Dec. 9, 1969 H. F. BRUNS 3,482,506

AIR DISTRIBUTION APPARATUS

Filed July 12, 1968 5 Sheets-Sheet 1

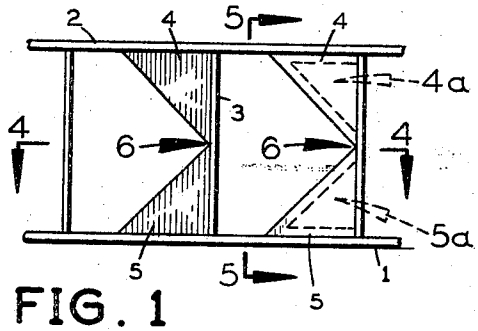


FIG. 1

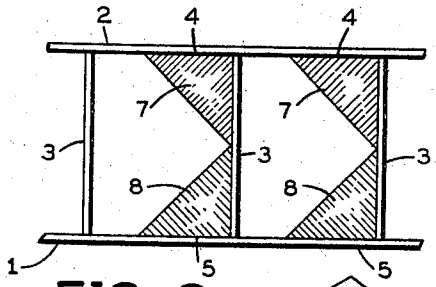


FIG. 2

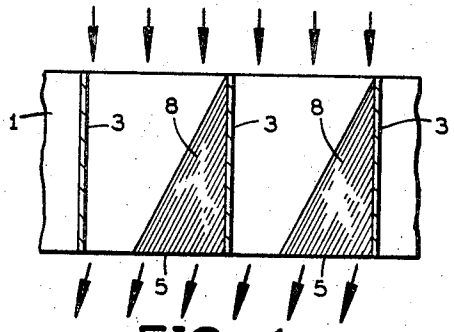


FIG. 4

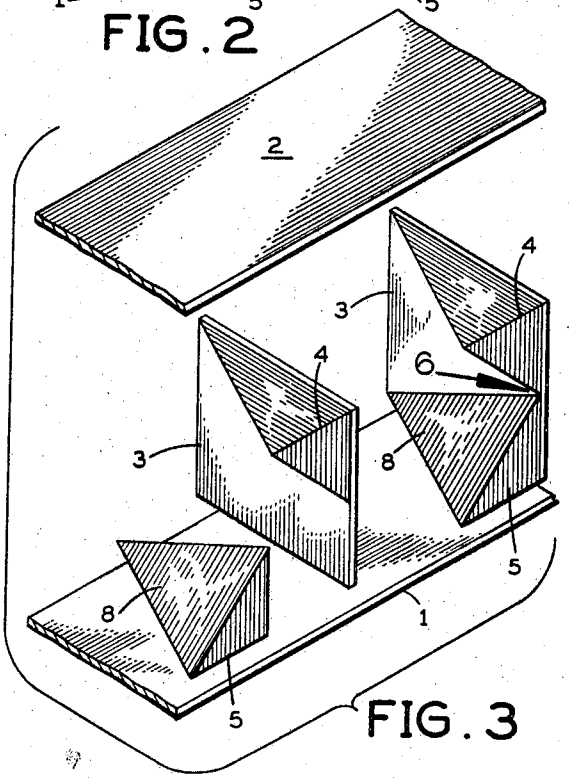


FIG. 3

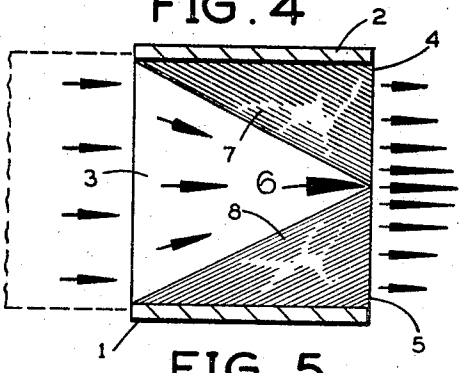


FIG. 5

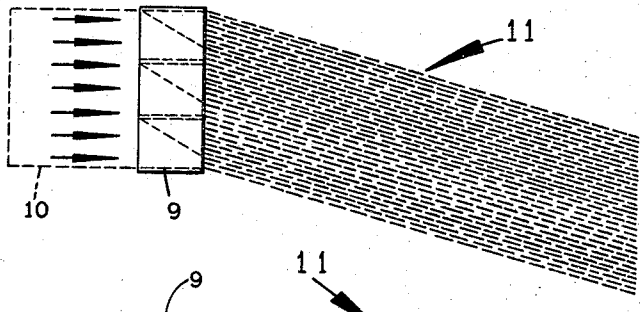


FIG. 6

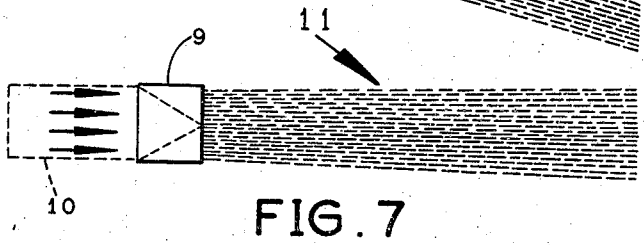


FIG. 7

INVENTOR.
HERBERT F. BRUNS
BY
Lloyd J. Anderson

Dec. 9, 1969 H. F. BRUNS 3,482,506

AIR DISTRIBUTION APPARATUS

Filed July 12, 1968 5 Sheets-Sheet 2

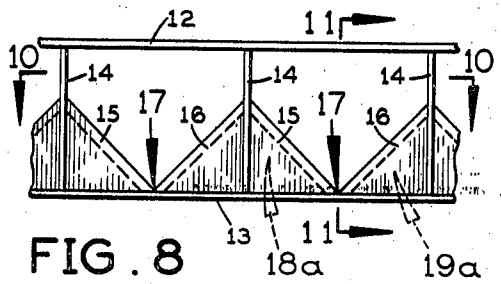


FIG. 8

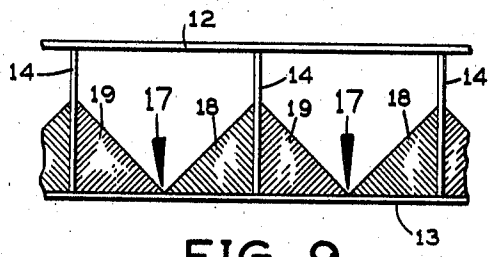


FIG. 9

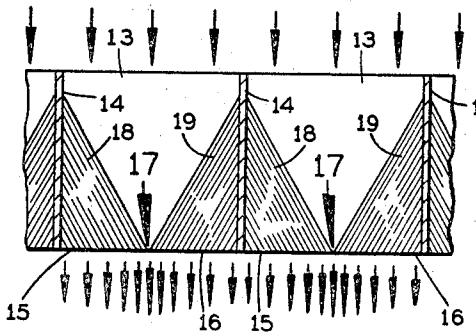


FIG. 10

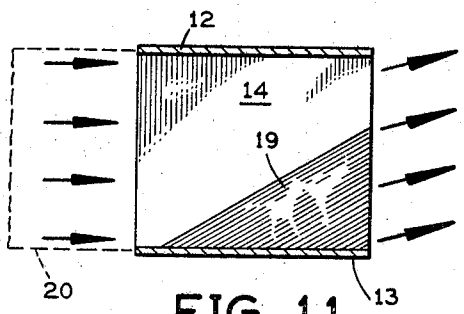


FIG. 11

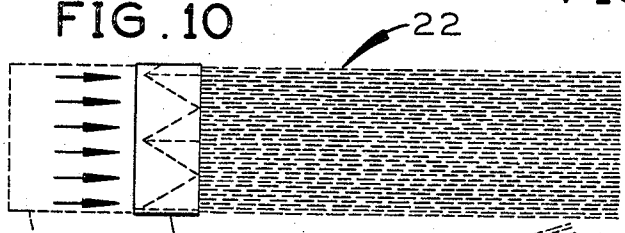


FIG. 13

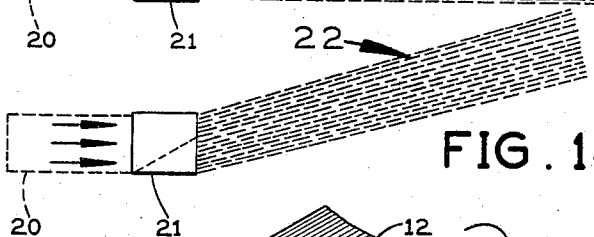


FIG. 14

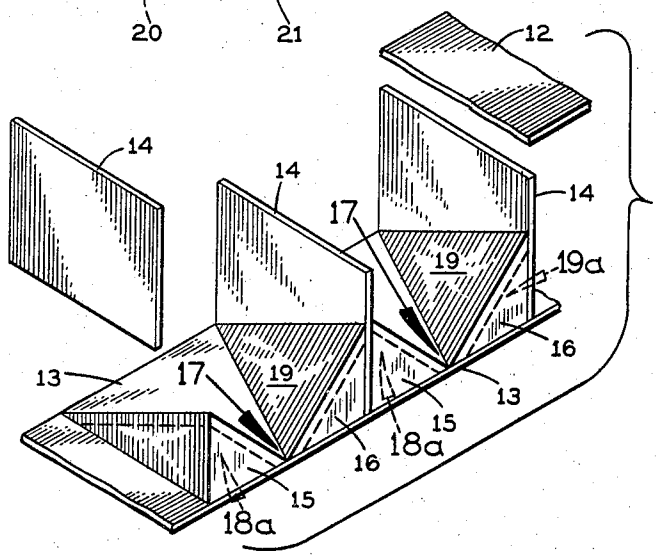


FIG. 12

INVENTOR.
HERBERT F. BRUNS
BY
Lloyd J. Anderson

AIR DISTRIBUTION APPARATUS

Filed July 12, 1968

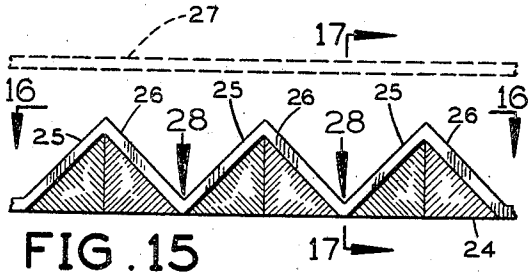


FIG. 15

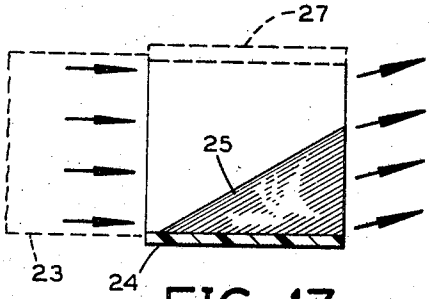


FIG. 17

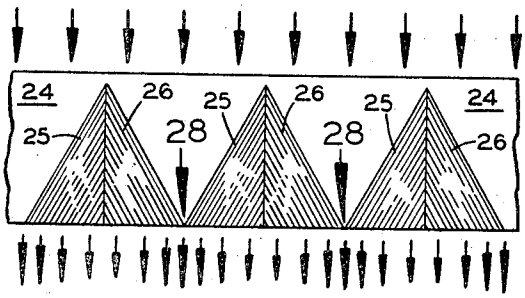


FIG. 16

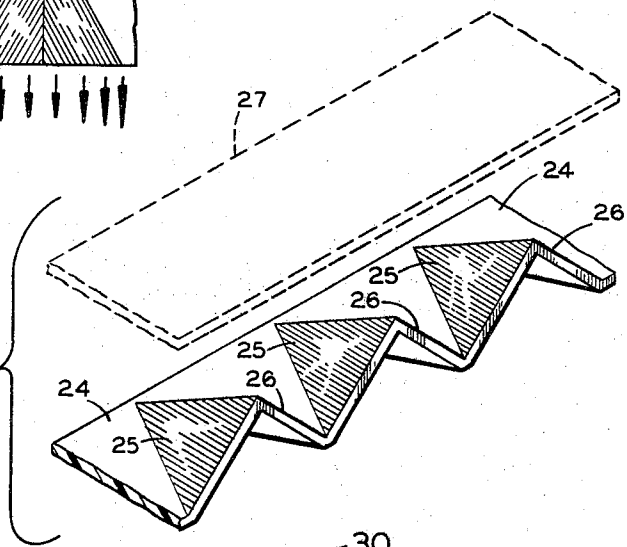


FIG. 18

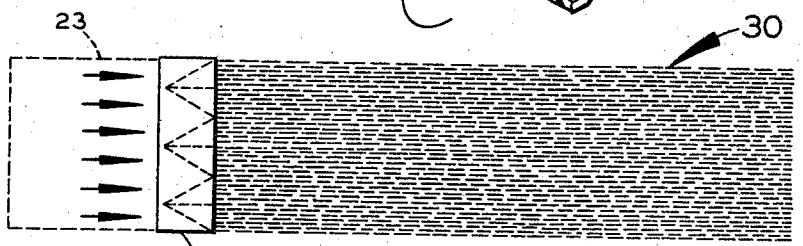


FIG. 19

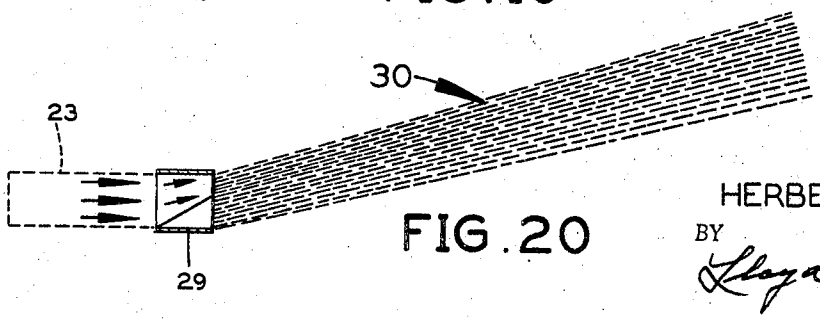


FIG. 20

INVENTOR.
HERBERT F. BRUNS
BY
Lloyd J. Andres

Dec. 9, 1969 H. F. BRUNS 3,482,506

AIR DISTRIBUTION APPARATUS

Filed July 12, 1968 5 Sheets-Sheet 4

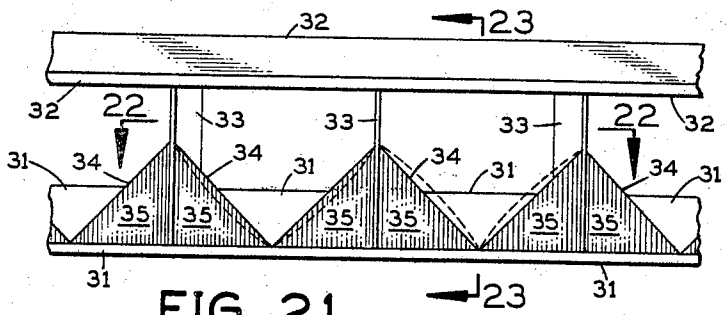


FIG. 21

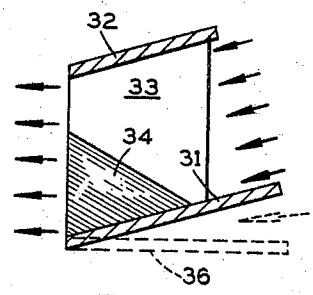


FIG. 23

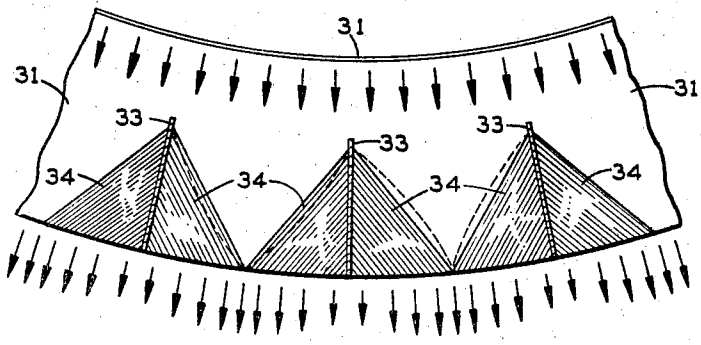


FIG. 22

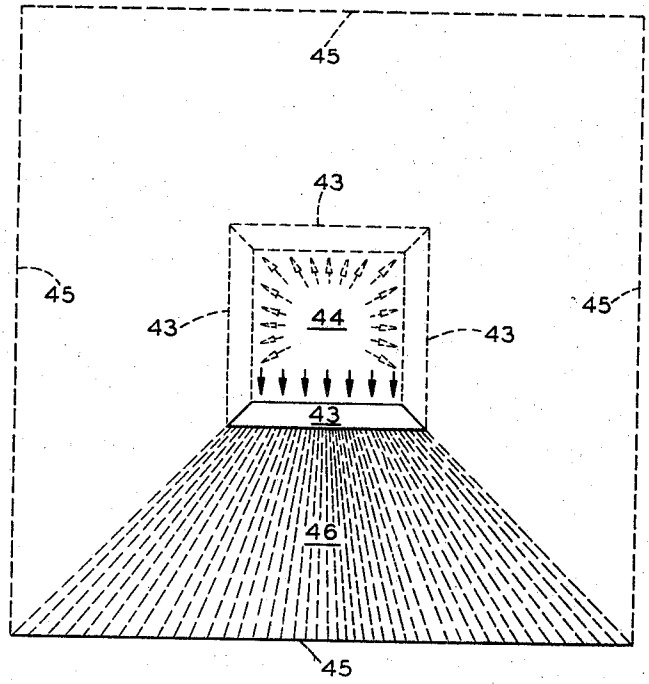


FIG. 28

INVENTOR.
HERBERT F. BRUNS
BY
Lloyd Jones

Dec. 9, 1969 H. F. BRUNS 3,482,506

AIR DISTRIBUTION APPARATUS

Filed July 12, 1968 5 Sheets-Sheet 5

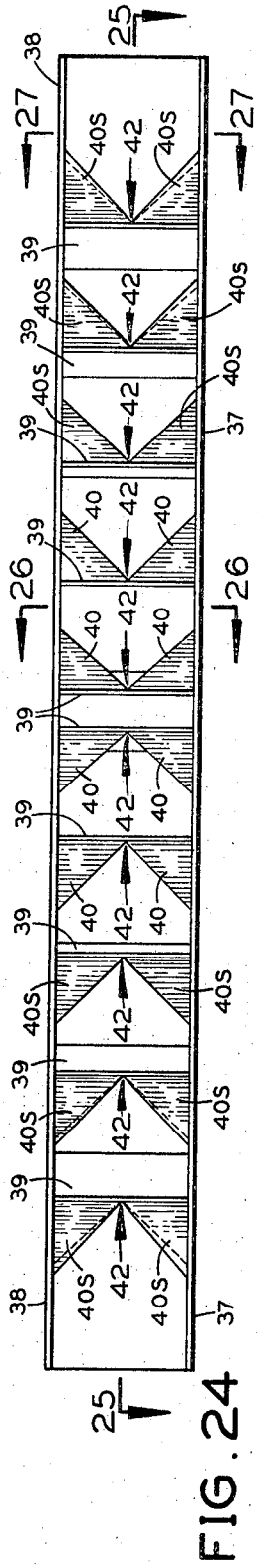


FIG. 24

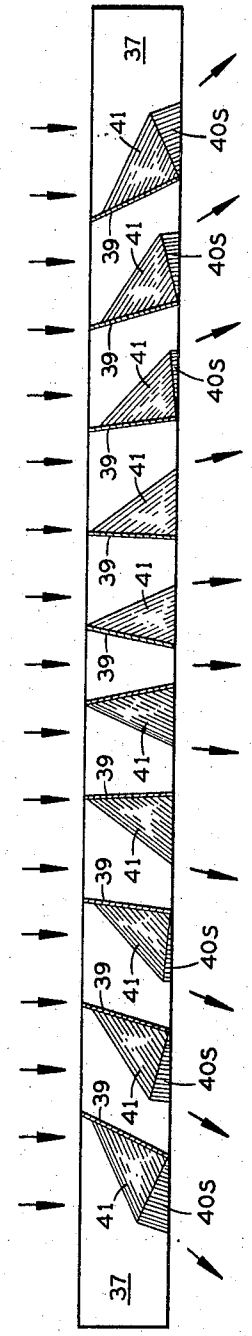


FIG. 25

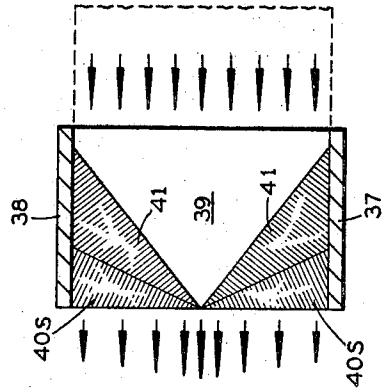


FIG. 27

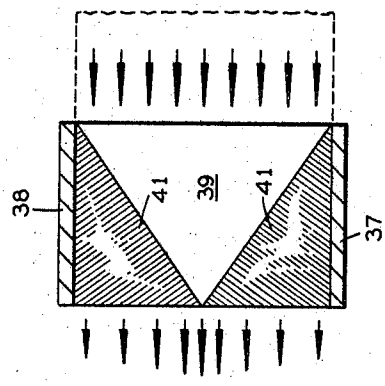


FIG. 26

INVENTOR.
HERBERT F. BRUNS
BY
Lloyd Jones

United States Patent Office 3,482,506 Patented Dec. 9, 1969

3,482,506

AIR DISTRIBUTION APPARATUS

Herbert F. Bruns, 3520 Segovia St., Coral Gables, Fla. 33134

Filed July 12, 1968, Ser. No. 744,496
Int. Cl. F24f 13/06
U.S. Cl. 98—40 4 Claims

ABSTRACT OF THE DISCLOSURE

An air directing device for connection to a substantially linear source of moving air for directing same into a plurality of discrete and coplanar jet streams for movement in a planar form over a predetermined distance including the inducement of ambient air between the jet streams for forming, directing and controlling a non-turbulent planar blanket of coherent air having substantially uniform predetermined thickness and lateral distribution.

This invention relates in general to devices for the control of motivated air and the predetermined controlled distribution of same and more particularly to the construction of an orifice means for converting power motivated air into a predetermined coherent flow including the inducement and entrainment of ambient air for projecting planar patterns over predetermined areas.

Prior air directing devices for distributing motivated air and inducing ambient room air therein are relatively ineffective in uniform draft-free distribution of cooled air in a predetermined zone and these prior devices usually depend upon fixed or adjustable multiple spaced vanes for inducing and mixing ambient air therein, which devices are relatively expensive to manufacture and fail to provide a non-turbulent relatively coherent blanket of moving air which is attracted into close proximity over ceilings and walls of rooms.

The present invention overcomes the above objections and disadvantages by the provision of an air directing and controlling device for receiving substantially linear moving air from a source, such as a duct, and directing same over angularly positioned pyramidal abutments having adjacent oblique triangular impingement surfaces, the output of which will form a plurality of coherent jets of air in planar relation and simultaneously induce ambient air in the spaces between the jets for forming and distributing a discrete coherent blanket of a relatively high initial velocity non-turbulent mixture of air for delivery over a variable range of distances.

A further object of the invention is the provision of an air distributing device for connection with high positioned wall outlets or outlets in ceilings or room air conditioners for distributing cooled air in the form of a discrete coherent flow of predetermined thickness, spread and range, which in its movement will induce and entrain ambient air of the room therein and provide a blanket-like distribution of cooled air over the entire ceiling of a room for complete mixing with the room air in the upper portion of the room.

Another object of the invention is the provision of a plurality of air outlets in a device adaptable to a variety of predetermined geometric shapes for producing a planar array of coherent jet streams for inducing ambient air therein and for forming a coherent blanket of moving air in close proximity to a wall or ceiling of a room when said device is connected to an outlet of moving air, such as a duct, in a substantially linear flow, which blanket adheres to plane surfaces, commonly known as the Coanda or "wall effect."

A further object of the invention is the provision of an air distributing device having a plurality of adjacent

cells containing triangular oblique surfaces with each of said surfaces in each cell formed at a different transverse angle for distributing a blanket of air of substantially uniform thickness over a relatively wide angular transverse area.

These and other objects and advantages in five embodiments of the invention are described and shown in the following specification and drawings, in which:

FIG. 1 is a fragmentary front outlet elevation of a pair of air distribution cells.

FIG. 2 is a fragmentary rear inlet elevation of the cells shown in FIG. 1.

FIG. 3 is a fragmentary partly exploded view of the elements shown in FIG. 1.

FIG. 4 is a fragmentary cross sectional plan view taken through section line **4—4**, FIG. 1.

FIG. 5 is a cross sectional end elevation taken through section line **5—5**, FIG. 1.

FIG. 6 illustrates a plan view of the operation of three cells, shown in FIGS. 1 and 5, illustrating the input and output flow of air.

FIG. 7 is a side elevation of the air flow illustrated in FIG. 6.

FIG. 8 is a fragmentary front outlet elevation of an alternate form of a pair of air distribution cells.

FIG. 9 is a fragmentary rear inlet elevation of the cells shown in FIG. 8.

FIG. 10 is a cross sectional plan view taken through section line **10—10**, FIG. 8.

FIG. 11 is a cross sectional end elevation taken through section line **11—11**, FIG. 8.

FIG. 12 is a fragmentary perspective partly exploded view of the cells shown in FIG. 8.

FIG. 13 illustrates a plan view of the air flow of the cells shown in FIG. 8.

FIG. 14 is a side elevation of the air flow illustrated in FIG. 13.

FIG. 15 is a front elevation of an elementary form of the air distributing device.

FIG. 16 is a fragmentary cross sectional plan view taken through section line **16—16**, FIG. 15.

FIG. 17 is a cross sectional end elevation taken through section line **17—17**, FIG. 15.

FIG. 18 is a fragmentary perspective view of the device shown in FIG. 15.

FIG. 19 is a plan view illustrating the air flow in a device such as shown in FIG. 18.

FIG. 20 is a side elevation of the air flow shown in FIG. 19.

FIG. 21 is a fragmentary front outlet elevation of an alternate conical form of a pair of air distribution cells.

FIG. 22 is a fragmentary cross sectional plan view taken through section line **22—22**, FIG. 21.

FIG. 23 is a cross sectional side elevation taken through section line **23—23**, FIG. 21.

FIG. 24 is a front elevation of a plurality of air distributing cells for the transverse distribution of air.

FIG. 25 is a cross sectional plan view taken through section line **25—25**, FIG. 24.

FIG. 26 is a cross sectional end elevation taken through section line **26—26**, FIG. 24.

FIG. 27 is a cross sectional end view taken through section line **27—27**, FIG. 24.

FIG. 28 illustrates a ceiling outlet formed from four of the devices shown in FIG. 24, illustrating the distribution of air flow along the ceiling of a room, in reduced scale.

FIGS. 1 through 5 illustrate a small portion of a cellular device for producing and directing coherent jets of air from the outlet side thereof from power motivated air entering the inlet side and inducing and entraining ambient air in, around and between the jet streams for forming a discrete and coherent blanket of projected air with rela-

tively rapid blending with the ambient air in the room or enclosure.

FIG. 1 is a front outlet elevation of two cells of the device formed by two planar parallel spaced lower and upper frame members **1** and **2** separated by three equi-spaced partitions **3**, in normal relation to the members **1** and **2**, forming the outlet side of the two cells. FIG. 2 shows the rear inlet elevation of the cells shown in FIG. 1.

The partly exploded view, FIG. 3, illustrates the frame members **1** and **2** and the partitions **3**. A pair of like irregular tetrahedrons **4** and **5** are secured in the corners of one side of each partition **3**, and the members **1** and **2**, as illustrated.

The adjacent apexes of each tetrahedron at the outlet side of each cell are in close proximity or in contact at a junction **6**, shown in FIGS. 1, 3, and 5, at a central position of the partition **3**, thus forming upper and lower triangular impingement surfaces **7** and **8**, respectively, better shown in FIG. 2.

FIG. 4 illustrates the position of a pair of lower tetrahedrons **5** with respect to the partitions **3** and the frame member **1**. The cross sectional view, FIG. 5, illustrates the relationship of the tetrahedrons **4** and **5** with respect to one side of a partition **3** and the frame members **1** and **2** and further illustrates the junction **6** at the adjacent apexes of the triangular impingement surfaces **7** and **8**.

It is now apparent that when a substantially uniform linear flow of air is caused to enter the inlet side of the two cells, shown in FIG. 2, a portion of the air will impinge against the oblique triangular surfaces **7** and **8** and form a jet stream with high concentration in the triangular outlet area formed by the forward adjacent vertexes of the adjacent tetrahedrons, which will produce a diminishing velocity gradient extending to the inner side of the adjacent partition **3** and against the exposed portions of the inner sides of frame members **1** and **2**. The general direction of flow of both input and output air is shown in FIG. 4 and the formation of the output blanket of coherent air is formed by the induction in the space between the jet streams of a portion of the input air and a portion of the ambient air. FIG. 5 is an approximate illustration of the relative density of the output air flow and the direction thereof.

FIGS. 6 and 7 represent a unit **9** of three of the cells shown in FIG. 1 and a source of input moving air **10** directed into the input of the cells showing a blanket of output coherent air **11** in width and thickness.

The close dash lines of the air **11** are intended to illustrate the spaced coherent jets of air from the triangular outlet area beginning at junction **6** and the remainder of the air from each cell, together with induced static ambient air, such as ordinarily present in a room. It is to be noted that the induction and entrainment of ambient room air occurs immediately upon the jet streams leaving the triangular orifices.

FIG. 8 is a front outlet elevation of two cells formed by two planar parallel spaced members **12** and **13** separated by three equi-spaced partitions **14** forming the outlet side of the two cells. FIG. 9 shows the rear inlet elevation of the cells shown in FIG. 8.

The partly exploded view, FIG. 12, shows the frame members **12** and **13** and the partitions **14** including a pair of like irregular tetrahedrons **15** and **16** secured on the inner side of frame member **13**, as illustrated.

It is to be noted that each pair of tetrahedrons **15** and **16** are fitted and secured in the lower corners of the junction of each partition and the frame member **13**.

The adjacent apexes of each tetrahedron at the outlet side of each cell are in close proximity or in contact at a junction **17**, as shown, in the central position of the frame member **13** of the cell, thus forming triangular impingement surfaces **18** and **19**, respectively, better shown in FIG. 10. The cross sectional view, FIG. 10, shows the relation of each pair of tetrahedrons **15** and **16** within each cell with respect to the frame member **13**. FIG. 10 also illustrates air of substantially uniform velocity entering the inlet side of the cells and an approximate view of the relative density and direction of air flow from the outlet side. The general side view of the direction of flow of air from each cell is also illustrated in FIG. 11.

FIG. 13 illustrates a plan view of a source of moving air **20** directed into a unit of a pair of cells **21**, such as shown in FIGS. 8–11, and the flow of the output of air **22**, shown in close dash lines. The output air, like that shown in FIGS. 6 and 7, is a combination of coherent jet streams formed in the area of the open triangular outlets beginning at the junctions **17** and the remainder of the air flowing through each cell, which will be augmented at the outlet side of the device by the induction of ambient room air around and between the jet streams, forming the coherent blanket of output air **22**, which is illustrated in FIGS. 13 and 14.

It is to be noted that the tetrahedrons **4** and **5** and **15** and **16**, shown in FIGS. 1 and 8, respectively, are secured in the position shown for clarity and the convenient model construction, particularly for the interchange of tetrahedrons of different angles to obtain different shapes and ranges of output air when the triangular impingement surfaces are subject to velocities of input air.

In a preferred reduction to practice, an entire group of cells and integral impingement angles may be molded from plastic material or formed from metal by well known means which will provide the cavities **4*a*** and **5*a***, illustrated by broken lines in FIG. 1. Likewise, the impingement surfaces **18** and **19** may be formed by integral well known molding processes to form cavities **18*a*** and **19*a***, illustrated by broken lines in FIGS. 8 and 12.

FIGS. 15 through 18 show a simplified alternate construction for producing a device forming the aforesaid coherent jet stream phenomena which is effective for producing a limited form of a moving blanket of coherent air, as compared to the previously described cellular devices and is more dependent upon the shape and close proximity of the orifice for delivering air to the device, which is represented by a duct **23**, shown in broken lines in FIGS. 17, 19 and 20.

Furthermore, FIGS. 15 through 18 show a base **24** having a planar upper surface on which adjacent angular projections form the impingement surfaces **25** and **26** of pyramidal triangular shape which are formed integral with base **24**, as shown.

FIGS. 15, 17, and 18 also illustrate in broken lines an upper planar top member **27** which may be positioned in predetermined spaced relation to the top of the impingement surfaces, as illustrated in FIGS. 15 and 17, thus improving the control of the output air pattern, to be hereinafter described.

It is to be noted that the triangular projections form channels **28** as described in previous figures.

FIG. 17 illustrates a source of air of substantially uniform velocity from the duct **23** which will impinge upon the surfaces **25** and **26** and produce coherent jets in the triangular open area between these surfaces beginning at the junction **28**.

FIG. 18 is a perspective view of the simplified form of the device in which member **27** may or may not be used therewith.

FIG. 19 illustrates the operation of a device **29**, shown in FIGS. 15 through 18 with a top member **27** in place with the input air supplied by the duct **23** and the output in the form a blanket of coherent air **30**, which will include induced ambient air immediately therein at the output side of the device to form a controlled uniform a controlled uniform blanket of output air. FIG. 20 illustrates a side cross sectional view of the air flow shown in FIG. 19. It has been found that in the absence of member **27**, the air **30** will move upward at a greater angle.

It is to be noted that the angles of the tetrahedrons (used for convenience) and the resulting impingment

triangular surfaces, shown in FIGS. 1 through 20, are functionally representative, however the angles may be modified to produce predetermined different modes of operation.

It is also to be noted in this particular embodiment, that the lateral projection of the blanket output of air from the device shown in FIG. 1 is approximately fifteen degrees with respect to the partitions in each cell.

In the device shown in FIG. 8, the same angles are applied to the impingement surfaces but the lateral projection of the output blanket of air is parallel to the ridge of the projections whereas in the side view the blanket of air projects upward approximately fifteen degrees with respect to the base of the cell. This particular phenomena varies in accordance with the selection of the angles of the pyramidal impingement surfaces and the angle at which air enters the input side of the device.

This invention also comprehends alternate construction shown in FIGS. 21, 22, and 23, in which the arcuate conical upper and lower members **31** and **32** are secured in spaced relation, as shown, with the vertical cell partitions **33** positioned substantially radial with respect to the center of the radius of the conical members **31** and **32**, and with the triangular impingement surfaces **34** shown for convenience formed by tetrahedrons **35**.

Thus it is apparent that air distributing devices may be made arcuate or circular for use in a corner or ceiling of a room or for wide angle or circular coherent air distribution along a ceiling or in a downward angle therefrom.

It is to be noted that the upper and lower members **31** and **32** and any one or more of the previously described upper and lower members may be of different width or be positioned a predetermined angle therebetween, as shown by broken lines **36**, for various particular uses without departing from the principle or operation of the device.

It is also to be noted that the triangular impingement surfaces in any of the forms shown may be slightly convex or concave, as illustrated in broken lines in FIGS. 21 and 22, for producing slight modifications in the coherent distribution patterns of the device.

FIGS. 24–27 show a linear form of air distributing device having an adjacent plurality of cells for converting a substantially linear input flow of air into a wide lateral coherent blanket of coherent air. Like previous embodiments, the device includes lower and upper members **37** and **38**, which include fixed partitions **39** substantially alike but positioned divergent from a center position of the members into increasingly divergent acute angles, as shown.

Referring to FIG. 24, from center to left of the members **37** and **38**, a pair of like tetrahedrons **40** are secured in the left corners of the partitions **39** and the upper and lower members, as shown. A like number of tetrahedrons are secured in the right corners of the right hand partitions **39**, as shown, which form two sets of divergent impingement triangles **41**, better shown in FIG. 25, with the outer adjacent vertex of each pair of tetrahedrons **40** forming a junction **42**, as shown. FIG. 25 shows three left and three right tetrahedrons which have space fillers **40***s* on the outside ends thereof.

As previously mentioned, the use of tetrahedrons and the frontal fillers therefor provide a convenient way to form the impingement triangular surfaces, which surfaces provide representative functional performance of the device.

FIG. 25 illustrates, by uniformly positioned arrows, the flow of air of substantially uniform velocity into the input side of the device and the divergent arrows indicate the transverse outlet flow resulting from the formation of jet streams by impingement against the triangules **41**.

FIGS. 26 and 27 represent by arrows the input and output flow showing the relative central density resulting from the aforesaid impingement phenomena.

FIG. 28 illustrates four rectangular devices **43** like that described and shown in FIG. 24, positioned in a rectangle to accept a flow of air from a duct **44** for distributing air substantially equally across the ceiling of a room, outlined by solid broken lines **45** with only one quarter of the coherent blanket of air **46** coherently projected over one quarter of the ceiling of the room.

It has been found that a relatively wide range of air velocities may be projected from apparatus of the character described ranging from approximately 500 to 2,000 feet per minute, with the velocity of the input air somewhat less due to the presence of the impingement triangles.

Having described my invention, I claim:

1. In an air distributing apparatus of the character described a lower air guide member of predetermined width having:

a planar upper guide surface,

an upper air guide member of predetermined width positioned in uniform spaced relation with said lower air guide member and having a planar lower surface,

a pair of partitions of predetermined height positioned in substantially parallel spaced relation integral with and in normal relation between said lower and said upper member forming the walls of an air projection cell having an input and output side,

a lower triangular impingement member with the triangular surface thereof diagonally spanned across the lower junction of said lower member and one of said partitions with the two opposite sides of the said triangular surface in angular junction with the said surface of said lower member and the surface of said one of said partitions and with the vertex of the said two sides of said triangular surface in close proximity to the input side of said cell, and

an upper triangular impingement member with the triangular surface thereof diagonally spanned across the upper junction of said upper member and the said one of said partitions with the two sides of the said triangular surface in angular junction with the surface of said upper member and the said surface of the said one of said partitions and the vertex of the said two sides in close proximity to the input side of said upper member and with the vertex formed by one said side and the base side of each triangular surface in close proximity with each other forming a horizontal V outlet in said cell whereby motivated air flowing into said input side of said members and into said cell will flow through same and impinge against the said triangular surfaces and form a coherent jet stream of air from said cell in a substantially straight linear vertical direction therefrom and at a predetermined horizontal angle therefrom.

2. The construction recited in claim **1** including:

elongated said lower and upper members with a plurality of said cells positioned in adjacent relation therebetween,

an elongated orifice means positioned adjacent the said input side of said cells for conducting substantially linear motivated air therein,

a source of substantially linear motivated air connected to said orifice means whereby the output side of said cells will project a like plurality of substantially coherent jet streams of air in spaced relation and whereby said streams of air will induce ambient room air therebetween to concurrently form a blanket of moving air of substantially uniform thickness and width flowing in a linear direction from said cells and at a predetermined angle transverse said partitions.

3. In air distributing apparatus of the character described a lower member of predetermined width having a planar upper surface and an air input side,

an upper member of pretedermined width in uniform spaced relation with said lower member having a

planar lower surface and a corresponding air input side,

a left and right partition of predetermined width positioned in substantially parallel spaced relation integral with and between said lower member and said upper member and substantially normal thereto forming the walls of a substantially rectangular air projection cell,

a left hand triangular impingement member with the triangular surface thereof diagonally spanned across the left junction of said lower member and the said left partition with the two sides of said triangular surface in angular junction with the said surface of said lower member and the surface of the said left partition and with the vertex of the said two sides in close proximity to the input side of said lower member,

a right hand triangular impingement member with the triangular surface thereof diagonally spanned across the right hand junction of said lower member and the said right hand partition with the two sides of said triangular surface in angular junction with the surface of said lower member and the surface of said right hand partition and the vertex of the said two sides in close proximity to the input side of said lower member with the vertex formed by one said side and the base side of each said triangular surface in close proximity with each other forming a vertical V outlet in said cell whereby substantially linear motivated air flowing between said input side of said members will impinge against the said triangular surfaces and form a coherent jet stream of air from said cell in a straight linear direction from said cell with a predetermined upward angle with respect thereto.

4. The construction recited in claim 3 including said lower and upper members formed of arcuate shape of like predetermined curvature related to radii a predetermined distance from the said input sides of said members with a plurality of partitions in predetermined spaced normal relation between said members and positioned substantially radial to said radii forming a plurality of laterally divergent air projection cells,

an elongated arcuate orifice means of said like curvature positioned adjacent the said input side of said members for conducting substantially linear motivated air into said cells,

a source of substantially linear motivated air connected to said orifice means whereby the output side of said cells will project a like plurality of substantially coherent jet streams of air in an angular divergent spaced relation and whereby said streams of air will induce ambient room air therebetween to concurrently form a blanket of coherent moving air in a relatively wide lateral angle of substantially uniform thickness flowing from said cells.

References Cited

UNITED STATES PATENTS

3,232,206 2/1966 Kennedy ---------- 98—40

WILLIAM E. WAYNER, Primary Examiner

U.S. Cl. X.R.

137—801