the outer end of the baffle. The width of the strip may be quite small in each case not more than ½ an inch and in smaller cases not more than ⅛ of an inch while the thickness of the material forming the strip can be as thin as possible having regard to its mechanical strength being sufficient to ensure the strip will not be readily deformed or deflected in normal usage.

As a general guide to the construction of satisfactory diffusers in accordance with the invention a description will be given with terminals of a large size diffuser suitable for fitting to a duct of 3'6" diameter and a diffuser suitable for fitting to a duct of 1¾ inches diameter.

With a duct of 3'6" diameter, 7 baffles in the shape of frusto-cones are provided, the outer one extending from the circumference of the duct forwards for 9$\frac{5}{16}$" and outwards to 8'9" diameter, the second extending forwards for 8$\frac{5}{16}$" from a diameter of 3'0" to a diameter of 8' with its open end in a plane 2$\frac{5}{16}$" in front of the plane of the open end of the outer baffle, the third extending forwards for 9⅜" from a diameter of 2'5" to a diameter of 6'9" with its open end in a plane 2$\frac{13}{16}$" in front of the plane of the open end of the second baffle, the fourth extending forwards from 9⅝" from a diameter 20¼" to a diameter of 4'8" with its open end in a plane 2¼" in front of the plane of the open end of the third baffle, the fifth extending forwards for 10¼" from a diameter of 13" to a diameter of 2'9" with its open end in a plane 1¾" in front of the plane of the open end of the fourth baffle, the sixth extending forwards for 11" from a diameter of 8¾" to a diameter of 21" with its open end in a plane of 1$\frac{3}{16}$" in front of the plane of the open end of the fifth baffle and the seventh extending forwards from 11⅝" from a diameter of 3½" to a diameter of 11⅝" with its open end in a plane ⅞" in front of the plane of the open end of the sixth baffle. To such a baffle arrangement according to the invention, between the baffle and next inner baffle is fitted a strip of frusto-conical shape at the inner end of the baffles so as to divide the entrance to the baffles into two parts being nearer to the outer baffle than the inner in the ratio of approximately 1 to 2. The inclination of the cone to be such that the strip lies so as to offer substantially minimum resistance to the air stream, the depth of the strip in the direction of the air stream being about ⅜", the gauge of the strip being about that of the baffles say 7–20 S. W. G. The space between the various adjacent baffles is similarly divided by similar strips conforming to the inclination of the baffles and approaching equality of spacing for the baffles the nearer they are to the centre. It has been desirable for the inner baffles to provide two strips to divide the space into three.

With a duct of 1¾" diameter 5 baffles in the shape of frusto-cones are provided, the outer one extending from the circumference of the duct forwards for $\frac{7}{16}$" and outwards to 4" diameter, the second extending forwards for ⅜" from a diameter of 1$\frac{5}{16}$" to a diameter of 3⅛" with its open end in a plane $\frac{7}{64}$" in front of the plane of the open end of the outer baffle, the third extending forwards for ⅜" from a diameter of $\frac{3}{16}$" to a diameter of 2¼" with its open end in a plane $\frac{7}{64}$" in front of the plane of the open end of the second baffle, the fourth extending forwards for $\frac{7}{16}$" from a diameter of $\frac{1}{32}$" to a diameter of 1$\frac{7}{16}$ with its open end in a plane $\frac{7}{64}$" in front of the plane of the open end of the third baffle, the fifth extending forwards for ½" from a diameter of $\frac{3}{32}$" to a diameter of $\frac{1}{8}$" with its open end in a plane $\frac{7}{64}$" in front of the plane of the open end of the fourth baffle.

It should be pointed out that the diffuser in Figures 1 and 7 which is formed of a plurality of frusto-conical members **25** to **31** is such that the diameter of the inner end of any one member is smaller than the diameter of the outer end of the immediately adacent member. Preferably the axis of the diffuser is in line with the axis of the conduit but this is not essential. If it is inclined it may be desirable to vary the screen according as to whether the passages are more or less inclined to the direction of air flow from the conduit although actually it has been found that the desired distribution and flow of air in accordance with the invention can be produced with the axis of the conduit at right angles to the axis of the diffuser.

If the method of ventilation described is to be used for the air conditioning of a room, heaters **70** and **71** may be provided such as shown in Figure 8 in the conduits **13** and **14** respectively, in this case the devices **17** and **18** might be desks at which clerks are working and the heated air admitted taking the course described does not impinge directly upon the clerks at the desks but travels round and heats the room uniformly.

This application is a continuation-in-part of my copending application Serial No. 540,942, filed June 19, 1944, now abandoned.

I claim:

1. A diffuser for ventilating and like purposes comprising a plurality of partitions forming adjacent diverging passages and dividing means located at the inner ends of the partitions which are nearest together and mounted in the inner ends of the passages intermediate the inner edges of the passage forming partitions and with their inner ends flush with the inner ends of the passage forming partitions, which cause the air streams through the entrance of the passages to be broken up so that the flow of air across the outlet end of each of the passages is substantially unidirectional while the direction of flow at some distance from the diffuser and immediately in front thereof is in the opposite direction to that of the air flowing through the diffuser and to the sides of the diffuser.

2. A diffuser for ventilating and like purposes comprising a plurality of partitions forming adjacent diverging passages and dividing means consisting of a framework of transverse members narrow with respect to the passages located at the inner ends of the partitions which are nearest together and mounted in the inner ends of the passages intermediate the inner edges of the passage forming partitions and with their inner ends flush with the inner ends of the passage forming partitions, which cause the air streams through the entrance of the passages to be broken up so that the flow of air across the outlet end of each of the passages is substantially unidirectional while the direction of flow at some distance from the diffuser and immediately in front thereof is in the opposite direction to that of the air flowing through the diffuser and to the sides of the diffuser.

3. A diffuser for ventilating and like purposes comprising a plurality of partitions forming adjacent diverging passages and dividing means consisting of a framework of elongated strips of substantially rigid material lying normal to and mounted in the inner ends of the passages intermediate the inner edges of the passage forming partitions and with their inner ends flush with the inner ends of the passage forming partitions, so as to cause the air streams to be broken up while permitting them to reunite at the outlet end so that the flow of air across the outlet end of each of the passages is substantially unidirectional while the direction of flow at some distance from the diffuser and immediately in front thereof is in the opposite direction to that of the air flowing through the diffuser and to the sides of the diffuser.

4. A diffuser as claimed in claim 3 in which the elongated strips extend at a substantially constant distance from the partitions forming he passage ways.

5. A diffuser as claimed in claim 3 in which the elongated strips extend at a substantially constant distance from the partitions forming the passages which is greater from the partition which is more diverging than it is from the partition which is less diverging.

6. A diffuser as claimed in claim 3 in which the width of the elongated strips is such that the strips extend from the inner end of the passages into the passages to a distance within the passages which is less than one quarter of the length of the passage ways.

7. A diffuser for ventilating and like purposes having a narrow inner end comprising a plurality of partitions positioned with their inner ends defining a concave surface at the narrow end of the diffuser, and extending to an outer end at least double the size of the inner end to form a series of diverging annular passages of successively greater cross section and dividing means in the form of a framework of transverse members narrow with respect to the width of the passages, mounted in the inner ends of the passages intermediate the inner edges of the passage forming partitions and with their inner ends flush with the inner ends of the passage forming partititons, to cause air streams entering said narrow end to be split up and to reunite so that the flow of air across the outlet end of each of the passage ways is substantially unidirectional while the air streams emanating from the various passages extend further in the direction of passages of greater cross section and less in the direction of passages having smaller cross section whereby

the flow of air at some distance and immediately in front of the diffuser is so slight as to be almost imperceptible while the direction of flow is in the opposite direction to the direction of air flowing through the diffuser and to the sides thereof.

8. A diffuser as claimed in claim 7 in which the framework is formed of elongated narrow strips of substantially rigid material secured so as to lie with their thinnest dimension normal to the air stream and to extend from the entrance of the passage ways inwards to an extent which is less than one quarter of the length of the passage way.

9. A diffuser as claimed in claim 8 in which the framework is formed of radial wires shaped to conform to said concave surface and elongated narrow strips of metal supported on said wire, the central radial wires extending over the central passage while the elongated narrow strips of metal having their thinnest dimension normal to the air stream divide up the narrow entrance to the annular passages into a limited number of substantially annular portions.

10. A diffuser for ventilating and like purposes comprising a plurality of partitions in the form of truncated coaxial cones of successively greater cross section having their narrow ends positioned to define a surface forming a segment of a sphere and concave with respect to the narrow end of the diffuser and a framework formed of radial wires adapted to conform to the curvature of said surface, and supporting spaced narrow elongated strips of metal in annular formation in the upper ends of the passages intermediate the upper edges of the passage forming partitions and with their upper ends flush with the upper ends of the passage forming partitions, to divide the passages between the cones at their narrowest end and located to offer approximately minimum resistance to flow of air, the action of the framework being such as to cause the movement of air at the outlet end of the passage ways to be substantially unidirectional while the direction of flow at some distance from the immediate front of the diffuser to be so slight as to be almost imperceptible and the direction of flow to be opposite that passing through the central cone and at the sides of the diffuser.

11. A ventilating system comprising an air conduit, a diffuser connected to the end of an extension of said conduit, a blower adapted to cause air to flow from the conduit through the diffuser, the diffuser comprising a series of partitions each of the shape of a frustrum of a cone and having successively wider cross section so as to leave diverging passages between said partitions to permit air being directed in expanding streams and dividing means comprising elongated strips of rigid material mounted n the upper ends of the passages intermediate the upper edges of the passage forming partitions and with their upper ends flush with the upper ends of the passage forming partitions, and arranged to divide said passages in such a way that the air streams emerging from the passages are unidirectional, expanding in a single stream with the movement of air at some distance from the diffuser being almost imperceptible while the actual movement in front of the central partition is in the opposite direction to the flow of air therethrough.

12. A ventilating system comprising a chamber, a first air conduit located at the upper part of said chamber, a diffuser connected to the end of an extension of said conduit, a blower adapted to

cause air to flow from the conduit through the diffuser, the diffuser comprising a series of partitions each of the shape of a frustrum of a cone and having successively wider cross section so as to leave diverging passages between said partition to permit air being directed in expanding streams and dividing means consisting of a framework of elongated strips of rigid material mounted in the upper ends of the passages intermediate the upper edges of the passage forming partitions and with their upper ends flush with the upper ends of the passage forming partitions, arranged to divide said passages in such a way that the air stream emerging from the partitions is unidirectional and expands in a single stream with the movement of air at some distance from the partitions being almost imperceptible while the actual movement in front of the central partitions is in the opposite direction to the flow of air therethrough, a second air conduit remote from the first air conduit and located at the lower part of said chamber, a second diffuser connected to said second air conduit, a second blower adapted to draw air through said second diffuser to said second conduit, the second diffuser comprising a series of partitions each of the shape of a frustrum of a cone except the outer one which is shaped so as to lie flush with a wall, so arranged as to provide a series of converging passages between said partitions to permit air being drawn in from a series of radiating directions and dividing means in the form of elongated strips of rigid material mounted in the upper ends of the passages intermediate the upper edges of the passage forming partitions and with their upper ends flush with the upper ends of the passage forming partitions, and arranged to divide said passages in such a way that the air is drawn unidirectionally in a single converging stream into said passages such that the movement of air at some distance from the partitions is almost imperceptible.

13. A diffuser as claimed in claim 3 in which the partitions consist of a series of truncated conical tubular members concentrically arranged about a common axis and including an inner member defining a central diverging passage, and successive outer members surrounding the inner member and forming a series of annular diverging passages.

THOMAS CHARLES FITT.

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