July 4, 1961 A. F. DENBO ET AL 2,991,004

ONE-PIECE RADIAL FLOW AIR MOVING DEVICE

Filed June 29. 1955 2 Sheets-Sheet 1

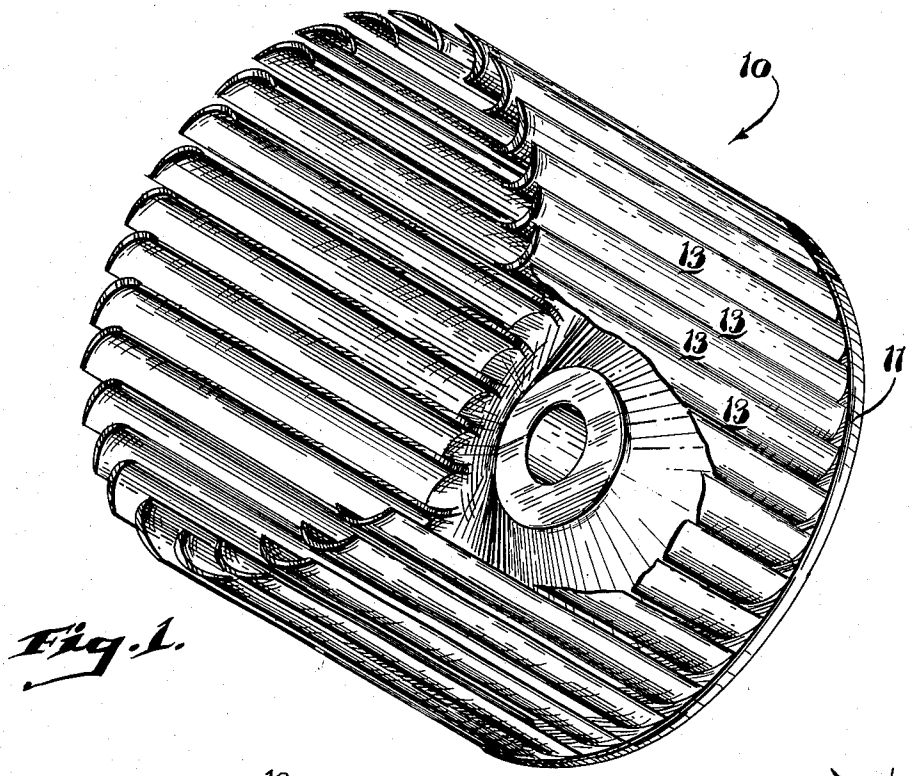


Fig. 1.

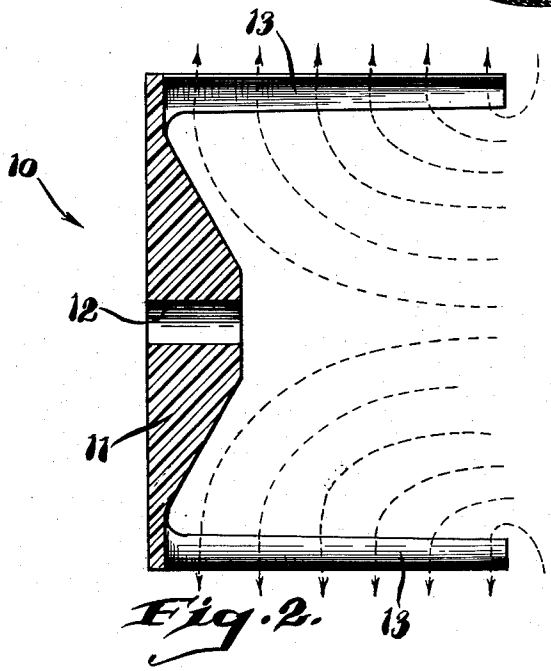


Fig. 2.

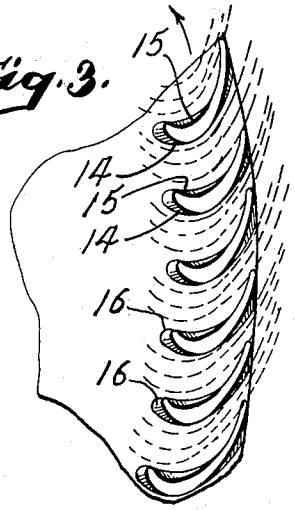


Fig. 3.

INVENTORS
ALBERT F. DENBO &
BY: JAMES W. SCHWIER,
Harold B. Hood.
ATTORNEY.

July 4, 1961 A. F. DENBO ET AL 2,991,004

ONE-PIECE RADIAL FLOW AIR MOVING DEVICE

Filed June 29. 1955 2 Sheets-Sheet 2

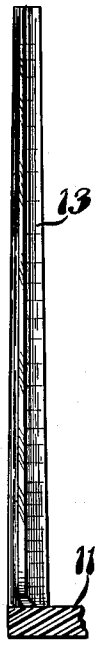


Fig.4.

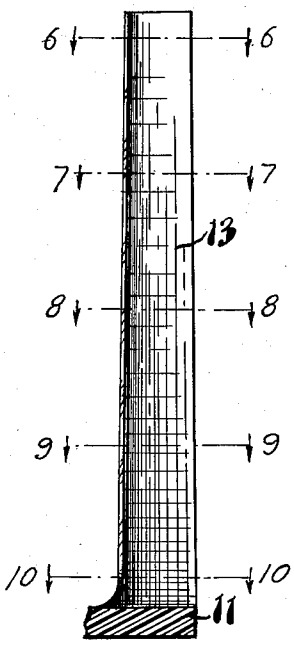


Fig.5.



Fig.6.



Fig.7.



Fig.8.



Fig.9.



Fig.10.

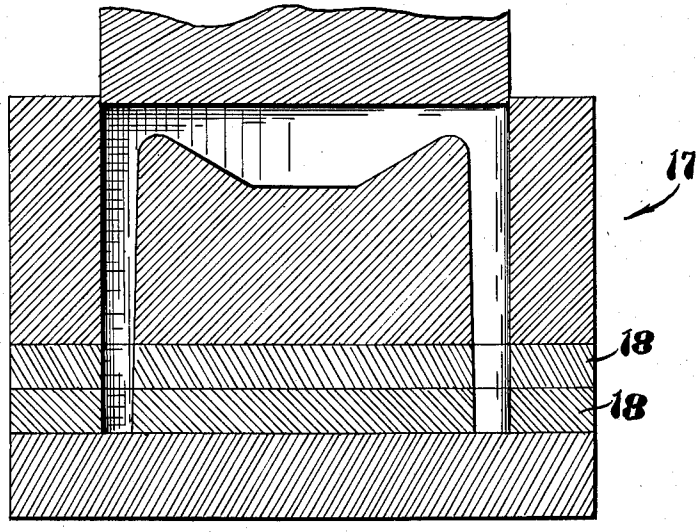


Fig.11.

INVENTORS
ALBERT F. DENBO &
BY: JAMES W. SCHWIER,
Harold B. Hood.
ATTORNEY.

United States Patent Office 2,991,004 Patented July 4, 1961

2,991,004

ONE-PIECE RADIAL FLOW AIR MOVING DEVICE

Albert F. Denbo and James W. Schwier, Indianapolis, Ind., assignors to Denbo Engineering and Sales Co., Inc., Indianapolis, Ind., a corporation of Indiana

Filed June 29, 1955, Ser. No. 518,762
7 Claims. (Cl. 230—134)

This invention relates to a device for moving air, and more particularly, to a radial flow, air moving device.

An object of our invention is to provide a radial flow, air moving device having blades which are supported at only one end to permit the unobstructed flow of air to the device whereby turbulence of the air being moved is decreased and the efficiency of the device is increased.

A further object of our invention is to provide a high capacity, radial flow, air moving device of improved form which is efficient and dependable in operation, and economical to construct.

A further object of our invention is to provide a one-piece, radial flow, air moving device having improved air flow characteristics.

Further objects of our invention will become apparent as the description proceeds.

To the accomplishment of the above and related objects, our invention may be embodied in the form illustrated in the accompanying drawings, attention being called to the fact, however, that the drawings are illustrative only, and that change may be made in the specific construction illustrated and described, so long as the scope of the appended claims is not violated.

FIG. 1 is a perspective view of a radial flow, air moving device embodying our invention, parts being broken away for clarity of illustration;

FIG. 2 is a view, partly in section, of the air moving device shown in FIG. 1, all but two diametrically opposed blades being omitted for clarity of illustration, the path of the moving air being indicated by dotted line arrows;

FIG. 3 is a fragmental view of a portion of our improved radial flow, air moving device taken from the right hand side of FIG. 2 and showing in dotted lines the path of air flow through the passageways between the blades;

FIG. 4 is an enlarged view of one of the blades of our improved device, along with a portion of the blade-mounting member with which it is integral;

FIG. 5 is another enlarged view of one of the blades of our improved device, taken from the right hand side of FIG. 4;

FIGS. 6 through 10 are sectional views taken along lines 6—6, 7—7, 8—8, 9—9 and 10—10 of FIG. 5; and

FIG. 11 is a somewhat simplified view of a moulding apparatus which may be used in manufacturing our improved device.

Our improved radial flow, air moving device **10** includes a blade-mounting member **11** having an aperture **12** concentric with respect to the axis of member **11** and providing means for connection to a rotatable driving shaft. Blade-mounting member **11**, along with blades **13**, may be formed of a suitable material such as plastic or metal.

A plurality of peripherally spaced blades **13** is provided in relatively fixed relationship with blade-mounting member **11**. Preferably, each of blades **13** is formed integral at one end with blade-mounting member **11** rather than being separately formed and suitably secured at one end to the blade-mounting member. In either case, the blade-mounting member provides a cantilever support for each of the blades. The device may take the form of a single, unitary member which may be moulded in one piece in a manner later to be described. Blades **13** are preferably identical with each other and each includes a convex surface **14** facing rearwardly, with respect to the direction of rotation of our improved device (see the arrow in FIG. 3), and a concave surface **15** facing forwardly to form, with the side edges of the blade, a generally air-foil cross-sectional blade shape. The convex surface **14** of each blade forms, with the concave surface **15** of the rearwardly adjacent blade, a passageway for the flow of air therethrough. Accordingly, the peripherally spaced blades provide a plurality of similarly spaced passageways through which air is moved peripherally forwardly and radially outwardly upon rotation of the device about its axis. Such a device is known as a forwardly-curved air moving device; and, as is clearly illustrated in the drawings, the aspect ratio thereof (the axial length of each blade: the perpendicular distance between parallel lines tangent to the radially inner and outer edges of the blade) is quite large. As shown, the aspect ratio somewhat exceeds **8**.

Referring particularly to FIG. 3, it is apparent that each of the passageways provided by each pair of relatively adjacent blades has a radially inner inlet and a radially outer outlet, and the area of each of the passageways decreases from said inlet to said outlet to provide for acceleration of the air moved therethrough. By accommodating the increase in velocity across the width of each blade the air-flow capacity of the device is materially increased.

The inlet edge **16** of each of blades **13** is convexly curved and thereby permits smooth flow therepast of the moving air. This convexly curved conformation **16** faces toward the direction of rotation, and in cooperation with the concavo-convex surface shape of each of the blades, permits the incoming air entering each of the passageways to enter approximately tangentially with respect to the inlet portion of each of the blades. This reduces the shock loss of the air coming into contact with the inlet edge **16** of each of blades **13** as that air enters said passageways. Of course, by reducing the shock loss of the entering air, the overall efficiency of our improved device is increased.

Referring particularly to FIGS. 5 and 6 through 10, it will be apparent that the discharge angle of each of the blades **13** increases along the length of the blade from the proximal end or end carried by the blade-mounting member to the distal or free end of that blade. That is, each blade is, in effect, twisted about its longitudinal axis, in a direction to advance the distal portion of its discharge edge ahead of the proximal portion of that edge; while at the same time the radius of concavo-convexity of the blade decreases from the proximal end of the blade to its distal end. The general path of the incoming air is depicted by the dotted-line arrows shown in FIG. 2. It is apparent that the movement of air through the path of revolution of each of blades **13**, is such that a sharper curve is followed by the air in its movement near the distal end of the blade than that near proximal end. Since the discharge angle of each of the blades gradually increases from the proximal end of the blade to the distal end of the blade, the velocity distribution of the air moving across that blade is more uniform. By balancing the velocity distribution along the length of each of the blades, the efficiency of the device is substantially increased.

The cantilever support for each of the blades permits entry of the incoming air to our improved device substantially without turbulence since no additional retaining or other supporting means is required or provided at the free end of each of the blades. Obviously, any additional supporting means at the free end of each of the

blades 13, or anywhere along the axial length of each of the blades, would result in deflection thereabout of the entering air. The resulting turbulence due to this deflection of air is eliminated in our device by the cantilever supporting arrangement provided by blade-mounting member 11 for each of blades 13.

The cantilever supporting arrangement for each of blades 13, with its consequent tendency toward elimination of turbulence, cooperates with the shape and arrangement of each of blades 13, and the passageways formed therebetween, to provide a highly efficient, high capacity air moving device. That is, since the incoming air flowing axially past the free end of each of blades 13 is less turbulent than would be the case if additional blade-supporting means were provided, the air flows more smoothly around convexly curved inlet edge 16 of each of the blades and flows more smoothly and uniformly during the increase in velocity as it flows from the inlet end of each of the passageways through the outlet thereof.

Referring particularly to FIG. 11, we have illustrated, in somewhat simplified form, a moulding apparatus 17 of the type which may be used in manufacturing our improved air moving device. Due to the unobstructed shape and construction of our improved air moving device, mould 17 may be formed with a plurality of removable sections 18 to accommodate the formation of different lengths of blades. To form our air moving device with a blade length shorter than that provided by the apparatus set-up as shown in FIG. 11, one or more of sections 18 of the apparatus would be removed and replaced with a solid section. It will be apparent, then, that our improved device may be provided in different blade-length forms; the same mould, with correspondingly different removable section set-ups, being capable of use to form each of the different blade lengths.

We claim as our invention:

1. A unitary, moulded radial flow air moving device comprising a plurality of peripherally spaced blades providing a plurality of peripherally spaced air flow passageways therebetween, each blade having an inlet edge and a discharge edge, a rotatable blade-mounting member providing a cantilever support for each of said blades whereby each blade is integrally carried by the blade-mounting member at its proximal end and is free at its distal end such that, upon rotation of the device, air is moved into the path of revolution of said blades substantially without turbulence, the discharge angle of each blade increasing progressively from its proximal end toward its distal end, said blades being so proportioned and arranged that the air flow velocity between adjacent blades is substantially uniform from the proximal ends to the distal ends of said blades.

2. A radial flow air moving device comprising a plurality of peripherally spaced blades providing a plurality of peripherally spaced air flow passageways therebetween, each blade having an inlet edge and a discharge edge, a rotatable blade-mounting member provididing a cantilever support for each of said blades whereby each blade is carried by the blade-mounting member at its proximal end and is free at its distal end such that, upon rotation of the device, air is moved into the path of revolution of said blades substantially without turbulence, the discharge angle of each of said blades increasing along its length from its proximal end to the distal end of that blade to balance the velocity distribution, along the length of each of the blades, of the air moving through said passageways.

3. A radial flow air moving device comprising a plurality of peripherally spaced blades providing a plurality of peripherally spaced air flow passageways therebetween, each blade having an inlet edge and a discharge edge, a rotatable blade-mounting member providing a cantilever support for each of said blades whereby each blade is carried by the blade-mounting member at one end and is free at its opposite end with its discharge edge radially outward from, and peripherally ahead of, its inlet edge, such that, upon rotation of the device, air is moved into the path of revolution of said blades substantially without turbulence, said inlet edge of each of said blades being convexly curved to permit smooth flow therepast of the moving air, and the discharge angle of each blade increasing progressively from the proximal end toward the distal end thereof.

4. A one-piece, radial flow, air moving device comprising a blade-mounting member rotatable about an axis, a plurality of axially extending blades spaced peripherally with respect to each other and spaced radially outwardly from said axis, the proximal end of each of said blades being integral with said blade-mounting member and the distal end being free whereby said blade-mounting member provides a cantilever support for each of said blades, each of said blades having an inlet edge, an outlet edge, a convex surface disposed rearwardly with respect to the direction of rotation of the device and a concave surface disposed forwardly of said convex surface to provide a generally air-foil cross-sectional shape, and the discharge angle of each blade increasing progressively from its proximal end toward its distal end.

5. The device as set forth in claim 4 wherein said inlet edge of each of said blades is convexly curved and faces toward the direction of rotation of the device, said convexly curved inlet edge, in cooperation with the concavo-convex surface shape of each of the blades, permitting the incoming air entering each of said passageways to enter approximately tangentially with respect to the inlet portion of each of the blades.

6. A one-piece, radial flow, air moving device comprising a blade-mounting member rotatable about an axis, a plurality of axially extending blades spaced peripherally with respect to each other and spaced radially outwardly from said axis, one end of each of said blades being integral with said blade-mounting member and the other end being free whereby said blade-mounting member provides a cantilever support for each of said blades, each of said blades having an inlet edge, an outlet edge, a convex surface disposed rearwardly with respect to the direction of rotation of the device and a concave surface disposed forwardly of said convex surface to provide a generally air-foil cross-sectional shape, the convex surface of each of said blades, with the concave surface of the blade spaced rearwardly of that blade with respect to the direction of rotation of said device, forming an air-flow passageway having a radially inner inlet and a radially outer outlet, the area of the passageway formed by said convex surface and concave surface decreasing from said inlet to said outlet to provide for acceleration of the air moved therethrough, and the radius of concavo-convexity of each blade decreasing from its first-named end to its free end.

7. A radial flow, air moving device comprising a plurality of peripherally spaced blades providing a plurality of peripherally spaced air flow passageways therebetween, each of said blades having a convexly curved inlet edge and a discharge edge, a rotatable blade-mounting member providing a cantilever support for each of said blades whereby each blade is carried by the blade-mounting member at one end and is free at its opposite end such that, upon rotation of the device, air is moved into the path of revolution of said blades substantially without turbulence, the discharge angle of each of said blades increasing along its length from the end carried by the blade-mounting member to the free end of that blade, and the area of air flow of each of said passageways provided by said blades gradually decreasing from said inlet to said outlet to provide for acceleration of the air moving therethrough, and each blade being twisted about its longitudinal axis to dispose that portion of its discharge edge adjacent its free end peripherally ahead of that portion of such edge adjacent its first-named end.

(References on following page)

References Cited in the file of this patent

UNITED STATES PATENTS

1,075,120	Rogers	Oct. 7, 1913
1,075,300	Moss	Oct. 7, 1913
1,143,365	Davidson	June 15 1915
1,165,931	Akimoff	Dec. 28, 1915
1,734,541	Tedman	Nov. 5, 1929
1,827,316	Haynsworth	Oct. 13, 1931
1,959,703	Birmann	May 22, 1934
2,037,880	Charavay	Apr. 21, 1936
2,083,996	Jonn	June 15, 1937
2,284,141	Funk	May 26, 1942
2,378,372	Whittle	June 12, 1945
2,418,012	Chester	Mar. 25, 1947

2,652,190	Meltzer et al.	Sept. 15, 1953
2,662,686	Wuerfel	Dec. 15, 1953

FOREIGN PATENTS

3,253	Great Britain	of 1878
27,409	Great Britain	of 1906
710,391	Great Britain	June 9, 1954
723,706	Great Britain	Feb. 9, 1955
795,304	France	Jan. 6, 1936
1,063,414	France	Dec. 16, 1953

OTHER REFERENCES

Publication: Westinghouse "Airfoil Centrifugal Fans," Electric Corporation, Sturtevant Division, Catalog 1320, May 1953. Pages 1–3.