Oct. 13, 1942. R. H. McELROY ET AL 2,298,576

AIR HANDLING APPARATUS

Filed July 17, 1941 2 Sheets-Sheet 1

FIG. 1.

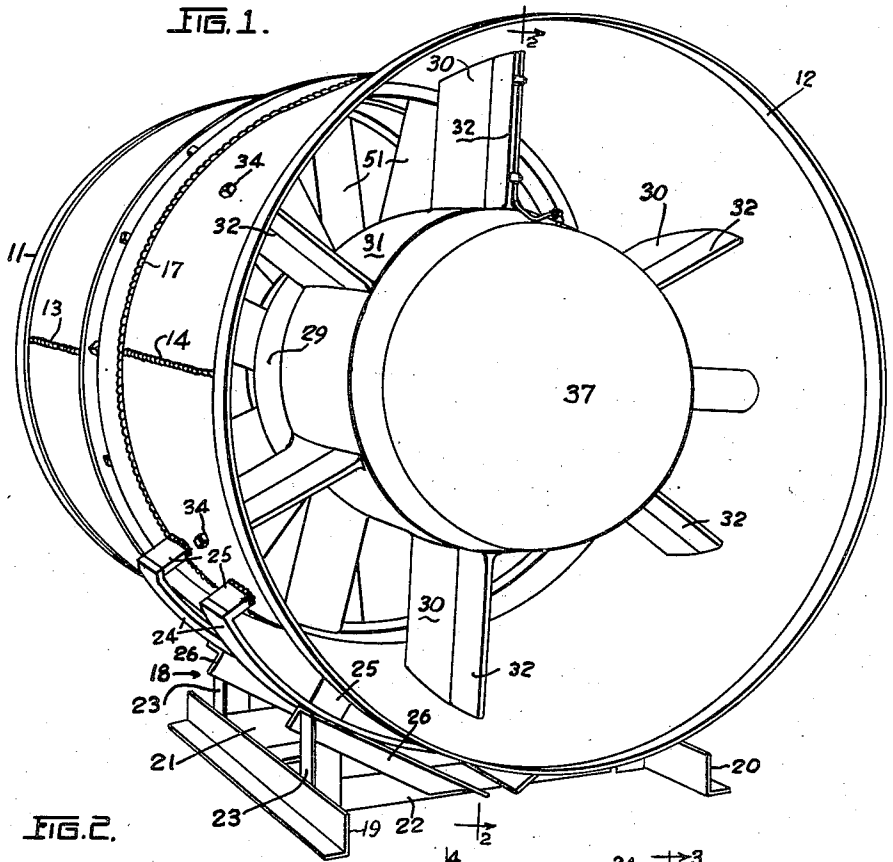
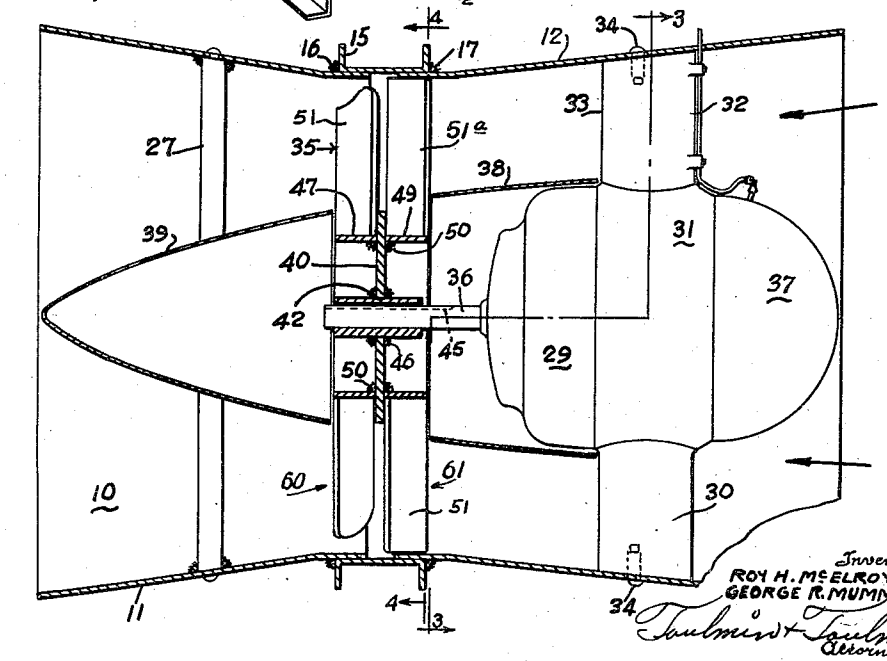


FIG. 2.



Inventors
ROY H. McELROY,
GEORGE R. MUMMA,
Toulmin & Toulmin
Attorneys

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FIG. 3.

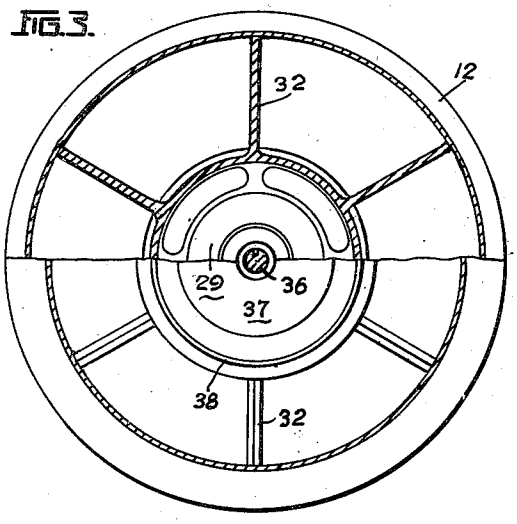

FIG. 4.

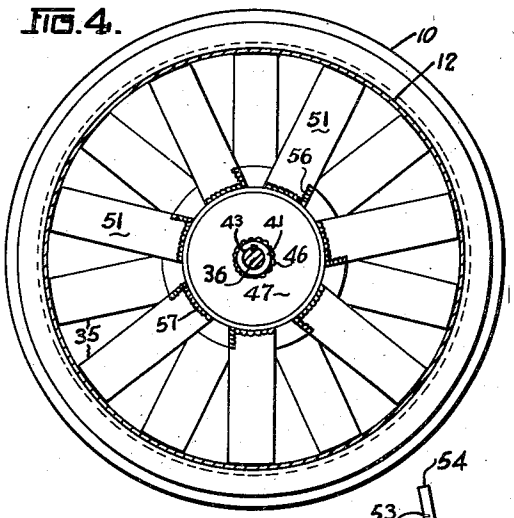

FIG. 7.

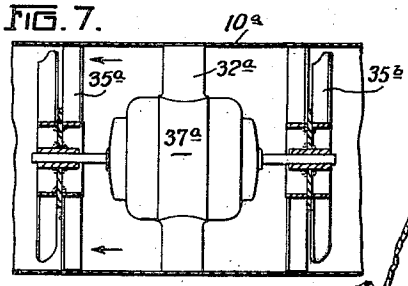

FIG. 6.

FIG. 5.

Inventors
ROY H. McELROY,
GEORGE R. MUMMA,
BY
Toulmin & Toulmin
Attorneys

Patented Oct. 13, 1942 2,298,576

UNITED STATES PATENT OFFICE

2,298,576

AIR HANDLING APPARATUS

Roy H. McElroy and George R. Mumma, Dayton, Ohio, assignors to The International Engineering, Inc., Dayton, Ohio, a corporation of Ohio

Application July 17, 1941, Serial No. 402,780

6 Claims. (Cl. 230—120)

This invention relates to an air handling device and particularly to a device for moving large quantities of air within an air tunnel.

An object of the invention is to provide an air handling device which is relatively inexpensive in construction, is extremely rigid and is not complicated in the assembly thereof.

It is another object of the invention to provide an air handling device which can be manufactured from relatively simple parts in order to eliminate the necessity of special tooling.

It is another object of the invention to provide an air handling device wherein the apparatus for moving the air through the device is supported therein by means of a plurality of streamlined fins.

It is a more specific object of the invention to provide an air tunnel wherein a motor is supported upon a plurality of radially disposed fins which are adapted to be secured to the walls of the tunnel.

It is another object of the invention to provide an air handling device having a plurality of radially disposed blades secured to a central hub.

It is another object of the invention to provide an air handling device having a plurality of radially disposed blades of like contour which are welded to a hub member composed of a plurality of parts welded together.

It is another object of the invention to provide a propeller or disc fan which is extremely rugged and has a low cost of manufacture.

Another object of the invention is to provide an air tunnel having a motor supported therein upon a plurality of streamlined fins.

It is another object of the invention to provide an air tunnel having a motor and fan supported therein wherein the central core of air moved through the tunnel passes over a streamlined core of which the motor is a part to reduce disturbance of air motion in its flow through the tunnel.

It is another object of the invention to provide a fan of the propeller type having a plurality of radially disposed blades and which is manufactured by a build up of elements welded into a unit assembly.

It is another object of the invention to provide a fan of the propeller type having blades arranged in two different planes for increasing the air flow by the fan.

It is another object of the invention to provide a fan in accordance with the foregoing object wherein the blades in the different planes are in staggered relationship.

It is another object of the invention to provide a propeller fan having a plurality of blades wherein a portion of the blades is adapted to pick up the air which slips by some of the blades and to discharge the same in the direction of the air stream.

It is another object of the invention to provide a propeller fan which can work against static pressure of a relatively high order.

It is another object of the invention to provide a propeller fan having a plurality of blades arranged in different planes and in staggered relationship with respect to one another so that the air which slips off the blade in the forward plane is caught by the blades in the rearward plane to advance the same in the direction of the air stream and thereby increase the efficiency of the fan.

It is another object of the invention to provide an air handling device wherein the motor for driving the fan for moving the air is supported upon a plurality of radially disposed fins within an air passage, which fins prevent the rotation of the air at the inlet face of the fan.

It is another object of the invention to provide an air handling device having a fan positioned upon opposite sides of a motor wherein the motor is supported by means of a plurality of radially disposed fins within an air passage, the fins eliminating the rotation of the air as discharged by one of the fans to direct the entry of the air in a straight flow into the inlet face of the other fan.

It is another object of the invention to provide an air handling device wherein propeller fans are placed in series air flow relationship and means is positioned between the fans for straightening the air flow discharged from one of the fans into the inlet face of the other of the fans.

It is another object of the invention to provide an air handling device in accordance with the foregoing object wherein the means for straightening the air comprises the supporting means for the motor which drives the fans.

Further objects and advantages will become apparent from the drawings and the following description.

In the drawings:

Figure 1 is a perspective elevational view of an air tunnel in which there is placed a fan constructed in accordance with the teachings of this invention, and which incorporates other features of the invention.

Figure 2 is a longitudinal cross-sectional view of Figure 1 taken along line 2—2 of Figure 1.

Figure 3 is an end view of the air tunnel shown in Figure 1, partially in cross-section and partially in elevation, taken along line 3—3 of Figure 2.

Figure 4 is a transverse cross-sectional view taken along line 4—4 of Figure 2.

Figure 5 is a perspective elevational view of the fan showing the manner in which the fan is constructed.

Figure 6 is a cross-sectional view of one of the blades of the fan taken along line 6—6 of Figure 5.

Figure 7 shows a modified arrangement using two fans for moving an air stream through an air tunnel.

In this invention the air handling device consists of a tunnel 10 constructed from two cone shaped members 11 and 12. Each of the cone shaped members 11 and 12 is formed from sheet metal and has the ends thereof welded together as indicated at 13 and 14 respectively. The small mouth of the cones 11 and 12 is positioned in adjacent relationship within a sleeve 15 formed by bending a channel member into a circle and welding the abutting ends thereof. The cones 11 and 12 are welded to the sleeve 15 as indicated at 16 and 17.

The tunnel 10 is adapted to be supported upon a base 18 which consists of a pair of angle iron members 19 and 20 arranged in spaced relationship by means of a pair of angle iron members 21 and 22. At each of the junctures between the members 19, 20, 21 and 22 a vertical leg 23 is provided which is adapted to engage an arcuately shaped strap iron member 24 which partially surrounds the tunnel 10. The strap iron members 24 are secured to the tunnel 10 by means of the spacers 25. Angular brace members 26 extend from the vertical legs 23 into engagement with the transverse spacing members 21 and 22 upon which the members 24 are supported and are secured thereto by a suitable welding operation. It is of course understood that the various angle iron members comprising the base 18 are suitably welded together.

A motor 29 is supported within the cone shaped member 12 by means of a plurality of fins 30 which extend radially from the motor casing 31. The fins 30 are preferably integral with the casing 31 and may be formed with the casing at the time of its manufacture. The fins 30 may be secured to the casing 31 by a suitable welding operation before the casing receives the final machining operation upon the interior thereof for receiving the stator of the motor.

The fins 30 are of streamlined contour having the blunt nose 32 thereof facing the enlarged end of the cone 12 which is the entrance end for air passing through the tunnel 10. The small pointed tail end 33 of the streamlined contour of the fins 30 is thus positioned toward the center of the tunnel 10. The streamlining of the fins 30 reduces disturbance to the air motion by the support members to a minimum so that a smooth flow of air through the tunnel 10 is maintained. In addition, the fins 30 tend to direct the air in a straight path through the tunnel 10 so that it is received by the fan 35 while moving in a straight line. The fins 30 engage the inner wall of the cone 12 and are secured thereto by means of the bolts 34.

When an air stream enters the sphere of influence of the inlet face of a propeller fan the normal tendency is for the air stream to begin rotation in the direction of rotation of the fan. After the fan has been operating for some time a vortex is produced at the inlet face of the fan. The rotative motion of the air stream at the inlet face of the fan reduces the quantity of air which can be handled by the fan. It is therefore of considerable value to be able to prevent or to reduce the tendency of the air to rotate at the inlet face of the fan and to direct the air stream into the face of the fan in a substantially straight line flow. Since the fins 30 are positioned between the motor 37 and the wall of the tunnel 10 a plurality of obstructions is positioned in the air stream parallel to the normal air stream flow. These obstructions or fins 30 being parallel to the normal air stream flow will not obstruct the flow of air to the inlet face of the fan 35. However, the fins 30 will prevent any tendency of the air stream to begin a rotative motion when entering the air tunnel 10. The fins 32 therefore direct the air stream into the inlet face of the fan 35 at substantially right angles thereto and in a substantially straight line flow so that the blades of the fan 35 can pick up the maximum quantity of air capable of being delivered by the blade and thereby increasing the fan efficiency.

The fan 35, the construction of which will be hereinafter described in more detail, is carried upon the armature shaft 36 of the motor 29 and is centrally located within the tunnel 10 so that the fan blades rotate within the narrow throat provided between the cone members 11 and 12 of the tunnel 10.

In order to provide for a smooth flow of air through the tunnel 10 from the right to the left, as viewed in Figure 2, the motor 29 is provided with a streamlined end casing member 37 forming the nose of a streamlined contour. A cylindrical member 38 is positioned between the motor 29 and the right hand side of the fan 35, while a cone-shaped member 39 is positioned upon the left hand side of the fan 35. The members 38 and 39 cooperate to form a streamlined core from the motor 29 to the discharge end of the tunnel 10. By streamlining the motor 29 in the manner heretofore described a minimum disturbance to the central core of air moving through the tunnel 10 is provided whereby the flow of air discharging from the tunnel 10 is smooth and evenly distributed over the entire face thereof. The cone shaped member 39 is supported within the cone 11 by means of streamlined brackets 27 which extend radially between the cone member 39 and the inner walls of the cone member 11.

The fan 35, for moving the air through the tunnel 10, consists of a metal disc 40 having a hub 41 welded within an opening 42 provided at the axis of the disc 40. The hub 41 is provided with a central bore 43 which is adapted to journal upon the motor shaft 36. A key slot 44 is provided in the bore 43 of the hub 41 which cooperates with the key slot 45 in the motor shaft 36 for retaining a key therein to prevent relative rotation between the hub 41 and the motor shaft 36. The welded joint between the hub 41 and the disc 40 is indicated at 46.

An annular ring 47 is placed upon one face of the disc 40 in coaxial alignment with the hub 41. The ring 47 is welded to the face of the disc as indicated by the welded joint 48. A similar annular ring 49 is positioned upon the opposite face of the disc 40 in coaxial alignment with the hub 41 and is welded to the disc 40 by means of the weld joint indicated at 50.

The disc 40 with the annular rings 47 and 49 welded thereto thus provides a hub upon which a plurality of blades 51 is secured. The blades 51 are identical in shape so that they can all be formed upon a single set of forming tools. The blades 51 have a contour, as shown in Figure 6, which consists of a curved portion 52 and a straight portion 53. When the blades 51 are positioned upon the hub comprising the disc 40 and the annular rings 47 and 49 the leading edge 54 of the blade 51 is formed by the end of the straight portion 53, while the trailing edge 55 of the blade 51 is formed by the end of the curved portion 52. The blades 51 are adapted to be positioned upon both sides of the disc 40 with one edge thereof adjacent the face of the disc 40 and the opposite edge adjacent the outer edge of the annular rings 47 and 49. The placement of the blades in this angular position provides the pitch for the blade. When viewing the drawing of Figure 5 the blades on the near face of the fan are positioned with their leading edges 54 adjacent the outer edge of the ring 47 while their trailing edges are adjacent the disc 40. The blades on the opposite side of the disc 40 have their leading edges 54 adjacent the disc 40 while their trailing edges 55 are adjacent the outer edge of the ring 49. It is thus seen that the pitch of the blades 51 on both sides of the disc 40 is the same.

Each of the blades 51 is welded to the disc by a weld 56 while the bottom edge of each of the blades 51 is welded to the respective rings 47 and 49 by a weld 57. It is thus seen that the fan 35 is assembled from parts which are relatively simple to manufacture and since the entire assembly is welded together an extremely rigid fan unit is produced at a relatively low cost. The various elements of the fan are produced from sheet metal so that each of the parts, except the hub 41, can be formed by an inexpensive punch press operation. The rings 47 and 49 can be made from the stock widths of strap iron formed to the desired circular shape. The only machining operation required is the drilling or boring of the bore 43 in the hub 41 and the milling of the key slot 44 therein.

As can be seen from the face view of the fan in Figure 4 a relatively large number of radially disposed blades 51 can be positioned circumferentially around the annular rings 47 and 49. By placing the blades 51 upon opposite sides of the disc 40 a greater number thereof can be disposed in a radial position about the hub formed by the disc 40 and the rings 47 and 49. The number of blades can be greatly increased over that capable of being positioned about a single ring element such as the ring 47 whereby the quantity of air handled by the fan due to the increased number of blades is greatly increased.

As previously described the blades 51 of the fan 35 are positioned upon opposite sides of the disc 40. This arrangement thereby positions certain of the blades in a forward plane of the fan indicated by the numeral 60 while certain of the remaining blades are positioned in a rearward plane indicated by the numeral 61. All of the blades 51 in the forward plane 60 and the blades 51*a* in the rearward plane 61 have the same pitch so that the blades all move the air stream in the same direction.

As is well known in propeller type fans the amount of air which can be handled by a blade is somewhat dependent upon the static pressure against which the fan is operating. As the static pressure increases the quantity of air which slips off the trailing edge of the blade increases and is lost as far as the total quantity of air moved by the fan is concerned. The fan of this invention however is constructed and arranged so that the blades of the fan are positioned in two different planes which have been referred to as a forward plane 60 and a rearward plane 61. The air which slips from the blades 51 in the forward plane 60 is caught by the blades 51*a* in the rearward plane 61 and again directed in a forward motion. The blades 51*a* in the rearward plane 61 therefore perform a double function of directing the air stream in a general forward motion and catching the air which slips off the blades 51 in the plane 60.

The static pressure against which the fan can operate is therefore increased since the air which would normally be lost by the conventional type propeller fan is caught by the second set of fan blades and returned into the general air stream.

The fan of this invention therefore provides in a single unit structure an apparatus which is capable of working against relatively high static pressures.

As will be noted from Figures 4 and 5 the blades 51 and 51*a* are arranged in staggered relationship to permit the blades 51*a* in the rearward plane 61 to catch the air which slips off the blades 51 in the forward plane 60.

In Figure 7 there is shown a slightly modified arrangement of an air handling device wherein the motor 37*a* has a shaft extending from both ends thereof. The motor 37*a* is provided with a plurality of fins 32*a* which are secured to the walls of an air passage 10*a* in the same manner as heretofore described. A fan 35*a* is positioned upon one end of the motor shaft while a fan 35*b* is positioned upon the opposite end of the motor shaft. The fans 35*a* and 35*b* are of the same construction as heretofore described and are both adapted to have their blades arranged to move the air stream in the general direction of the arrows positioned in Figure 7. The fans 35*a* and 35*b* are therefore in series air flow relationship.

The arrangement shown in Figure 7 increases the quantity of air which can be carried through an air passage and also discharges the air against a relatively high static pressure.

However, when propeller type fans have been arranged in series flow relationship the fan at the inlet side of the air passage develops a vortex or rotative motion of the air between the discharge face of the inlet fan and the inlet face of the discharge fan. As heretofore mentioned in the description it is preferable and advisable to maintain the air flow to the inlet face of the fan in a straight line flow.

In this invention the fins 32*a* for supporting the motor 37*a* provide means for preventing or halting the rotative motion of the air stream discharged by the fan 35*b* so that the air stream entering the inlet face of the fan 35*a* has been straightened out and is in a straight line flow relationship with respect to the inlet face of the fan 35*a*. The fins 32*a* thus serve the double purpose of supporting the fan driving motor 37*a* and preventing an air vortex to be developed between the fans 35*a* and 35*b*.

Since the air stream flow to the fans 35*a* and 35*b* is directed to the inlet face of the fan in a straight line flow each of the fans can move its proportionate quantity of air and thus in-

crease the total quantity delivered by the air handling device.

Having thus fully described our invention, what we claim as new and desire to secure by Letters Patent is:

1. An air handling device comprising a disc having an annular ring secured to and extending from each side thereof, the edge of said disc extending but slightly beyond said rings, and a plurality of blades radially disposed adjacent each side of said disc having their inner ends secured to said disc and said rings and extending substantially beyond the edge of said disc for producing axial flow of air.

2. An axial flow fan comprising a disc, an annular ring positioned coaxially upon said disc, a weld fillet extending around said ring securing the same to said disc, said disc extending but slightly beyond said ring, a plurality of blades disposed radially about said ring with the major portion of said blades extending beyond said disc to provide axial flow blades and having their inner ends in engagement with said disc and said ring, and a weld fillet extending along the inner ends of said blades securing the same to said disc and ring.

3. An axial flow fan comprising a disc, an annular ring positioned coaxially upon said disc, a weld fillet extending around said ring securing the same to said disc, said disc extending but slightly beyond said ring, a plurality of blades disposed radially about said ring with the major portion of said blades extending beyond said disc to provide axial flow blades and having their inner ends in engagement with said disc and said ring and being disposed with one longitudinal edge thereof adjacent said disc and the opposite longitudinal edge thereof adjacent the outer edge of said ring with one of the faces of said blades at an angle less than 90° to the face of said disc against which said blades are disposed, and a weld fillet extending along the inner ends of said blades securing the same to said disc and ring.

4. An axial flow fan comprising a sheet metal disc, sheet metal cylinders secured to each face of said disc coaxial therewith, said disc extending but slightly beyond said cylinders, and a plurality of blades disposed radially from said cylinders upon opposite sides of said disc in staggered relationship with the major portion of said blades extending beyond said disc to provide axial flow blades, said blades having their inner ends in engagement with and secured to said disc and to said cylinders.

5. An axial flow fan which includes a sheet metal disc, a hub extending coaxially of said disc and secured thereto, a hollow sheet metal cylinder positioned upon each face of said disc coaxial therewith and secured thereto, with an edge thereof abutting said disc, said disc extending but slightly beyond said cylinders, and a plurality of sheet metal blades disposed radially about each of said cylinders with the major portion of said blades extending beyond said disc to provide axial flow blades and having one of their longitudinal edges abutting the faces of said disc and the other of the longitudinal edges adjacent the outer edge of said cylinders with a face of said blades at an angle of less than 90° to the adjacent face of said disc, the inner ends of said blades abutting the outer face of said cylinders, and means securing the inner ends of said blades adjacent said cylinders and the longitudinal edge of said blades adjacent said disc to the respective members.

6. An air handling device comprising a pair of multi-effect air moving members arranged in series air flow relationship, each of said members consisting of a sheet metal disc, sheet metal cylinders secured to each face of said disc coaxial therewith, said disc extending but slightly beyond said cylinders, a plurality of blades disposed radially from said cylinders upon opposite sides of said disc in staggered relationship with the major portion of said blades extending beyond said disc to provide axial flow blades, said blades having their inner ends in engagement with and secured to said disc and to said cylinders, a common means for driving said members positioned between said members, and a plurality of fins extending radially from said driving means axially thereof for preventing rotation of air between said air moving members and for supporting said driving means.

ROY H. McELROY.
GEORGE R. MUMMA.