Jan. 6, 1953 L. R. PHILLIPS 2,624,262

DEVICE FOR DELIVERING AIR INTO ENCLOSURES

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Fig. 1.

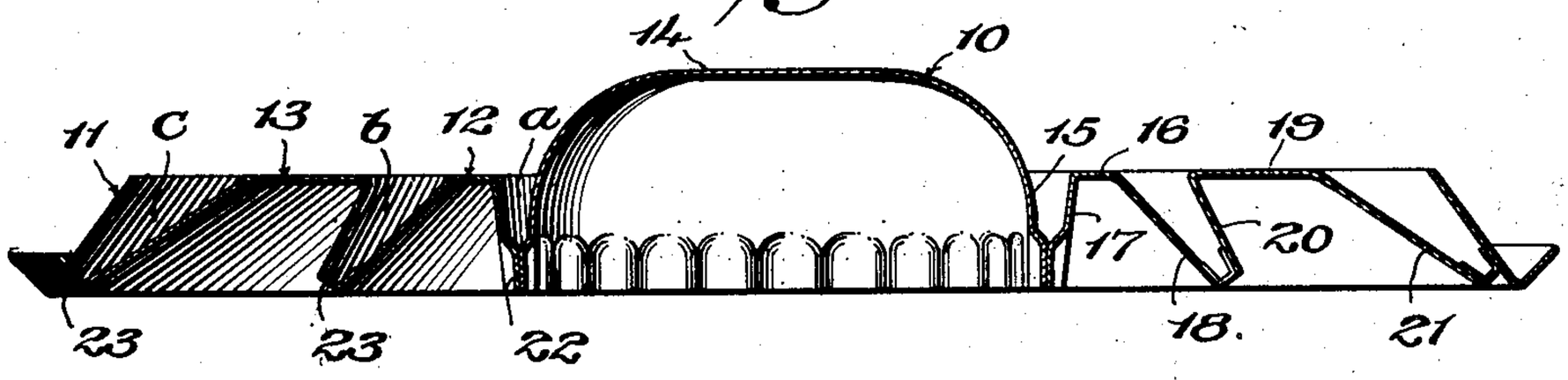
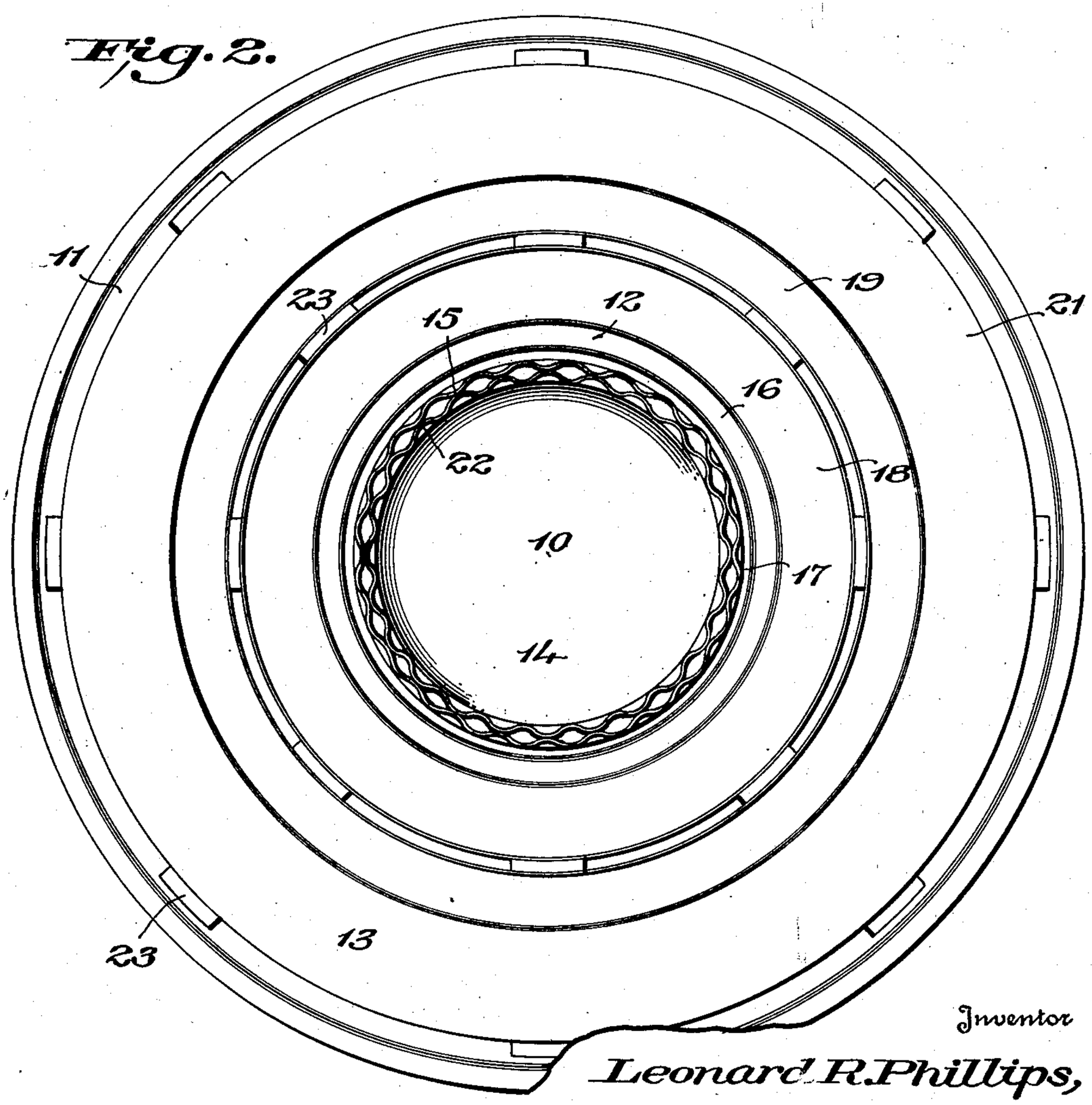


Fig. 2.



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DEVICE FOR DELIVERING AIR INTO ENCLOSURES

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Fig. 3.

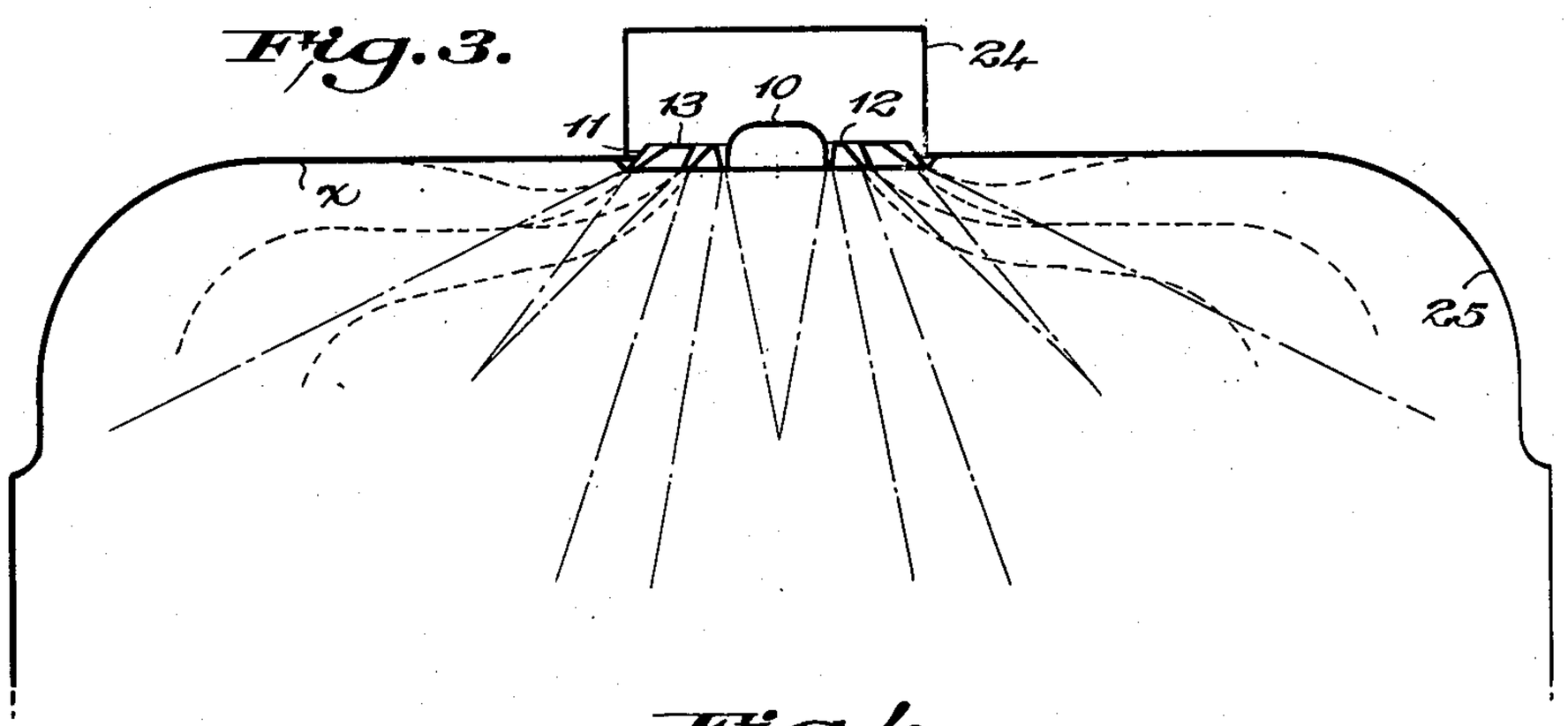
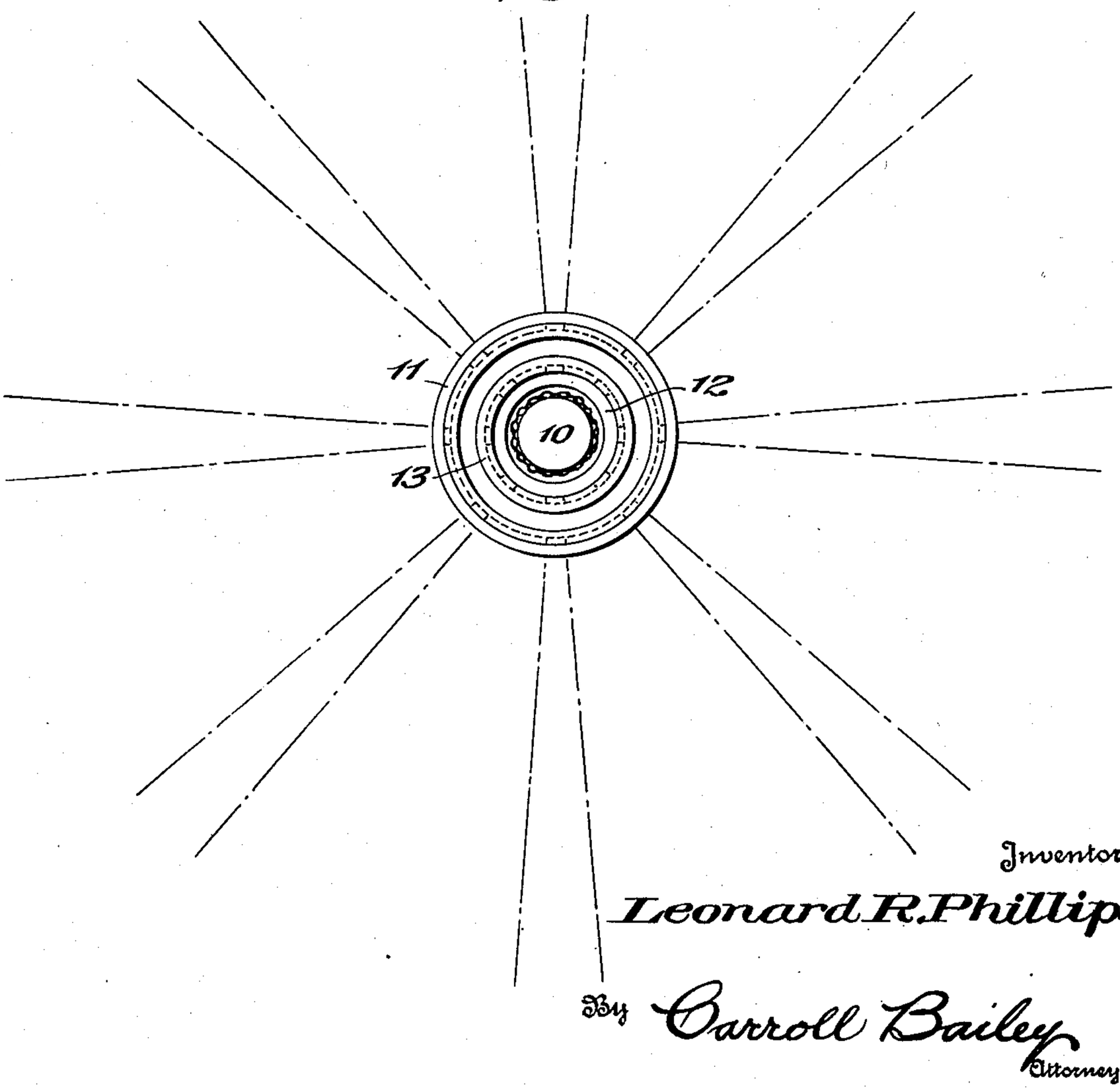


Fig. 4.



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DEVICE FOR DELIVERING AIR INTO ENCLOSURES

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Fig. 5.

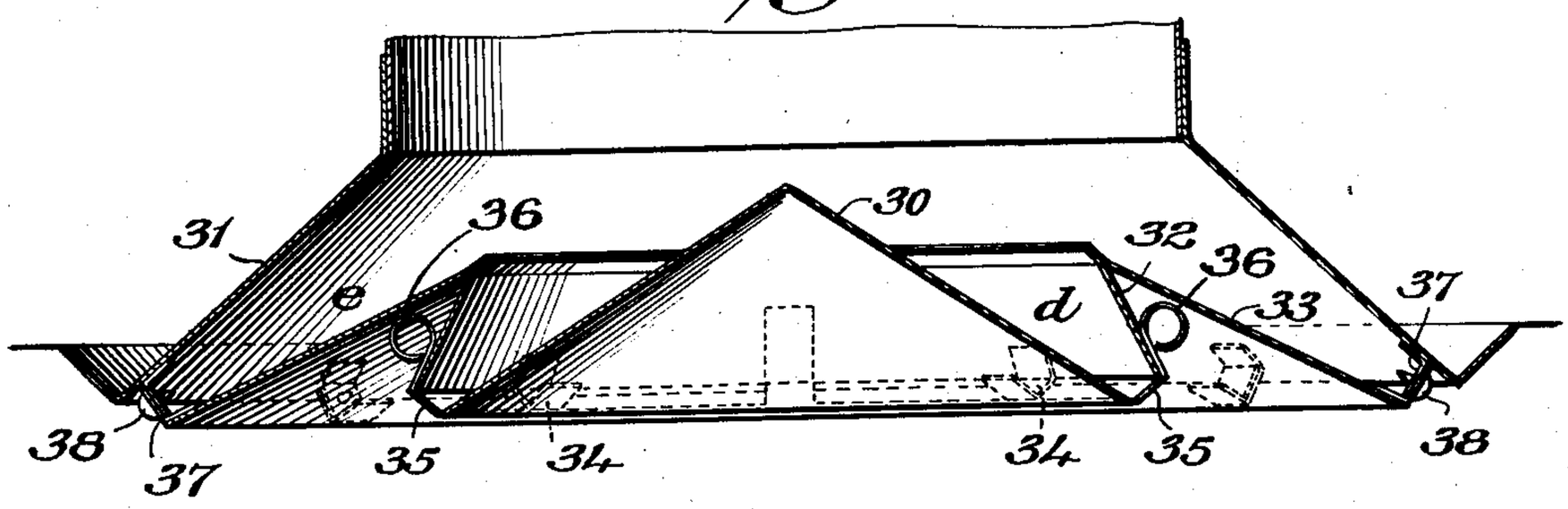
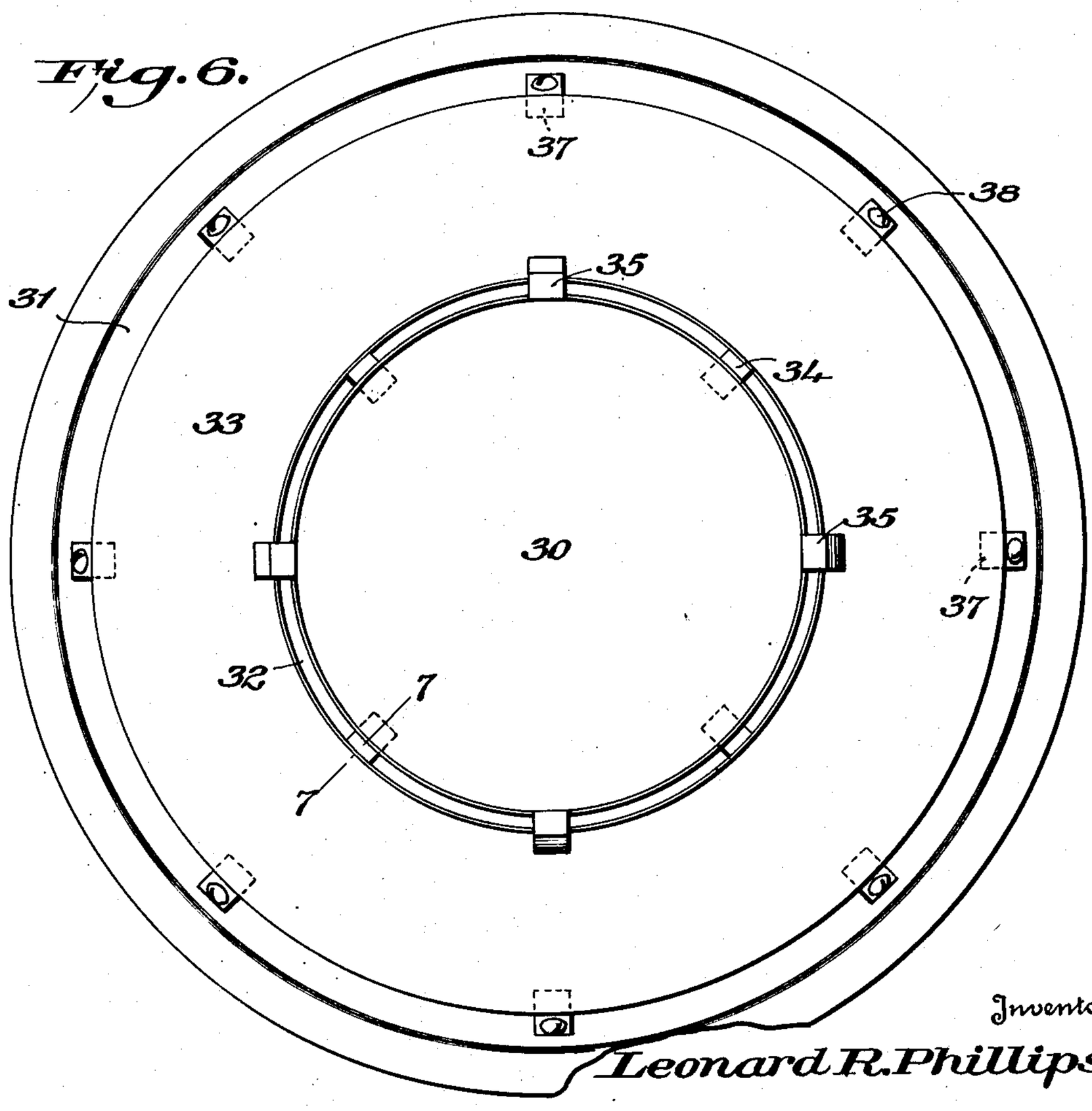


Fig. 6.



Inventor

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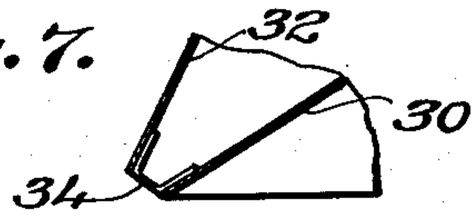
Fig. 7.



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Patented Jan. 6, 1953 2,624,262

UNITED STATES PATENT OFFICE

2,624,262

DEVICE FOR DELIVERING AIR INTO ENCLOSURES

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Application June 10, 1947, Serial No. 753,760

3 Claims. (Cl. 98—40)

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This invention relates to devices for delivering air for ventilating, heating, cooling or other purposes into enclosures such as rooms, railway cars, buses, aircraft cabins and the like, and has particular reference to improvements in devices for this purpose which are designed to be mounted at or near the ceiling and to deliver the air in a pattern which, generally speaking, is endless and may be of circular or any other desired shape.

Devices of the type mentioned and as heretofore constructed may deliver the air either in a single or a plurality of endless streams and are advantageous and desirable for different reasons. To secure satisfactory air delivery from them under certain conditions has, however presented problems. For example, in supplying air to enclosures such as aircraft cabins, buses, railway cars and especially subway cars, it often is desirable, as when the air is cool, to have the air delivered both laterally and downwardly over substantially the full width of the enclosure under high velocity and turbulence and yet with desired diffusion above head level.

The ceilings of enclosures such as mentioned usually are low and therefore the air delivery devices cannot be mounted at any considerable height above head level. Under such conditions, in order to insure delivery of the air as far outwardly as the sides of the enclosure, the devices must be constructed to effect considerable lateral deflection of the air. If, however, the air is delivered in a single endless stream of circular or equivalent shape, and with sufficient lateral deflection to reach the sides of the enclosure, the single air stream will, by entraining air from the space between it and the ceiling, produce a sub-atmospheric pressure in said space with the result that the air will be urged upwardly into said space and thereby will be caused to flow more or less horizontally across the ceiling, leaving the medial portion of the enclosure substantially without air supply. Similarly, in case there should be one or more additional air streams, air will be entrained from the space or spaces between the streams and the streams will be urged together and upwardly and outwardly toward the outermost stream with the result that all of the streams will be caused to flow more or less horizontally outwardly with generally the same result of leaving the medial portion of the enclosure without air supply. On the other hand, if the devices are constructed to deliver the air so as effectively to supply the medial portion of the enclosure, the air does not have sufficient lateral flow to reach the sides of the enclosure.

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Accordingly, one special and important object of the present invention is to provide an air delivery device of the type mentioned embodying a construction such that the air is not delivered therefrom in a truly endless stream, or streams, with the disadvantage mentioned, but, on the contrary, is delivered therefrom in one or more endless series of separate streams with spaces between them through which more or less of the enclosure air may flow to the space between the ceiling and the outermost streams and to the space or spaces between the respective series of streams, in case there should be more than one series of streams. By predetermining the lengths of the spaces between the streams of the single series or between the streams of the respective series, as the case may be, the amount of enclosure air which may flow to the spaces between the single or outermost series of streams and the ceiling and between the streams of the respective series, may be predetermined and thereby the pressure in said spaces and its effect upon the directions of flow of the air streams may be predetermined with the decidedly advantageous result that the directions of flow of the air streams may be controlled as desired to insure not only high velocity and turbulence of the delivered air, but also its flow over substantially the full width of an enclosure with desired diffusion above head level. Moreover, by providing for introducing enclosure air between the air streams after they have been delivered from the device, a particularly thorough mixing of the enclosure air with the supplied air is advantageously effected.

In other instances, as when the delivered air is warm, it may be desirable to deliver it primarily downwardly. Accordingly, another special and important object of the invention is to provide an air delivery device of the type mentioned embodying simple, practical adjustable means for readily varying the lengths of the spaces between the streams of either the single endless series or between the streams of each endless series so as to cause the streams to flow from the device either substantially uniformly over a wide area or primarily downwardly over a narrower area as desired.

Heretofore, when it has been desirable to provide for effecting a change in the direction of flow of an air stream, or streams, delivered from an air outlet device of the type mentioned the usual practice has been to provide air deflector means of some suitable form for disposition in the path or paths of flow of the air stream or streams. This entailed not only provision of the

deflector means and mounting means for the same, but usually the provision for some suitable additional means for effecting adjustment of the deflector means, all of which involved more or less structural and production complications with attendant expense. The present invention, by its provision for effecting change in the directions of flow of air streams as a consequence of controlling the pressure at the sides of the streams, avoids many of the disadvantages experienced in connection with air deflector means interposed in the paths of the air streams.

Another special and important object of the invention is to provide an air delivery device of the type mentioned which possesses the advantages stated and which, at the same time, is of simple, practical construction, which may be produced economically and which is thoroughly reliable and efficient in operation.

With the foregoing and other objects in view, which will become more fully apparent as the nature of the invention is better understood, the same consists in an air delivery device embodying the novel features of construction, combination and arrangement of parts as will be hereinafter more fully described, illustrated in the accompanying drawings and defined in the appended claims.

In the accompanying drawings, wherein like characters of reference denote corresponding parts in related views:

Fig. 1 is a central, vertical section through an air delivery device constructed in accordance with one practical embodiment of the invention.

Fig. 2 is a bottom plan view of the device shown in Fig. 1.

Fig. 3 is a diagrammatic view similar to Fig. 1 illustrating the manner in which air flows from the device.

Fig. 4 is a diagrammatic top plan view of the device and the manner of air flow therefrom as shown in Fig. 3.

Fig. 5 is a view similar to Fig. 1 illustrating a device of alternative form.

Fig. 6 is a bottom plan view of the device shown in Fig. 5; and

Fig. 7 is a detail section on the line 7—7 of Fig. 6.

Referring to the drawings in detail, first to Figs. 1 and 2, it will be observed that the device is of circular shape as viewed in plan and is composed of a plurality of annular walls which are spaced apart to define between them a plurality of annular, concentric, open-ended air passageways.

More particularly it will be observed that, according to the specific construction shown in Figs. 1 and 2, the device is composed of an innermost, circular member 10; an outermost, open-ended, hollow, flaring, circular member 11, and, between said members 10 and 11, a pair of inner and outer circular members 12 and 13, respectively, which are of inverted U-shape, generally speaking, in cross section.

The innermost member 10 is open at its bottom, closed at its top by a top wall 14 and closed at its sides by a side wall 15 which may be vertical or inclined either downwardly and inwardly or downwardly and outwardly as desired.

The inner inverted U-shaped member 12 is composed of a top wall 16 having depending therefrom inner and outer side walls 17 and 18, respectively, the former of which may be vertical or inclined either downwardly and inwardly or downwardly and outwardly, as desired, and the latter of which is inclined downwardly and outwardly or flared.

The outer inverted U-shaped member 13 is composed of a top wall 19 having depending therefrom inner and outer side walls 20 and 21, respectively, both of which are inclined downwardly and outwardly or flared.

According to the specific construction shown, the side wall 15 of the member 10 is disposed vertically; the inner side wall 17 of the member 12 is slightly inclined downwardly and inwardly and is spaced from the side wall 15 of the member 10 to provide between said side walls 15 and 17 an innermost annular air pasageway *a* of downwardly converging cross section; the outer side wall 18 of the member 12 is spaced from and has a greater amount of downward and outward inclination or flare than the inner side wall 20 of the member 13 to provide between said side walls 18 and 20 an intermediate, annular air passageway *b* which itself is of downwardly converging cross section, but which is inclined downwardly and outwardly or flared with respect to the vertical or longitudinal axis of the device; and the outer side wall 21 of the member 13 is spaced from and has a greater amount of downward and outward inclination or flare than the outermost member 11 to provide between said side wall 21 and said member 11 an outermost, annular air pasageway *c* which, like the passageway *b*, is itself of downwardly converging cross section and is inclined downwardly and outwardly or flared with respect to the vertical or longitudinal axis of the device, but which has an amount of downward and outward inclination or flare somewhat greater than the passageway *b*.

In further accordance with the specific construction illustrated in Figs. 1 and 2, the passageway *a*, at or adjacent to its lower or outlet end or mouth and at suitable angularly spaced points, is suitably baffled or blocked, as indicated at 22, against flow of air therethrough, the said baffles or blocks being provided, for example, by crimping the lower end portions of the walls 15 and 17 against one another at spaced intervals as shown. Either in similar manner or by means of separate pieces 23 suitably mounted in the lower or outlet ends or mouths of the passageways *b* and *c*, the mouths of the latter passageways also are baffled or blocked at suitable angularly spaced points against flow of air therethrough.

The members 10, 11, 12 and 13 may be secured together in their assembled relationship shown and described by the baffles 22 and 23 or in any other suitable manner. Moreover, the device may be mounted in any suitable manner and air may be supplied to the upper ends of the passageways *a*, *b* and *c* in any suitable manner, as, for example, through an air supply duct 24 as illustrated in Fig. 3 of the drawings. In any event, assuming that the device is mounted at the top of an enclosure such as a railway car, or the like, midway between the sides thereof, as indicated by way of example in Fig. 3 of the drawings wherein the interior cross sectional outline of the upper part of a car is designated as 25, and that air is supplied by the duct 24 or by other suitable means to the tops of the passageways *a*, *b* and *c*, it is apparent that the air will be divided, by said passageways and their baffles 22 and 23, into three separate, annular, concentric sets of angularly spaced apart streams the innermost set of which will be directed generally directly downwardly, the outermost set of which will be directed laterally outward and downward, and the intermediate

set of which will also be directed laterally outward and downward, but a lesser amount than the outermost set of streams.

Due to the downward convergence of the passageways *a*, *b* and *c*, the streams of air issuing from the lower ends of said passageways will be more or less in the form of jets, and in accordance with known laws of air flow these jets, upon delivery from said passageways, will have an expansion angle of about fifteen degrees. In this connection, for a given pressure and velocity of the supplied air, the height of the device above head level, the width of the car or other enclosure into which the air is delivered, and other known factors, the inclination or flare of the passageways *b* and *c* relative to the vertical or longitudinal axis of the device may be so chosen that the air streams flowing from these passageways will, by their natural lateral expansion, meet and intermingle or diffuse at about or suitably above head level and, together with the streams flowing from the passageway *a*, will approximately blanket or cover the entire sectional area of the car or other enclosure.

The streams will flow as directed by the passageways *a*, *b* and *c* due to the baffles **22** and **23** serving to produce, between the streams of each annular set, spaces through which the car or other enclosure air may flow to the spaces between the respective annular sets of streams and to the spaces between the ceiling *x* and the streams of the outermost annular set to avoid the production of low pressures in these spaces by the air streams. In other words, in the absence of the baffles **22** and **23**, air would flow from the device in three annularly continuous streams, the outermost of which would blanket the space between the same and the ceiling *x*, entrain air from said space and thus produce in said space a sub-atmospheric pressure with the result that the outermost stream would be urged upwardly to satisfy the partial vacuum thus created above it. Similarly, the intermediate stream would blanket the space between the same and the outermost stream, entrain air from said space and thus produce in said space a sub-atmospheric pressure with the result that the intermediate stream would be urged upwardly to satisfy the partial vacuum thus created above it. The net result would be that both of the two outermost annular air streams would flow substantially laterally from the device to and down the sides of the car or other enclosure, as indicated by dotted lines in Fig. 3, and the primary purpose of having the air flow substantially as indicated by the dot and dash lines in said figure would therefore be defeated. Due, however, to the baffles **22** and **23** serving to divide the air into annular sets of streams spaced apart for flow of the enclosure air between them to the spaces between the respective sets and to the spaces between the outermost set and the ceiling, sub-atmospheric pressures cannot be developed in said spaces and the streams therefore will flow as desired and as predetermined by the angularity of the passageways *b* and *c*.

The baffles **22** and **23** must be sufficiently long to produce, between the separate streams of each annular set, spaces of sufficient angular extent to permit flow between the streams of each set of sufficient of the enclosure air to prevent any tendency toward the production of a sub-atmospheric pressure between the respective sets of streams and between the streams of the outermost set and the ceiling. Beyond this, the baffles

may be of any desired number and may be arranged as desired to cause the spaces between the streams of the respective sets to be angularly related as desired to each other and to the enclosure.

The device obviously need not be of circular shape, but may be of any other desired shape as viewed in plan. Moreover, instead of having three separate sets of air passageways, the device obviously may have two or only one, or more than three sets of passageways, depending upon the particular conditions of its use.

The space within the innermost member **10** may advantageously be used, if desired, to house a radio receiving set, a radio loud speaker, a voice amplifier, illuminating means or any other desired instrumentality for any desired use.

Summarizing, it will be apparent that the present device provides for delivering air from a relatively low height into an enclosure under high velocity and turbulence, with diffusion of the air at or above head level or other desired level and yet with distribution of the air across practically the entire width of the enclosure.

Referring now particularly to Figs. 5 to 7 of the drawings, it is pointed out that the device therein illustrated is generally similar to the device illustrated in Figs. 1 and 2, but differs from the latter device primarily in that it is adjustable to vary the number and lengths of the spaces between the air streams of at least one of the sets and thus vary the pressure particularly at the outer side of the streams of this set to control the directions of flow of the air streams of said set from the device.

The device illustrated in Figs. 5 to 7 comprises an innermost member **30** of hollow, conical form having its base disposed downwardly; an outermost, open-ended, hollow, flaring member **31** and two intermediate, inner and outer annular flaring members **32** and **33**, respectively, joined together at their upper ends.

The inner intermediate member **32** is spaced from and has a lesser amount of flare than the conical member **30** to provide between the same and said conical member an annular, open-ended air passageway *d* which is inclined downwardly and outwardly or is flared relative to the vertical or longitudinal axis of the device, but which itself tapers toward its lower or outlet end or mouth. On the other hand, the outer intermediate member **33** is spaced from and has a greater amount of flare than the outermost member **31** to provide between the same and said outermost member an annular, open-ended air passageway *e* which is inclined downwardly and outwardly or is flared relative to the vertical or longitudinal axis of the device, but which, like the passageway *d*, itself tapers toward its lower or outlet end or mouth.

The passageway *d*, at or adjacent to its lower or outlet end or mouth and at suitable angularly spaced points, is suitably baffled or blocked, as by means of tabs **34** of sheet material, against flow of air therethrough. These tabs **34** may be fastened to the member **32** and may be loose with respect to the conical member **30**, against the upper, marginal face of which they may bear, whereby said member **30** is held properly spaced from and may be rotated with respect to said member **32**. Other tabs **35** may extend from the lower part of the member **30** across the mouth of the passageway *d* and upwardly over the outer face of the lower portion of the member **32** to hold the member **30** assembled with the member **32** for rotation with respect thereto. The tabs **35**

may have handle formations 36 for finger engagement to facilitate rotation of the member 30, or any other suitable means may be provided for this purpose.

The passageway *e*, at or adjacent to its mouth and at suitable angularly spaced points, is baffled or blocked in any suitable manner, as, for example, by means of tabs 37. Each baffle may consist of an overlapping pair of the tabs 37 one of which is fixed to the member 31 and the other of which is fixed to the member 33, and the tabs or each pair may be detachably connected together by a screw 38. Thus, the entire assembly consisting of the members 30, 32 and 33 may be attached to and removed from the member 31, as a unit.

The tabs 34, 35 and 37 serve to cause air flowing through the passageway *d* and *e* to be divided into separate streams with spaces between them for the same purpose as set forth in connection with the form of the device illustrated in Figs. 1 to 4. For any given installation of the device, where factors such as those mentioned in connection with the Figs. 1 to 4 form of the invention are known, the number, angular disposition relative to each other and width of the tabs 37 may be such as so to control the pressure between the ceiling and the streams of the outermost set as to cause the streams of the outermost set to flow in desired directions from the device. Similarly, the number, angular disposition relative to each other and the width of the tabs 34 and 35 may be such as so to control the pressure in the space between the streams of the two sets as to cause the streams of the inner set to flow in desired directions from the device. In this latter connection it has been found that by a proper selection in number and width of the tabs 34 and 35, said tabs do not, when they are disposed in overlying relationship to each other, prevent the production of sub-atmospheric pressures outwardly of the streams of the inner set, but that, when the member 30 is rotated to shift them more or less apart, the number and widths of the spaces between the streams of the inner set become sufficiently increased so that the production of sub-atmospheric pressures outwardly of said streams are substantially completely avoided. Consequently, when the tabs 34 and 35 are disposed in overlying relationship to each other, the streams of the inner set are caused, by the low pressures created outwardly of them, to be deflected laterally outwardly. On the other hand, when said tabs are angularly spaced apart, low pressures outwardly of them are avoided and they are caused to flow more directly forwardly. Accordingly, by rotatably adjusting the member 30, the directions of flow of the streams may be controlled substantially as desired to cause the air delivered from the device to be directed primarily laterally, or primarily downwardly. If the tabs 34, 35 are adjusted to spaced apart positions, as distinguished from complete or partial overlapping positions, they preferably are equally spaced apart to provide for greater uniformity of the air flow more directly forwardly from the device.

The tabs 37, 37 may be adjustable in the same manner and for the same purpose as the tabs 34 and 35 and, as in the case of the device illustrated in Figs. 1 to 4, the last described device may have only a single air passageway or any desired plurality of air passageways, depending upon the particular conditions of its installation. Moreover, as in the case of the Figs. 1 to 4 form of the device, the Figs. 5 to 7 form of the device may be modified in various different particulars without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. A device for delivering air into an enclosure, said device comprising a plurality of flaring members spaced apart to define therebetween at least two substantially coaxial air delivery passageways which extend around the longitudinal axis of the device and are inclined forwardly and outwardly relative to the longitudinal axis of the device and have their outlet ends materially spaced apart laterally so that a space of material width exists between air streams flowing from the respective passageways, a plurality of air intercepting elements extending across the outlet ends of said air passageways to divide air flowing from each of said passageways into an endless row of separate streams which extend around the axis of the device and are materially spaced apart so that enclosure air may flow between the separate streams of each row to and from the space at each side of the streams of each row to control the air pressure at each side of the streams of each row and thus control the directions of flow of the air streams from the device, one of said flaring members being fixed and having certain of said air intercepting elements fixed thereto, and another of said flaring members being rotatable and having other of said air intercepting elements fixed thereto for adjustment into and from overlying relationship to said first mentioned air intercepting elements by rotation of said rotatable flaring member relative to said fixed flaring member, thereby to vary the number and the spaced apart relationship of the air streams of one of said rows.

2. A device for delivering air into an enclosure, said device comprising means defining at least two substantially coaxial air delivery passageways which extend around the longitudinal axis of the device and are inclined forwardly and outwardly relative to the longitudinal axis of the device and have their outlet ends materially spaced apart laterally so that a space of material width exists between air streams flowing from the respective passageways, a plurality of air intercepting elements extending across the outlet ends of said air passageways to divide air flowing from each of said passageways into an endless row of separate streams which extend around the axis of the device and are materially spaced apart so that enclosure air may flow between the separate streams of each row to and from the space at each side of the streams of each row to and from the space at each side of the streams of each row to control the air pressure at each side of the streams of each row and thus control the directions of flow of the air streams from the device, and means connecting together certain of said air intercepting elements for collective adjustment into and from overlying relationship to other of said elements to vary the number and the spaced apart relationship of the air streams of one of said rows.

3. A device for delivery of air from a source of supply into an enclosure, said device including a pair of flaring members spaced apart to define therebetween an annular passageway for the air, one of said members being fixed and the other being rotatable, a first set of air intercepting elements fixed to said fixed flaring mem-

ber and extending across the outlet end of said passageway, and a second set of air intercepting elements fixed to said rotatable flaring member and extending across the outlet end of said passageway and serving to mount said rotatable flaring member upon said fixed flaring member for rotation relative to the latter to aline and disaline the air intercepting elements of said second set with and from the air intercepting elements of said first set, thereby to divide air flowing from said passageway into different numbers of different streams of variable widths annularly with respect to the device.

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