June 19, 1956 R. D. TUTT 2,750,865

DIFFUSER

Filed Feb. 14, 1951 2 Sheets-Sheet 1

Fig. 1

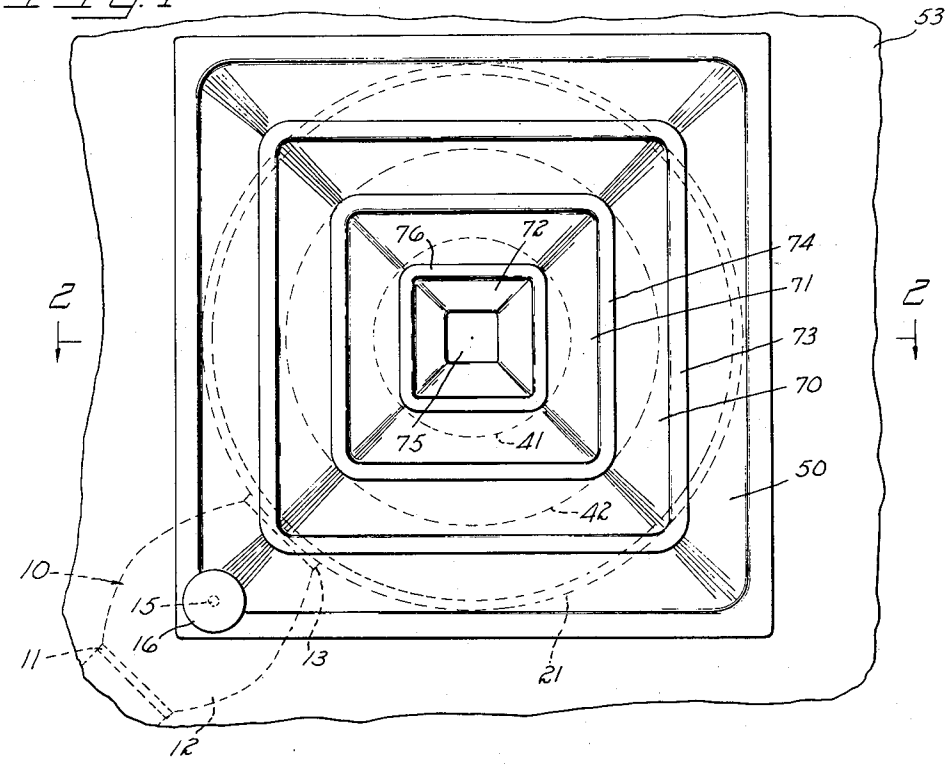

Fig. 2

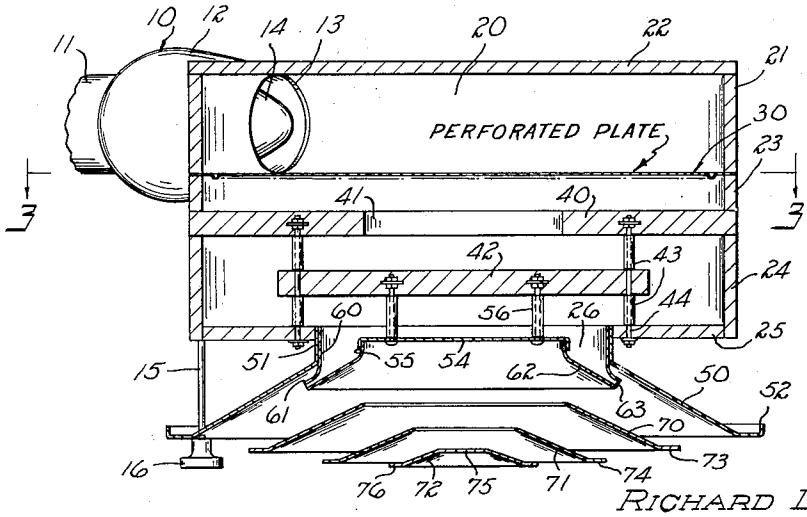

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Fig. 3

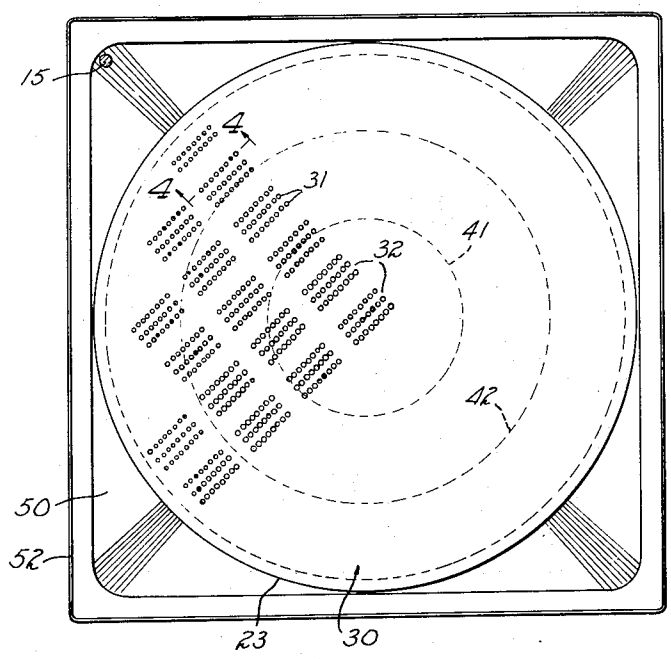
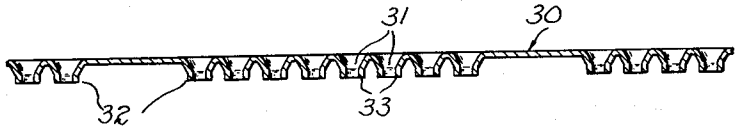


Fig. 4



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2,750,865

DIFFUSER

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Application February 14, 1951, Serial No. 210,838

13 Claims. (Cl. 98—40)

The present invention relates to air diffusers for use in air conditioning and distributing systems. In the preferred embodiment, the diffuser is utilized in a wall, preferably the ceiling, of an enclosure in connection with a supply of primary air under pressure and operates efficiently to mix the primary air with room air and to disperse the mixture of room and primary air into the room in an advantageous and satisfactory manner.

The diffuser of the present invention is particularly advantageous for use in systems where it is desired to supply the primary air at relatively high pressures, i. e., at pressures up to 5 inches of water, or more. The diffuser is effective not only for inducing a flow of a desired quantity of room air for admixture with the primary air and a dispersal of the mixed air into the room in a stream having acceptable throw and drop characteristics but, in addition, is effective for avoiding an undesirable increase in the noise level of the enclosure which normally accompanies the use of high pressure air.

It is an object of the present invention to provide a diffuser having an intake for room air and means for controlling the release of primary air under elevated pressure in such fashion that the flow of primary air effectively induces a desired intake flow of room air for admixture with the primary air and so that the resulting mixture is dispersed into the room in a stream of satisfactory throw, temperature, and drop characteristics.

A further object is to provide a diffuser of the type referred to having novel and effective means within the diffuser for attenuating noise whereby the operation of the diffuser in connection with high pressure air is rendered satisfactory from a noise standpoint.

A further object of the present invention is to provide a diffuser of the character referred to having greatly improved operating characteristics, but which, at the same time, has a compactness and simplicity of construction rendering it easy and economical to fabricate and assemble as well as a streamlined and pleasing appearance, whereby it may be used efficiently and conveniently in a wide variety of installations without detracting from the appearance of the room.

Another object of the invention is to provide a diffuser of the character referred to which will have a minimum of parts, particularly moving parts or parts which would deteriorate in use, whereby the diffuser will operate efficiently over long periods of time without breakdown or requiring repair or replacement.

Other objects will be in part obvious, and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth and the scope of the application of which will be indicated in the appended claims.

In the drawings:

Fig. 1 is a bottom view of a specific embodiment of the diffuser of the present invention, the diffuser being mounted in a ceiling or other supporting structure;

Fig. 2 is a cross sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is a cross sectional view taken along the line 3—3 of Fig. 2; and

Fig. 4 is a cross sectional view taken along the line 4—4 of Fig. 3.

Referring to the drawings, air is admitted to the diffuser of the present invention from any convenient source (not shown) such as by means of a standard air conduit employed in air conditioning and distributing systems. In accordance with the invention, it is preferred to employ suitable damping means, such as the damper **10**, at the entranceway for the primary air, the damper **10** being connected at its outer end **11** to the source of primary air. Since it is contemplated that the diffuser of the present invention will be utilized with air under relatively high pressure, there has been illustrated a damper **10** of the type shown in the co-pending application of Nelson M. Payne, Serial No. 177,859, filed August 5, 1950, now Patent No. 2,713,350. In general, a damper of this type is provided with a generally tear-drop shaped housing **12** having an axial outlet opening **13** adapted to be opened and closed by a plug **14** which is manipulated by a depending rotatable adjusting rod **15** having a suitable manually operable knob **16** on the lower end thereof. When high pressure air is utilized, there is a tendency for a damper to introduce noise into the system, this being particularly noticed as a whistlelike sound as the size of the effective opening of the damper is decreased and, for this reason, it is preferred to utilize a damper of the construction referred to here which does not have this disadvantage.

The outlet opening **13** of the damper communicates with the upper end of a cylindrical chamber **20** which is defined by a cylindrical side wall **21** and a circular end wall **22**. The damper **10** is preferably disposed generally radially of the chamber **20** so that the flow of primary air received through the damper **10** will be directed centrally of the chamber **20**.

The side wall **21** and end wall **22** are preferably formed of suitable sound absorbing material. For example, one material which I have found to be entirely satisfactory for this purpose is a commercially available soft board formed of pressed asbestos fibers. By reason of the sound absorbing qualities of the walls **21** and **22**, a certain amount of the noise transmitted by the high pressure air will be absorbed at this point.

Immediately below the entrance of the primary air there is disposed a transverse sound plate **30** which extends completely across the chamber **20** and which may be suitably anchored in place by insertion between the bottom end of the wall **21** and a ring **23** registering with and forming a continuation of the wall **21** and also formed of sound absorbing material.

The sound plate **30** is designed and constructed in accordance with the invention to effectively aid in the attenuation of the sound carried by the primary air. For this purpose, the plate **30** is preferably formed of sheet metal, for example, of sheet steel, so as to have a high degree of rigidity. It is essential that the plate have a high degree of rigidity or stiffness so that it will not create a "drum" effect which would impart rather than attenuate sound in the system. I have found that sheet steel, in the range of 16 to 22 gauge, and preferably about 18 gauge, will generally form the most satisfactory sound plate for the present purposes.

Further, in accordance with the invention, the sound plate **30** is provided with a plurality of perforations. In the preferred form, the perforations are formed by striking out lip portions **33** defining restricted openings **31** of definite predetermined shape and size. It has been found that the openings defined by the lips **33** should be rela-

tively small in size; otherwise, an undesirable amount of noise is admitted to pass through the plate **30**. In general, it is believed that diameter of the openings preferably should not exceed 0.1 inch. For example, in one commercial embodiment of the invention, holes of approximately .07 inch in diameter have been found to provide desired results. It is important, moreover, that there shall be maintained a high ratio between closed and open areas of the plate. The best results appear to be obtained when the effective hole area does not exceed approximately 6 to 10 percent of the gross area of the plate. For convenience, there has been illustrated in Fig. 3 of the drawings a manner of spacing the perforations **31** so as to provide the desired high ratio of closed to open area. As viewed in Fig. 3, the openings **31** are disposed in a plurality of groups **32** and in the lines extending generally parallel to a line between the lower left-hand and upper right-hand corner and the perforations **31** are spaced fairly closely together, such as approximately nine thirty-seconds inch between centers. The perforations **31** falling in a line generally parallel to a line between the lower right-hand and upper left-hand corners are spaced slightly farther apart such as a distance of seven-sixteenths inch between centers. The perforations may be grouped, as shown, to increase the ratio of closed to open area.

Beneath the ring **23**, but spaced therefrom, there is disposed a transverse annular or ring-shaped baffle plate **40** which is formed of a relatively thick sheet of sound absorbing material such as the soft pressed asbestos fiber board from which the walls **21**, **22** and **23** are formed. By way of example, the central opening **41** of the baffle plate **40** may have a diameter which is of the order of one-third the diameter of the plate **40**. The baffle **40** is spaced from the sound plate **30** by disposing it on the bottom edge of the ring **23**. Beneath the baffle **40**, the cylindrical chamber is continued by a cylindrical wall **24** and the bottom thereof is partially closed by an annular ring-like bottom wall **25**. Here again, the preferred material utilized in forming the walls **24** and **25** is a sound absorbing material.

Situated beneath the opening **41** of the baffle **40** and intermediate the baffle and the bottom wall **25** is a circular or disk-like baffle **42** also formed of sound absorbing material. The disk-like baffle **42** may be supported in any convenient manner such as by means of a plurality of sleeves **43** received on studs **44** extending between the baffle **40** and the bottom wall **25**. The diameter of the baffle **42** is preferably of the order of three-fourths the diameter of the chamber.

A central circular opening **26** in the bottom wall **25** is provided for the release of the air into the venturi and diffusing section of the diffuser, to be described immediately hereafter. The opening **26** is of smaller diameter than the baffle **42**.

Accordingly, it will be seen that, when primary air is admitted into the chamber **20** through the damper **10**, the flow of air is first expanded outwardly and given a uniform vertical direction by passage through the sound plate **30**. At the same time some of the sound carried by the primary air is absorbed by the walls **21** and **22**. Some of the sound will be reflected by the sound plate **30** so as to increase the absorption thereof by the walls **21** and **22**. Some of the sound also will cause vibration of the plate **30**, thus absorbing energy of the sound. The air which has passed through the perforations **31** in the plate **30** is then forced to strike against the baffle plates **40** and **42**, since these plates, in connection with the side walls, form a tortuous passage for the air. The resulting impact of the sound waves at right angles to the baffles **40** and **42** results in a very efficient and high degree of sound attenuation.

As a result of the structure just described, the primary air is conditioned for release into the room without raising the noise level of the room beyond acceptable limits. It is an advantage of the present invention that this efficient sound absorption may be carried out in a unit which is as small as two feet in diameter and less than a foot in height, between the upper wall **22** and bottom wall **25**.

Turning now to the venturi and air dispersing section of the diffuser, as best shown in Figs. 1 and 2 of the drawings, there is provided an outer or peripheral vane **50** which is generally frusto-conical in shape and which is provided with a circular flange **51** at its upper end for registry with the periphery of the opening **26**. The lower extremity of the vane **50** is in the form of a horizontal flange **52** of generally square configuration, the merging surfaces being rounded off to give a smooth uninterrupted surface. The flange **52** is adapted to rest against the under surface of the ceiling or other supporting structure shown generally at **53**.

Within the confines of the upper circular flange **51**, there is positioned a disk **54** of lesser diameter than opening **26** and having a downwardly bent peripheral portion **55** defining an annular air passageway therebetween. The disk **54**, which may be formed of sheet metal, may be supported in the position shown by means of a plurality of posts **56** secured to the baffle **42**.

In accordance with the invention, the flange **51** is engaged by a ring-like member **60** having an outwardly flared arcuate end portion **61**. There also is secured to the rim **55** of disk **54** a generally frusto-conical plate **62** which is co-extensive with member **60**. The result is that the plates **60** and **62** define an annular diagonally, i. e. outwardly and downwardly, directed venturi opening **63** spaced adjacent the inner surface of the peripheral vane **50**.

Disposed beneath the disk **54** and generally within the deflector **50** are nested rings **70** and **71** which are coaxially positioned as shown in the drawings at respectively lower levels by any suitable supporting means (not shown). The rings **70** and **71** are generally frusto-conical and are open at the top and bottom. The bottom edges are bent outwardly in the form of horizontal flanges **73** and **74**, respectively, which are generally similar in shape to the flange **52** of the peripheral vane **50**, i. e., generally square in configuration, with the intermediate area smoothly rounded out to permit a transition from circular to square form. A center baffle **72** which is closed at the top by a rectangular section **75** and provided with a rectangular flange **76** is axially supported by any suitable means (not shown).

In the operation of the device, the primary air from which the sound has been effectively attenuated is released through the annular venturi opening **63**. This induces a flow of room air upwardly through the diagonal entranceways provided by the spaces between the rings **70**, **71** and **72**. The air drawn upwardly from the room through these passageways is then mixed with the primary air issuing from the venturi opening **63** and the mixture is dispersed outwardly through the passageway between the ring **70** and the outer vane **50**. The arrangement is such that a stream of air is produced which is generally parallel to but spaced from the supporting surface **52** and the flow is substantially uniform in all directions radially of the central axis of the diffuser to form a circular pattern. This has been found to be a distinct advantage of the diffuser of the present invention in that I have found that, when the square face of the diffuser is mounted flush with the ceiling and the diffused air forms a circular air pattern similar to that emanating from a round diffuser, smudging is practically avoided. It thus will be seen that, when the deflector is installed in an enclosure, an upward flow of room air is drawn into the diffuser centrally thereof and the mixture of room air and primary air is dispersed outwardly along the ceiling from which it eventually drops and joins the returning flow of room air. It is an advantage of the arrangement of the diffuser of the present invention that a high ratio of room air to primary air is induced. A one-to-one or greater ratio can easily be obtained. As

a result, the pressure and temperature differential of the primary air may be increased without adversely affecting the throw and drop characteristics of the stream of mixed room and primary air being dispersed from the diffuser.

The arrangement of the diffuser in accordance with the invention is such that a highly compact and efficient sound attenuating and air diffusing unit is produced which is highly efficient and thus permits the use of high pressure air without undesirably increasing the noise level of the enclosure and produces a desired mixture of primary air with room air having among its many advantages the dispersing of a stream of air into the enclosure having desirable throw and drop characteristics. Furthermore, the diffusing section is of simple design rendering it economical to produce and is arranged in a desirable square or rectangular configuration rendering the diffuser more adaptable for use in modern designs of enclosures and also giving a desired directional component to the stream of air dispersed through the diffuser.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the language used in the following claims is intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

I claim as my invention:

1. In a diffuser, a generally frusto-conical vane having a generally rectangular outwardly directed flange at its lower end, an annular outwardly and downwardly directed venturi nozzle adjacent the inner surface of the vane, and a second generally frusto-conical vane of smaller diameter than the first vane and of similar shape disposed generally coaxially with the first vane to form an interior air inlet passageway to the space adjacent the venturi nozzle and an air outlet passageway of substantially constant width between the vanes, said second vane having a generally rectangular outwardly extending flange of smaller size than the flange of the first vane and disposed at a greater distance from the nozzle.

2. In a diffuser, a generally frusto-conical vane having a generally rectangular outwardly directed flange at its lower end, an annular outwardly and downwardly directed venturi nozzle disposed adjacent the inner surface of the vane, a plurality of concentric and spaced apart generally frusto-conical rings within the vane forming interior air inlet passageways to the space adjacent the venturi nozzle and an air outlet passageway between the outer ring and the vane, said rings being provided with generally rectangular outwardly extending flanges of progressively smaller size and disposed at progressively greater distances from the venturi nozzle than the flange of the vane.

3. In a diffuser, a generally frusto-conical outer vane having a generally rectangular outwardly directed flange at its lower end, an annular outwardly and downwardly directed venturi nozzle disposed adjacent the inner surface of the vane, a plurality of concentric and spaced apart generally frusto-conical rings within the vane forming an interior air inlet to the space adjacent the venturi nozzle and an air outlet passageway between the outer ring and the vane, said rings being provided with generally rectangular outwardly extending flanges of progressively smaller size and disposed at progressively greater distances from the nozzle than the flange of the outer vane, and the center ring having means closing the upper end thereof.

4. In a diffuser, a venturi nozzle, a plurality of vanes forming air inlet and outlet passageways adjacent the nozzle and means for connecting the nozzle to a source of air under pressure comprising a chamber having an interior surface of sound absorbing material and a sound attenuating member comprising a perforated plate extending across the chamber transversely to the flow of air.

5. In a diffuser, a venturi nozzle, a plurality of vanes forming air inlet and outlet passageways adjacent the nozzle, and means for connecting the nozzle to a source of air under pressure comprising a generally cylindrical chamber having an interior surface of sound absorbing material and a rigid metal plate extending across the chamber transversely to the flow of air having perforations in a minor proportion of its area.

6. In a diffuser, a sound absorbing and attenuating member for connection between a source of air under pressure and the air outlet of the diffuser comprising a generally cylindrical chamber having an interior surface formed of sound absorbing material, a relatively thin but rigid perforated metal plate extending transversely to the flow of air across the chamber intermediate the ends of the chamber and having both faces spaced from the sound-absorbing material, said plate being provided with a high ratio of imperforate to perforate area, a series of baffles of sound absorbing material in the lower end of the chamber, and a venturi type outlet disposed beneath the baffles.

7. In a diffuser, a sound absorbing and attenuating member for connection between a source of air under pressure and the air outlet of the diffuser comprising a generally cylindrical chamber having an interior surface formed of sound absorbing material, a relatively thin but rigid perforated plate extending across the chamber transversely to the flow of air and intermediate the ends of the chamber, a first baffle formed of sound absorbing material disposed below but spaced from the plate comprising an annular ring having a central air passageway, a second baffle formed of sound absorbing material disposed below but spaced from the first baffle comprising a disk of greater area than the central passageway of the first baffle, and means forming an air outlet disposed beneath the second baffle.

8. In a diffuser, a generally cylindrical chamber having an interior surface formed of sound absorbing material, an air inlet adjacent the upper end of the chamber, a sound attenuating member comprising a metal plate extending across the chamber intermediate its upper and lower ends and disposed transversely to the flow of air through the chamber, said plate having a plurality of nozzles extending axially of the chamber and spaced from the sound-absorbing material to form small open passageways through a minor proportion of the plate, and an annular venturi nozzle communicating with the lower end of the chamber.

9. In a diffuser, a generally cylindrical chamber having an interior surface formed of sound absorbing material, an inlet for primary air under pressure adjacent the upper end of the chamber, a perforated rigid metal plate extending across the chamber intermediate its ends transversely to the flow of air through the chamber, a first baffle formed of sound absorbing material disposed below but spaced from the plate comprising an annular ring having a central air passageway, a second baffle of sound absorbing material disposed below but spaced from the first baffle comprising a disk of greater area than the central passageway of the first baffle, and an annular venturi outlet nozzle disposed beneath the second baffle.

10. In a diffuser, a generally cylindrical chamber having an interior surface formed of sound absorbing material, an inlet for primary air under pressure adjacent the upper end of the chamber, a single rigid perforated metal plate extending across the chamber intermediate its ends and transversely to the flow of air through the chamber,

the perforations of said plate being of small size and comprising a minor proportion of the plate area, a series of baffles formed of sound absorbing material extending transversely of the chamber and forming a tortuous air passageway through the remainder of the chamber, and an annular venturi outlet nozzle forming an air outlet from the bottom of the chamber.

11. A diffuser comprising a generally cylindrical chamber having an interior surface formed of sound absorbing material, an inlet for primary air adjacent the top of the chamber, a rigid perforated metal plate extending across the chamber intermediate its ends and transversely of the flow of air through the chamber, the perforations of said plate being of small size and comprising a minor proportion of the plate area, a series of baffles formed of sound absorbing material extending transversely of the chamber defining a tortuous air passageway through the lower portion of the chamber, means forming an annular outwardly and downwardly directed venturi nozzle depending from and communicating with the bottom of the chamber, a first generally frusto-conical outer vane secured at its upper edge to the chamber and spaced radially outwardly from the venturi nozzle, and a second generally frusto-conical inner vane of smaller diameter than the first vane and spaced radially inwardly of the venturi nozzle.

12. A diffuser comprising a generally cylindrical chamber having an interior surface formed of sound absorbing material, an inlet for primary air adjacent the top of the chamber, a rigid perforated metal plate extending across the chamber intermediate its ends and transversely of the flow of air through the chamber, the perforations of said plate being of small size and comprising a minor proportion of the plate area, a series of baffles formed of sound absorbing material extending transversely of the chamber defining a tortuous air passageway through the lower portion of the chamber, means forming an annular outwardly and downwardly directed venturi nozzle depending from and communicating with the bottom of the chamber, a first generally frusto-conical outer vane secured at its upper edge to the chamber and spaced radially outwardly from the venturi nozzle, and a plurality of concentric and spaced-apart frusto-conical rings within the vane forming interior air inlet passageways to adjacent the venturi nozzle and an air outlet passageway between the outer of said rings and the vane registering with the venturi nozzle.

13. In a diffuser, a generally frusto-conical vane for insertion in a wall orifice having a peripheral flange at its large end for engaging the wall surface, a plurality of concentric and spaced apart frusto-conical rings of similar shape and of progressively smaller diameter disposed within the vane to form a plurality of air passageways therebetween of substantially equal width throughout, the inner ring being closed at its smaller end and the large ends of the rings being formed with outwardly turned flanges of relatively narrow width, an annular venturi nozzle having a small cross section relative to the width of said passageways disposed between the vane and the next adjacent ring and extending into the passageway, the axis of said venturi nozzle being substantially parallel to that of the air passageway formed by said vane and the ring next adjacent thereto, and means for connecting the nozzle to a source of air under pressure.

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