

Sept. 3, 1963

E. RUDY

3,102,679

CENTRIFUGAL IMPELLER UNITS

Filed Jan. 15, 1962

4 Sheets-Sheet 1

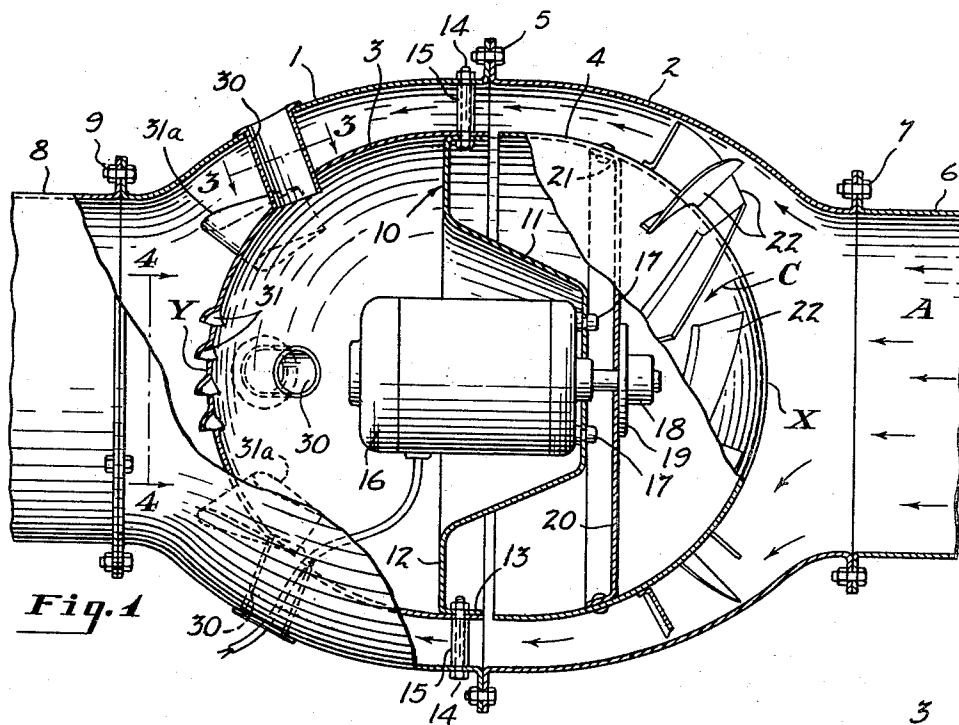


Fig. 1

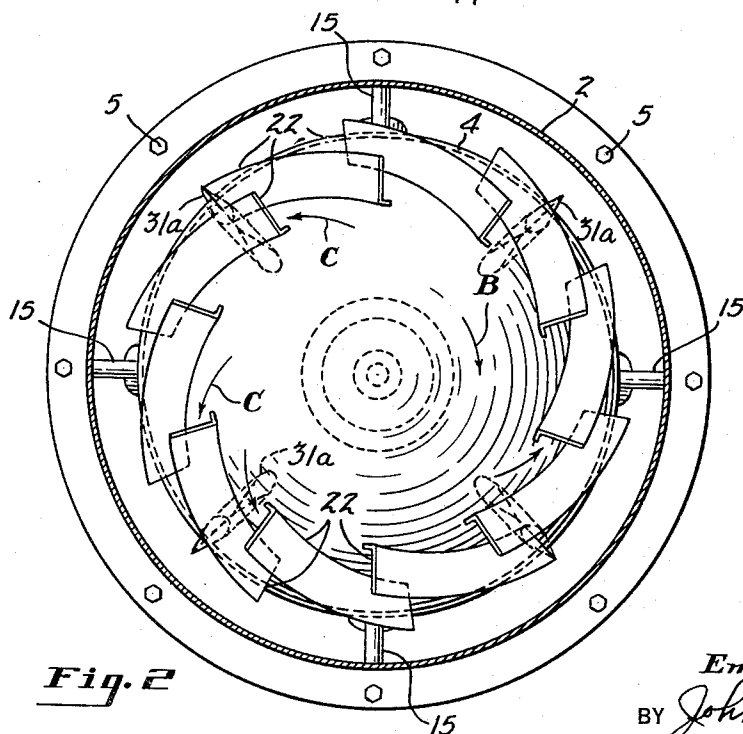


Fig. 2

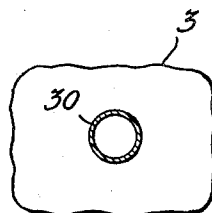


Fig. 3

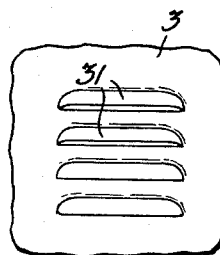


Fig. 4

INVENTOR

Emil Rudy

BY

John Mahoney

ATTORNEY

Sept. 3, 1963

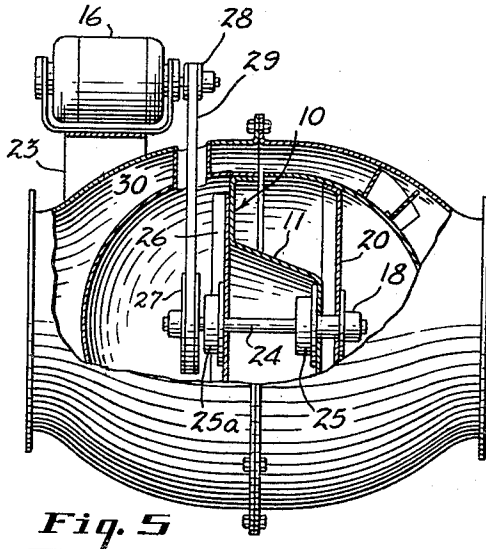
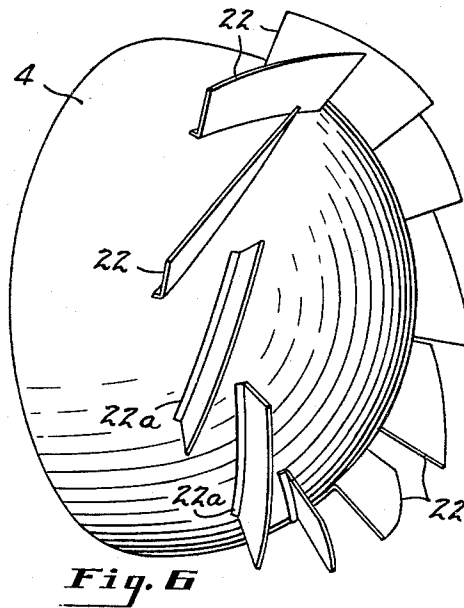
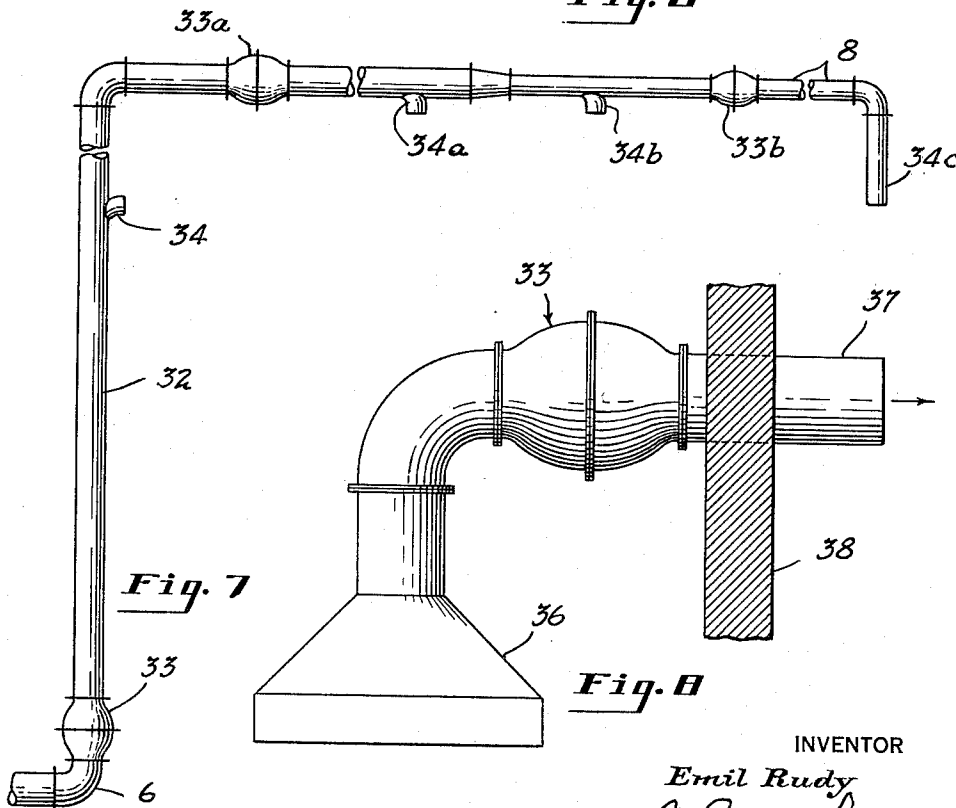
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INVENTOR
Emil Rudy
BY *John Mahoney*
ATTORNEY

Sept. 3, 1963

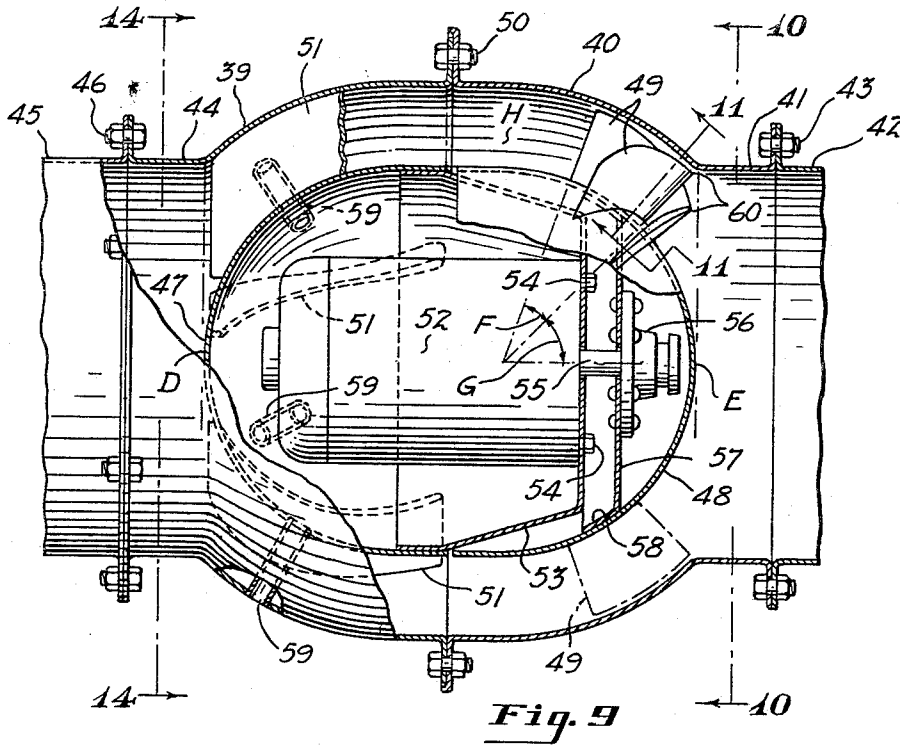
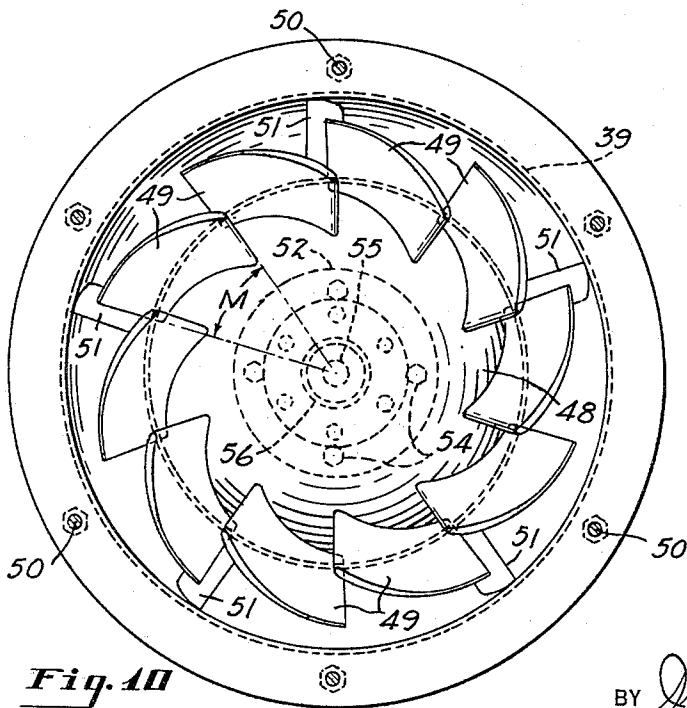
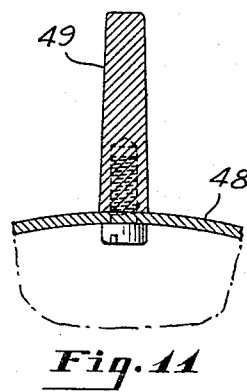
E. RUDY

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4 Sheets-Sheet 3



INVENTOR

Emil Rudy

BY

John Mahoney

ATTORNEYS

Sept. 3, 1963

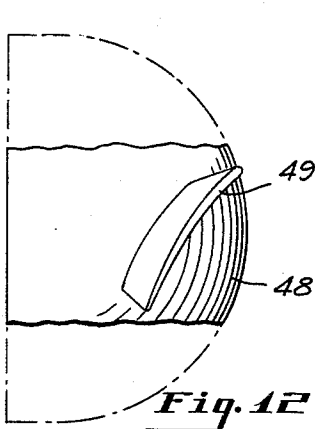
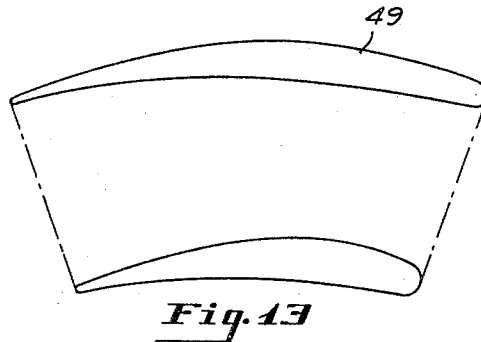
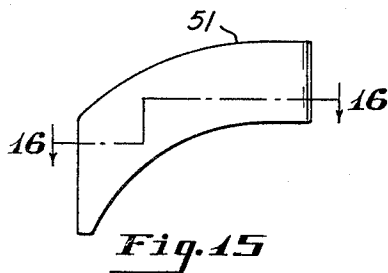
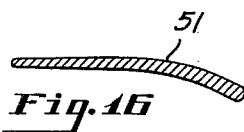
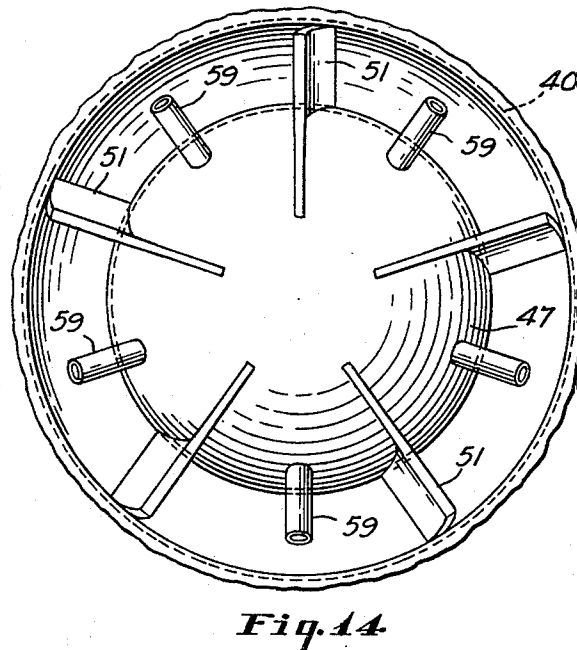
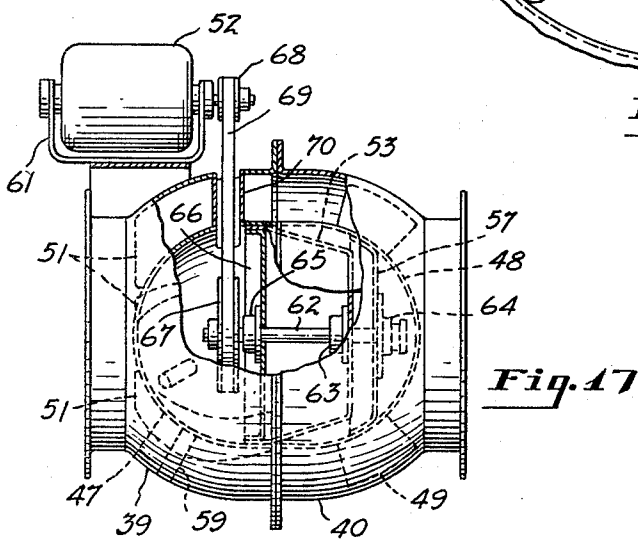
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CENTRIFUGAL IMPELLER UNITS

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4 Sheets-Sheet 4



INVENTOR

Emil Rudy

BY

John Mahoney

ATTORNEYS

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CENTRIFUGAL IMPELLER UNITS

Emil Rudy, Cleveland, Ohio, assignor to Loren Cook

Company, a corporation of Ohio

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14 Claims. (Cl. 230-117)

My invention relates to air moving means for use in heating, air conditioning, or ventilating systems, and more particularly to a centrifugal impeller unit for drawing air in a substantially linear direction from an inlet duct means and discharging it in a substantially linear direction through an outlet duct means, and is a continuation in part of my application Ser. No. 86,076 filed on January 31, 1961, which has become abandoned.

Air moving means in use at the present time is of the fan or propeller type except when a comparatively high pressure is desired in which case centrifugal blowers are utilized. Air moving means of the fan or propeller type consists of a hub provided with blades or propellers for moving air in a substantially linear direction. Comparatively high speed, however, is required to provide the desired pressure with such air moving means unless the fan or propeller is large and has a comparatively large number of blades. When the size and the number of blades are increased, however, correspondingly larger duct means is required which increases the resistance to air flow and the amount of floor space required for the unit. When a centrifugal blower is utilized to move air from an inlet duct means to an outlet duct means, a greater amount of pressure may be obtained at a lower speed than when a fan or propeller is used. In centrifugal blowers, however, the air is drawn from the intake duct means to the blower in one direction and exhausted through an outlet duct means in a direction substantially radial to the inlet duct means. More duct means is therefore required than when the air is moved in a substantially linear direction which increases the resistance to the air flow and in addition considerable pressure is lost because of the resistance encountered in effecting a change in the direction of the air flow. Centrifugal blowers also require a greater amount of floor space than air moving means of the fan or propeller type and because air is drawn into the blower in one direction and discharged in a direction radially thereto, it is impractical to use two or more of them in series.

In accordance with my invention, a centrifugal impeller is provided including an outer casing which consists of two similar substantially conically-shaped parts connected together at their maximum diameters to provide a substantially spherically-shaped central casing, each part of which terminates in a throat portion, one of which throat portions is connected to an inlet duct means and the other of which is connected to an outlet duct means, and arranged interiorly of the outer casing are two substantially semispherically-shaped inner casings, the inner ends of which are spaced a short distance from each other and the central axes of which coincide with the axes of the conduit means. One of the semispherical portions of the inner casing is secured at a fixed distance from the outer casing and has a convex end portion Y arranged in proximity to the outlet duct means and the other semispherical inner casing is rotatable and has a convex end portion X arranged in advance of the inlet duct means and is provided with a plurality of blades fixed to its outer periphery, each of which originates at a substantial distance from its convex end portion and each of which terminate at a substantial distance from its open end. In my invention the blades on the inner rotatable casing are arranged to direct the air in a substantially straight line direction during the rotation of the casing and the

2

outer casing is arranged at such distance from the inner casing that the desired static pressure is maintained in that area between the inner and outer casings which extends between the rear ends of the driving blades and a series of air directing vanes which are arranged between and fixed to the outer casing and the inner stationary semispherical portion. As shown in the drawings, the distance between the outer and inner casings over such area is substantially equivalent to the height of one of the air driving blades.

Another advantage of my improved unit is that it may be placed in a duct system at any desired location or two or more units may be arranged in series in a duct means with the second unit acting as a booster. My improved impeller unit is particularly adapted for use in a heating or air conditioning systems. For instance, it may be utilized for exhausting air from a room or building, or impelling air, such as cold or conditioned air, into a room or building, or it may be used for other purposes, such as to blow air into a furnace. It may also be utilized in conduit means for expelling air contaminated with acid or other fumes from hoods or the like.

It is therefore an object of the present invention to provide an improved impeller unit for connection to inlet and outlet duct means in which air is compressed in a manner somewhat similar to that of centrifugal blowers but in which the air is drawn into and exhausted from the unit in a substantially linear direction.

Another object of my invention is to provide an improved impeller unit including an outer casing having end portions which are shaped to be connected to line duct means and a pair of inner casings, one of which is fixed and the other of which is rotatable and in which the rotatable casing has air driving blades secured to its outer periphery which are arranged to direct the air in a substantially linear direction and in which air turning vanes are provided on the stationary inner casing to eliminate the swirl in the air stream and in which the distance between the inner and outer casings between the air driving blades and the air turning vanes is such that a desired static pressure within the impeller is provided.

A still further object of my invention is to provide an impeller unit including an outer spherically-shaped casing having throat portions shaped to be connected to duct lines and a pair of inner semispherical casings, one of which is arranged inwardly of and is fixed to the outer casing and has a convex end portion arranged in alignment with the axis of the outlet duct means and a plurality of air directing vanes on its periphery and the other of which is rotatable and has a convex portion aligned with the axis of the inlet duct means and in which the rotatable semispherical casing has relatively short air driving blades which originate at a spaced distance from its convex end portion and which are arranged at such angle on the periphery of the rotatable casing that air drawn through the inlet duct means is directed in a substantially linear direction into the space between the inner and outer casings and between the air directing blades and the air turning vanes on the stationary inner casing without substantial turbulence and in which the inner and outer casings are spaced in such close proximity to each other that a desired static pressure is maintained within the impeller unit during the rotation of the rotatable inner casing.

Other objects and advantages of my invention will be apparent as the specification proceeds.

My invention will be better understood by reference to the accompanying drawings in which

FIG. 1 is a cross sectional view of one form of my improved impeller unit with parts in elevation and showing it connected to inlet and outlet duct means;

3

FIG. 2 is an end elevational view of the rotatable portion of the inner casing of the propeller unit and a sectional view of the outer casing at approximately the open end portion of the rotatable inner casing;

FIG. 3 is a cross sectional view taken on a plane passing through the line 3—3 of FIG. 1, looking in the direction of the arrows;

FIG. 4 is a fragmentary elevational view as seen from a plane passing through the line 4—4 of FIG. 1;

FIG. 5 is partly an elevational and partly a sectional view showing modified means for driving the rotatable portion of the inner casing of my improved unit;

FIG. 6 is a perspective view of the rotatable portion of the inner casing of my improved impeller unit;

FIG. 7 is a diagrammatic view of duct means, showing in elevation a series of my improved impeller units arranged in series in the duct means;

FIG. 8 is an elevational view of my improved unit arranged within the duct means leading from a hood;

FIG. 9 is a sectional view of another form of my improved impeller with some parts shown in elevation and other parts shown broken away;

FIG. 10 is an elevational view as seen from a plane passing through the line 10—10 of FIG. 9 with the adjacent portion of the outer casing removed;

FIG. 11 is a detail sectional view through one of the air driving blades taken on a plane passing through the line 11—11 of FIG. 9;

FIG. 12 is a diagrammatical view of one of the air driving blades;

FIG. 13 is a diagrammatical side elevational view of one of the air driving blades;

FIG. 14 is a sectional elevational view as seen from a plane passing through the line 14—14 of FIG. 9, looking in the direction of the arrows with the adjacent portion of the outer casing removed and the other portion of the outer casing being shown in dotted lines with parts broken away;

FIG. 15 is a side elevational view of one of the air turning vanes;

FIG. 16 is a cross sectional view taken on a plane passing through the line 16—16 of FIG. 15; and

FIG. 17 is a view similar to that shown in FIG. 5 but in which the impeller is of the type shown in FIGS. 9 to 16.

As shown in FIGS. 1 to 4 of the drawings, my improved unit includes an outer casing consisting of similar conically-shaped portions 1 and 2 having throat portions and an inner spherical casing including a stationary semispherical part 3 arranged inwardly of the conically shaped portion 1 of the outer casing and a similar semispherical rotatable part 4 arranged inwardly of the conically-shaped portion 2 of the outer casing. To provide a continuous passage for the air, means are provided to connect the conically-shaped portions of the outer casings together and to the inlet and outlet duct means of a system which may be of any desired type, such as an air conditioning, ventilating, or heating system. For this purpose, the inner end portions of parts 1 and 2 of the outer casing are provided with annular mating flanges which are connected together by suitable means, such as bolts 5, and the throat portion at the end of conically-shaped portion 2 is provided with an outwardly extending annular flange which is connected to an outwardly extending annular flange on the inlet duct means 6 by suitable means, such as bolts 7, and the throat portion at the outer end of the conically-shaped portion 1 has an outwardly extending annular flange which is connected to an outwardly extending annular flange on an outlet duct means 8 by suitable means, such as bolts 9.

According to my invention, means are provided to maintain the inner spherical casing in spaced central relation to the outer casing to provide a space of a desired volume between the inner and outer casings and to rotate the semispherical portion 4 of the inner casing. As

4

shown, a mounting plate 10 is provided having a dish-shaped portion 11 and a radially extending annular flat portion 12 which terminates in an annular flange 13 and the semispherical-shaped portion 1 of the outer casing is connected to the inner semispherical portion 3 of the inner casing and the annular flange 13 of the mounting 10 by suitable means, such as bolts 14, and in order to maintain the inner spherical casing in a central portion within the outer casing, a sleeve 15 surrounding each bolt 14 is interposed between the inner face of the semispherical-shaped portion 1 of the outer casing and the semispherical portion 3 of the inner casing.

Suitable means, such as a motor 16, is provided for rotating the semispherical portion 4 of the inner casing which motor may be arranged within the inner casing as shown in FIG. 1 or as shown in FIG. 5, it may be arranged outside of the casing and transmission means, part of which is arranged within the inner casing, may be provided for rotating the spherical portion 4 of the inner casing. As shown in FIG. 1, one end of the motor 16 which may be of the multispeed type for rotating the semispherical portion 4 of the inner casing at the desired speed is connected to the mounting plate 10 by bolts 17 and the shaft of the motor extends into and is secured to a hub 18 having a flange 19 which is secured by suitable means, such as by bolts or by welding, to a mounting plate 20 which terminates in an annular flange 21 which is secured by suitable means, such as rivets, to the inner portion 4 of the inner casing.

As shown in the drawings, blades 22 are welded, riveted, or otherwise secured to the outer periphery of the rotatable portion 4 of the inner casing at a substantial distance inwardly from its forward or convex end portion which is designated by the letter X in FIG. 1, and the blades are of such shape and are arranged in such manner that during the rotation of the semispherical portion 4 of the inner casing, air is drawn through the inlet duct means 6 and is discharged in a substantially linear direction through the exhaust duct means 8. The forward or convex end X of the inner semispherical portion 4 is arranged centrally of the inlet duct means 6 and as the spherical portion 4 extends rearwardly, it tapers outwardly to its maximum diameter which is in proximity to the inner end of the semispherical portion 3 of the inner casing. The portion 2 of the outer casing is also tapered outwardly to provide an annular passageway for the air. In a like manner, the semispherical portion 3 of the inner casing tapers inwardly to its opposite convex end portion Y which is arranged centrally of the outlet duct means 8 and the portion 1 of the outer casing also tapers inwardly to form a narrow passageway which extends between the inner and outer casings and as the air is drawn inwardly between the inner and outer casings, it flows around the inner casing in the direction of the arrows A and outwardly through the exhaust duct means 8.

To enable a comparatively large number of blades to be applied to the rotatable portion of the inner casing, they are not only secured to the spherical portion at a substantial distance from its convex end portion but as shown they are arranged so that if the forwardly extending edge of each blade were extended it would form with the next preceding blade in the order in which the blades are revolved, an acute angle on the rear side of the blades and an obtuse angle on the forward side of the blades, and to enable the blades to be firmly secured to the outer face of the semispherical portion 4, each blade is provided with an outwardly extending flange 22a at its lower edge as shown more particularly in FIG. 6. As shown in the drawings, the blades are spaced from each other and the upper edge of each blade is tapered so that it extends from its inner toward its outer end so that the upper edge of each of the blades conforms approximately to the taper of the conically-shaped portion 2 as portion 2 extends toward the central portion of the outer casing.

5

Because a comparatively large number of blades are provided in my improved impeller, a comparatively high air pressure may be obtained even when the semispherical portion of the inner casing is rotated at low speed which pressure is increased as the speed of the inner semispherical portion 4 of the casing is increased and because the forward portion of each blade is inclined outwardly toward the tapered portion of the outer casing 2, it will also be apparent that a comparatively high air pressure is produced because during the rotation of the semispherical portion 4 of the inner casing, it is necessary for substantially all of the air to flow between the blades.

Assuming that the semispherical portion 4 of the inner casing is rotated in a clockwise direction as indicated by the arrow B, air will be drawn inwardly and will impinge upon the face of the forward end portion of each blade and will pass between the blade and the next succeeding blade in the order the blades are rotated as indicated by the arrows C and as the semispherical portion 4 continues to rotate, the air will flow outwardly from between the blades in a substantially linear direction.

Because the upper edges of the blades are arranged in close proximity to the outer casing and because a greater number of blades may be provided than on the usual hub to which a fan or propeller blades are attached, a higher air compression is obtained at the same rotative speed than if air moving means of the fan or propeller type were arranged adjacent the inlet duct means. The amount of air pressure produced by my improved centrifugal impeller is in fact substantially equivalent to that produced by a centrifugal blower. In my improved impeller, however, the air is exhausted from the impeller in a direction substantially linear to its inlet duct means whereas in the usual centrifugal blower, air is exhausted from the blower in a direction radial to its inlet duct means.

Instead of arranging the motor 16 within the inner casing, it may be supported on the exterior of part 1 of the outer casing as shown in FIG. 5 in which a bracket 23 supports the motor. When the motor 16 is arranged outside of the casing, a shaft 24 is provided within the inner casing which extends through a bearing 25 secured to the bottom face of the dish-shaped portion 11 of the mounting plate 10 and is secured to hub 18 which in turn is secured to the mounting plate 20. The opposite end of shaft 24 extends through bearing 25a mounted upon a pair of angle irons 26, only one of which is shown, which angle irons are secured by suitable means, such as welding, to the radial portion 12 of the mounting plate 10. A pulley 27 is secured to the opposite end of shaft 24 which is arranged in alignment with a pulley 28 secured to the shaft of motor 16. The pulley 28 may of course be of a type in which its parts are adjustable away from and toward each other to vary the speed of the transmission means and shaft 24.

As shown in FIG. 5, power is transmitted from pulley 28 of motor 16 by means of a belt 29 which passes through an opening 30 provided between the portion 1 of the outer casing and the portion 3 of the inner casing. When the motor is arranged within the casing 3 as shown in FIG. 1, a plurality of tubes 30 forming openings are provided through which air may pass to cool the motor and in such case, the inner casing is provided with louvers 31 so that when the air flows between the inner and outer casings, it will draw heated air outwardly from the inner casing which is replenished by the air passing through the openings 30.

To further eliminate the swirl in the air and to cause it to flow in a substantially linear direction as it leaves the impeller, a plurality of air directing vanes 31a may be provided as shown in FIGS. 1 and 2 which may be arranged between the tubes 30 and if desired, the tubes 30 may also be shaped in the form of air directing vanes. The vanes 31a also aid in increasing the rigidity between the outer casing and the semispherical portion 3 of the

6

inner casing. If desired, air directing vanes as shown in FIGS. 1 and 2 may be inserted between the outer casing and the stationary portion of the inner casing in the modification shown in FIG. 5.

Because in my improved impeller unit, air drawn in through the inlet duct means is exhausted in a substantially straight line direction through the outlet duct means, two or more impeller units may be arranged in a single duct means 32 as shown in FIG. 7 of the drawings in which the numeral 6 indicates the inlet duct means and 8 the outlet duct means. As shown in the drawings, three of my improved impeller units indicated by the numerals 33, 33a and 33b are arranged in series in the duct means and an outlet duct means 34 may be arranged between the units 33 and 33a and second and third outlet duct means 34a and 34b may be arranged between units 33a and 33b, and another outlet duct means 34c may be secured to the duct means 8.

It will of course be understood that by reversing the arrangement of parts 3 and 4, contaminated air may be withdrawn from a room or from a factory or school house in which case air is drawn inwardly through duct means 34, 34a, 34b and 34c and exhausted through duct means 6 which is such case becomes the outlet duct means. Other uses of my improved unit will of course be apparent. For instance in FIG. 8, a unit 33 is shown for forcing air containing frames, such as acid fumes, from a hood 36 and exhausting it through duct means 37 which extends through an opening in a wall 38 of a building.

In my improved impeller, the blades 22 originate at a substantial distance from the convex end portion X of the inner rotatable casing and the air directing vanes are arranged at a considerable distance from the convex portion of the stationary casing 3. A chamber between the inner and outer casings and the driving blades and air directing vanes is therefore provided in which a static pressure is built up which minimize the amount of turbulence of the air in the impeller when air is drawn into the impeller by blades 22 and delivered between the vanes 31a to the outlet duct means.

When the area between the outer and inner casings and the driving blades and turning vanes is comparatively large, the volume of air flowing through the impeller unit will also be comparatively large. In such case, however, the static pressure in the area between the inner and outer casings and the air driving blades and the air turning vanes will be comparatively low and considerable power will be required to rotate the inner casing 4, and while such impellers have considerable advantages over the usual fan or centrifugal propellers, I have found that by providing driving blades which are comparatively short in length and arranging the driving blades to provide a comparatively high static pressure in the area between the inner and outer casings and the blades and air turning vanes, air may be drawn into the impeller and delivered to the outlet duct means without substantial turbulence, thereby reducing the power required to rotate casing 48 and improving the efficiency of the impeller. This form of my invention is shown more particularly in FIGS. 9 and 10 in which the outer casing consists of two similar conically-shaped parts 39 and 40, part 40 terminating in a cylindrical throat 41 having an outwardly extending annular flange which is connected to an outwardly extending annular flange on the inlet duct means 42 by bolts 43 and part 39 terminating in a cylindrical throat 44 having an outwardly extending flange which is connected to an outwardly extending flange on the outlet duct means 45 by bolts 46 and arranged within the outer casing is the inner casing consisting of a stationary semispherical part 47 and a rotatable semispherical part 48. The outer surface of stationary part 47 of the inner casing has a convex portion D which is arranged in alignment with a plane passing through the junction of throat 44 and the con-

7

ically-shaped portion 39 and the rotatable semispherical part 48 has a convex portion E which is arranged in a plane passing through the junction of throat 41 and the conically-shaped portion 40. As shown, the axis of the inner casing is in alignment with the axis of the inlet and outlet duct means.

As in previous modifications, a plurality of blades 49 are secured to the outer periphery of the rotatable portion 48 of the inner casing. As shown, the blades are of the air foil type and are relatively short and while the length of the blades of different size impellers will of course vary, in the modification shown, the root of the blade is approximately 2.7 inches and the tip is approximately 3.7 inches in length. As shown in FIG. 10, each of the blades has a concave portion facing the inlet duct means and the angle F formed between the leading and trailing edges of each blade with the longitudinal axis of the impeller as a center is approximately 25° , and the angle G between the leading edge of each blade and the axis of the impeller is approximately 45° , and while the number of blades may be varied depending upon the size of the rotary part of the propeller, in the modification shown, ten blades are provided and the angular distance between the leading and trailing edges of each of the blades on the periphery of the rotatable casing is approximately 39° as indicated by the letter M in FIG. 10.

As in the previous modification, the conically-shaped portions 39 and 40 are provided at their contiguous ends with mating flanges which are connected together by bolts 50. The outer casing 39 and the stationary portion 47 of the inner casing are also connected together by air turning vanes 51 which in this modification are of the form shown in FIGS. 14 to 16 and extend from the inner end of the conically-shaped portion 39 to the junction of the conically-shaped portion 39 with the throat 44. Each of the turning blades is of an air foil design and has a slight bend therein to provide a substantially concave surface which is arranged in opposed relation to the concave surface of each of the driving blades.

For rotating the part 48 of the inner casing, a motor 52 is provided which is secured to a mounting plate 53 by suitable means, such as bolts 54. As shown, the outer end of motor shaft 55 is secured to a hub 56 having a flange secured to a plate 57 which plate terminates in a flange 48 which is secured to casing 53. For cooling motor 51, a plurality of tubes 59 may be provided which extend through and provide openings between the outer and inner casings.

In the modification shown in FIGS. 9 to 17, the conically-shaped part 40 of the outer casing is arranged at such distance from the rotatable part of the inner casing that the leading ends of the tip portions of the blades are arranged in proximity to the part 40 of the casing at the junction of the part 40 with the throat 41 and the conically-shaped portion 39 of the outer casing is arranged at approximately the same distance from the inner casing as the part 40 of the outer casing is arranged from the rotatable inner part 48 and the trailing edge of each of the air turning vanes terminates at the junction of the conical portion 39 of the outer casing with the throat 44. By arranging the tip end 60 of each of the blades in line with the junction of the part 40 with the throat 41, a substantially straight line flow into the impeller with the minimum of resistance is obtained and in a like manner by arranging each of the turning blades so that their trailing ends terminate at the junction between the conical portion 39 and the cylindrical throat 44, air is discharged from the impeller with a minimum of resistance.

In accordance with my invention, the air driving blades are comparatively short and the outer casing is arranged at such close proximity to the inner casing that a static pressure is built up in the area between the outer and inner casings and the air driving blades and the air turning vanes. From comparative tests, I have found that when the angle F formed by a plane passing through the leading

8

edge and a plane passing through the trailing edge of each blade is an acute angle of approximately 25° the driving blades 49 are particularly efficient during rotation in drawing air smoothly into the impeller and in discharging it therefrom with less impact than when the angle varies substantially from 25° . When the blades are comparatively short, the area of the space H between the inner and outer casings and the driving blades and the air turning vanes is comparatively large which permits air to be built up within the impeller and enables the part 48 of the impeller to be rotated with more efficiency because of the low air turbulence. The fact that the turning vanes are slightly concave also aids in providing a straight line flow. In my improved propeller as shown in FIGS. 9 to 17, there is a distinct combination between the short driving blades, the tips of the trailing edges of which are arranged at the junction of the outer part 40 with the throat 41, and which extend substantially parallel to each other and are provided with a concave surface, the plenum chamber H arranged between the inner and outer casings and the driving blades and turning vanes which permits air pressure to be built up within the impeller, and the turning vanes, each of which has a concave surface arranged opposite to the concave surface on the driving blades, because when such a combination is present, air from the inlet duct means may be drawn into the impeller in a substantially straight line flow and discharged in a substantially straight line flow into the outlet duct means with substantially no turbulence. In the modification shown in FIGS. 9 to 17, it will also be noted that the cross sectional area of the outlet duct means is substantially the same as the cross sectional area of the inlet duct means, and the cross sectional area of the plenum chamber between the inner and outer casings is approximately the same as the cross sectional area of each of the inlet and outlet duct means. By providing such an arrangement, air passing through the unit will have a substantially constant pressure and velocity.

The modification of my invention illustrated in FIG. 17 is similar to that shown in FIG. 5 with the exception that the impeller is of the type shown in FIGS. 9 and 10. As shown, the motor 52 is supported on a bracket 61 secured to the outer casing and a shaft 62 is provided within the inner casing which extends through a bearing 63 secured to the bottom of a dish-shaped portion of the mounting plate 53 and is secured to a hub 64 which in turn is secured to the mounting plate 57. The opposite end of shaft 62 extends through a bearing 65 mounted upon a pair of angle irons 66, only one of which is shown, which angle irons are secured by suitable means, such as welding to mounting plate 53. A pulley 67 is secured to the opposite end of shaft 62 which is arranged in alignment with a pulley 68 secured to the shaft of motor 52. The pulley 68 may of course be of a type in which its parts are adjustable away from and toward each other to vary the speed of the transmission means and shaft 62. As shown power is transmitted from pulley 68 by means of a belt 69 which passes through a tube 70 arranged between the outer conical portion 39 of the outer casing and the stationary portion 47 of the inner casing and maintains them in spaced relation to each other.

The impeller shown in FIGS. 9 and 10 may of course be inserted in duct means as shown in FIG. 7 or utilized to draw air containing fumes from a hood as shown in FIG. 8.

What I claim is:

1. A centrifugal air impeller including first and second similar conically-shaped parts having their enlarged ends connected together to form a substantially spherically-shaped central portion and the first conically-shaped part of the outer casing having a reduced open end shaped to be connected to an outlet duct means and the second conically-shaped part of the outer casing having a reduced open end shaped to be connected to an inlet duct means, an inner casing arranged within and spaced from the outer casing to form a circumferential passage for air and includ-

ing a stationary substantially semispherically-shaped part having a convex end arranged in alignment with the axis of the outlet duct means and a second rotatable semispherically-shaped part having a convex end arranged in alignment with the axis of the inlet duct means, means for driving the rotatable part of the inner casing and maintaining it in spaced relation to the second part of the outer casing, a plurality of spaced driving blades, each having its root portion secured to the outer periphery of the rotatable part of the inner casing and its tip arranged in close proximity to the inner surface of the second part of the outer casing, each of which blades originates at a spaced distance from the convex end part of the inner casing and terminates at a substantial distance from the enlarged end thereof and each of said blades being arranged to extend substantially diagonally on the rotatable part of the inner casing in such relation to each other that during the rotation of the second part of the inner casing, air striking each blade will flow between that blade and the next succeeding blade in the order of revolution and will be directed in a substantially axial direction through the circumferential space between the inner and outer casings, and a plurality of air turning vanes, each having an arcuate-shaped portion arranged between and connected to the semispherically-shaped first portion of the outer casing and the semispherical part of the inner casing, said air turning vanes each being connected to the first part of the outer casing and the stationary part of the inner casing at a substantial distance from the air driving blades to thereby provide a plenum chamber between the inner and outer casings and the air driving blades and the air turning vanes.

2. A centrifugal air impeller including first and second similarly-shaped conical parts having their enlarged ends connected together to form a semispherically-shaped outer casing and the first part of the outer casing having a reduced open end portion shaped to be connected to an outlet duct means and the second part of the outer casing having a reduced open end portion shaped to be connected to an inlet duct means, an inner casing including a first stationary semispherically-shaped portion having a convex end arranged in alignment with the axis of the outlet duct means and a second rotatable semispherically-shaped portion having a convex end arranged in alignment with the axis of the inlet duct means and its enlarged end arranged in alignment with but spaced from the enlarged end of the stationary part of the inner casing, a mounting plate arranged within the rotatable part of the inner casing, a shaft secured to said mounting plate for maintaining the rotatable part of the inner casing in spaced relation to the second part of the outer casing, means arranged within the stationary part of the inner casing for supporting said shaft and means arranged at least partly within the stationary part of the inner casing for rotating said shaft and the second part of the inner casing, a plurality of spaced driving blades, each having its root portion secured to the outer periphery of the rotatable portion of the inner casing and its tip arranged in close proximity to the inner surface of the second part of the outer casing, each of which blades originates at a spaced distance from the convex end of the rotatable portion of the inner casing and terminates at a substantial distance from the enlarged portion thereof, each of said blades being arranged substantially diagonally on the outer part of the inner casing to intercept air drawn into the impeller through the inlet duct means during the rotation of the second part of the inner casing and to direct it in a substantially axial direction through the circumferential space between the inner and outer casings, a plurality of air directing vanes, each having an arcuate-shaped portion arranged between the semispherically-shaped first portion of the outer casing and the semispherically-shaped part of the inner casing, said air directing vanes being connected to the first part of the outer casing and the stationary part of the inner casing at a substantial distance from the air driving blades to form a

plenum chamber between the inner and outer casings and the air driving blades and the air turning vanes.

3. A centrifugal air impeller as defined in claim 2 in which each driving blade is arranged in such relation to the preceding driving blade in the order of revolution so that if it were extended it would form an obtuse angle between the leading edge of each blade and the leading edge of the preceding blade so that during the rotation of the second semispherically-shaped portion of the inner casing air drawn from the inlet duct means between the blades is first subjected to a centrifugal force and then leaves the areas between the blades in a substantially axial direction.

4. A centrifugal air impeller as defined in claim 2 including means for providing an opening between the first part of the outer casing and the stationary semispherical portion of the inner casing and in which the means for rotating the second semispherical portion of the inner casing includes a motor, means associated with the outer casing for supporting the motor, and transmission means arranged between the shaft of the motor and the shaft secured to said mounting plate, part of which transmission means extends through said opening into the first semispherical portion of the inner casing.

5. A centrifugal air impeller as defined in claim 2 in which the means for rotating the second semispherical portion of the inner casing is a motor and which includes a plate within the first semispherical portion of the inner casing upon which said motor is mounted and in which the shaft that is secured to the mounting plate within the rotatable portion of the inner casing is the shaft of said motor.

6. A centrifugal air impeller as defined in claim 5 in which means are provided to form an opening from the atmosphere between the first portion of the outer casing and the stationary portion of the inner casing and in which the first semispherical portion of the inner casing is provided with an opening at its convex end portion so that during the rotation of the second portion of the inner casing, air from the atmosphere will be drawn into the semispherical portion of the inner casing to cool the motor and will pass outwardly through the opening at the convex end portion of the stationary portion of the inner casing.

7. A centrifugal impeller as defined in claim 2 in which the convex portion of the stationary part of the inner casing is provided with an opening and in which means are provided to form a series of openings between the outer casing and the first semispherical portion of the inner casing through which air passes into the first semispherical part of the inner casing and through the opening at its convex end portion to cool the motor and in which the means for forming each of the openings between the stationary part of the inner casing and the first part of the outer casing are substantially pear-shaped in cross section so as to eliminate any centrifugal whirl in the air stream passing between the inner and outer casings.

8. An air impeller comprising an outer casing including first and second similar conically-shaped parts having their enlarged ends connected together to form a substantially spherically-shaped central portion and the first conically-shaped part of the outer casing having a reduced end portion terminating in a cylindrical throat for connection to an outlet duct means and the second conically-shaped portion terminating in a reduced cylindrical throat for connection to the inlet duct means, an inner casing consisting of a stationary semispherical part having its convex end portion arranged in alignment with the outlet duct means and a second rotatable semispherical part arranged inwardly of the second conically-shaped part of the outer casing and having its convex end arranged in alignment with the inlet duct means, a plurality of air driving blades supported on the outer periphery of the rotatable part of the inner casing, means for driving the rotatable part of the inner casing and for maintaining it in spaced relation to the

second part of the outer casing, and the blades on the rotatable part of the inner casing being comparatively short and being angularly arranged on the periphery of the rotatable part of the inner casing with the root of each blade being secured thereto and the tip of each blade arranged in close proximity to the inner face of the second part of the outer casing and the leading edge of the tip end of each blade being arranged at approximately the junction of the second conically-shaped part of the outer casing and its throat so that during the rotation of the second part of the inner casing air will be drawn between the blades with a minimum of resistance and said blades being so shaped that air entering between the blades will be directed inwardly from the blades in a substantially linear direction, and air directing vanes arranged between and secured to the first part of the outer casing and the stationary part of the inner casing which are arranged at a substantial distance from the trailing edges of the air driving blades to form a plenum chamber between the inner and outer casings and the air driving blades and the air turning vanes to thereby enable the unit to operate at high static pressure.

9. An air impeller comprising an outer casing including first and second conically-shaped parts having their enlarged ends connected together to form a substantially spherically-shaped central portion and the first conically-shaped part of the outer casing having a reduced end portion terminating in a cylindrical throat for connection to an outlet duct means and the second conically-shaped portion terminating in a reduced cylindrical throat for connection to an inlet duct means, an inner casing consisting of a stationary semispherical part having its convex end portion arranged in alignment with the outlet duct means and a second rotatable semispherical part arranged inwardly of the second conically shaped part of the outer casing and having its convex portion arranged in axial alignment with the inlet duct means, a plurality of air driving blades superposed on the outer periphery of the rotatable part of the inner casing, means for driving the rotatable part of the inner casing and for maintaining it in spaced relation to the second part of the outer casing, and the blades on the rotatable part of the inner casing being comparatively short and being angularly disposed on the outer periphery of the rotatable part of the inner casing with the root of each blade being secured thereto and the tip of each blade being arranged in close proximity to the inner surface of the second part of the outer casing and the leading edge of the tip of each blade being arranged approximately at the junction of the second conically-shaped part of the outer casing and its throat and the trailing edge of each blade terminating at a substantial distance from the enlarged end of the rotatable part of the inner casing so that air will be drawn between the blades with a minimum of resistance and said blades being so shaped that air entering between the blades will be directed inwardly in a substantially linear direction, and air turning vanes arranged between and secured to the first part of the outer casing and the stationary part of the inner casing, the leading edge of each of said turning vanes being arranged between the enlarged end portion of the outer casing and the enlarged stationary part of the inner casing and the trailing edge of each of said vanes being arranged in alignment with the junction of the conically-shaped portion of the first part of the outer casing and its throat to thereby provide a plenum chamber between the inner and outer casings and the air driving blades and the air turning vanes.

10. An air impeller comprising an outer casing including first and second similar conically-shaped parts having their enlarged ends connected together to form a substantially spherically-shaped central portion and the first conically-shaped part of the outer casing having a reduced end portion terminating in a cylindrical throat for connection to an outlet duct means and the second conically

shaped part terminating in a reduced cylindrical throat for connection to an inlet duct means, an inner casing consisting of a stationary semispherical part having its convex end portion arranged in axial alignment with the outlet duct means and tangent to a plane passing through the junction of the first conically-shaped portion of the outer casing and its throat and a second rotatable semispherical part arranged inwardly of the second conically-shaped part of the outer casing and having a convex end arranged in axial alignment with the inlet duct means and tangent to a plane passing through the junction of the second conically-shaped part with its throat, a plurality of air driving blades superposed on the outer periphery of the rotatable part of the inner casing, means for driving the rotatable part of the inner casing and for maintaining it in spaced relation to the second part of the outer casing and the blades on the rotatable part of the inner casing being comparatively short and being angularly disposed on the outer periphery of the rotatable part of the inner casing with the root of each blade being secured thereto and the tip of each blade being arranged in close proximity to the inner surface of the second part of the outer casing at approximately the junction of the first conically-shaped part of the outer casing and its throat and the trailing edge of each blade terminating at a substantial distance from the enlarged end of the rotatable part of the inner casing, each of said blades having a concave surface so that air entering the spaces between the blades will be directed inwardly in a substantially linear direction and air turning vanes arranged between and secured to the first part of the outer casing and the stationary part of the inner casing, the leading edge of each of said turning vanes being arranged between the enlarged first part of the outer casing and the enlarged part of the stationary part of the inner casing and the trailing edge of each of said vanes being tangent to a transverse plane passing through the junction of the conically-shaped portion of the first part of the outer casing and its throat and being spaced at a substantial distance from the air driving blades to form a plenum chamber between the outer and inner casings and the air driving blades and air turning vanes and each of the air turning vanes having a concave surface that is shaped opposite to the concave surface of each of the driving blades so that air will be discharged from the impeller in a substantially straight line without substantial turbulence.

11. An air impeller comprising an outer casing including first and second conically-shaped parts having their enlarged ends connected together to form a substantially spherically-shaped central portion and the first conically-shaped part of the outer casing having a reduced end portion terminating in a cylindrical throat for connection to an outlet duct means and the second conically-shaped portion terminating in a reduced cylindrical throat for connection to an inlet duct means, an inner casing consisting of a stationary semispherical part having its convex end arranged in axial alignment with the outlet duct means and tangent to a plane passing through the junction of the first conically-shaped part of the outer casing and its throat and a second rotatable semispherical part arranged inwardly of the second conically-shaped part of the outer casing and having a convex end arranged in axial alignment with the inlet duct means and tangent to a transverse plane passing through the junction of the second conically-shaped part with its throat, means for driving the rotatable part of the inner casing and maintaining it in spaced relation to the second part of the outer casing, a plurality of air driving blades, each having its root secured to the outer periphery of the rotatable part of the inner casing, a tip which is longer than the root, and inclined ends, the planes of which ends when extended from an angle of approximately 25° with each other and the tip of the trailing edge of each of said blades being arranged in proximity to the junction of the second conically-shaped part of the outer casing and its throat

13

and the leading edge of each of said blades being inclined at an angle of approximately 45° to the axis of the impeller and the trailing edge of each of said blades being spaced at a substantial distance from the enlarged inner end of the rotatable casing, each of said blades having a concave surface so that air entering the space between the blades will be directed inwardly in a substantially linear direction, and air turning vanes arranged between and secured to the first part of the outer casing and the stationary part of the inner casing, the leading edge of each of which is arranged between the enlarged first part of the outer casing and the enlarged part of the stationary casing and the trailing edge of each of which is tangent to a transverse plane passing through the junction of the conically-shaped portion of the first part of the outer casing and its throat and said vanes being spaced at a substantial distance from the air driving blades to form a plenum chamber between the outer and inner casings and the air driving blades and the air turning vanes and each of the air turning vanes having a surface that is concave in a direction opposite to the concave surface of each of the driving blades so that air will be discharged from the impeller in a substantially straight line without substantial turbulence.

12. An air impeller comprising an outer casing including first and second conically-shaped parts having their enlarged ends connected together to form a substantially spherically-shaped portion and the first conically-shaped part of the outer casing having a reduced end portion terminating in a cylindrical throat for connection to an outlet duct means and the second conically-shaped part terminating in a reduced cylindrical throat for connection to the inlet duct means, a casing spaced inwardly from the outer casing which forms a circumferential path for the air between the inner and outer casings and consisting of a stationary semispherical part having its convex end portion arranged in axial alignment with the outlet duct means and tangent to a plane passing through the junction of the first conically-shaped part of the outer casing and its throat and a second rotatable semispherical part arranged inwardly of the second conically-shaped part of the outer casing and having a convex end arranged in axial alignment with the inlet duct means and tangent to a transverse plane passing through the junction of the second conically-shaped part with its throat, means for driving the rotatable part of the inner casing and maintaining it in spaced relation to the second part of the outer casing, a plurality of air driving blades, each having its root secured to the outer periphery of the rotatable part of the inner casing, a tip which is longer than the root, and inclined ends, the planes of which when extended form an angle of approximately 25° with each other, and the tip of the leading edge of each of said blades being arranged in proximity to the junction of the second conically-shaped part of the outer casing and its throat and being inclined at an angle of approximately 45° to the axis of the impeller and the trailing edge of each of said blades being spaced at a substantial distance from the enlarged inner end of the rotatable casing, and each of said blades having a concave surface so that air entering the spaces between the blades will be directed inwardly into the circumferential path between the casings in a substantially linear direction.

13. A centrifugal air impeller including first and second similar conically-shaped parts having their enlarged ends connected together to form a substantially spherically-shaped central portion and the first conically-shaped part of the outer casing having a reduced open end shaped to be connected to an outlet duct means and the second conically-shaped part of the outer casing having a reduced open end shaped to be connected to an inlet duct means, an inner casing arranged within and spaced from the outer casing to form a circumferential passage for air between the casings and including a stationary substantially semispherically-shaped part having a convex end

14

arranged in alignment with the axis of the outlet duct means and a second rotatable semispherically-shaped part having a convex end arranged in alignment with the axis of the inlet duct means, a motor arranged within the stationary part of the inner casing, means associated with the shaft of the motor and the rotatable part of the inner casing for driving the rotatable part of the inner casing and maintaining it in spaced relation to the second part of the outer casing, a plurality of spaced driving blades, each having its root secured to the outer periphery of the rotatable part of the inner casing and its tip arranged in close proximity to the inner surface of the second part of the outer casing, each of which blades originates at a spaced distance from the convex end of the inner casing and terminates at a substantial distance from the enlarged end thereof and each of said blades being arranged to extend substantially diagonally on the rotatable part of the inner casing in such relation to each other that during the rotation of the second part of the inner casing, air striking each blade will flow between that blade and the next succeeding blade in the order of revolution and will be directed in a substantially linear direction through the circumferential space between the inner and outer casings, a plurality of air turning vanes, each having an arcuate-shaped portion arranged between and connected to the conically-shaped first part of the outer casing and the stationary part of the inner casing at a substantial distance from the air driving blades to thereby provide a plenum chamber between the inner and outer casings and the air driving blades and the air turning vanes, and a plurality of tubes extending between the first part of the outer casing and through the stationary part of the inner casing through which air from the atmosphere may flow to cool the motor.

14. A centrifugal air impeller including first and second similar conically-shaped parts having their enlarged ends connected together to form a substantially spherically-shaped central portion, an inlet conduit means and an outlet conduit means, each having substantially the same cross sectional area, and the first conically-shaped part of the outer casing having a reduced open end shaped to be connected to the outlet duct means and the second conically-shaped part of the outer casing having a reduced open end shaped to be connected to the inlet duct means, an inner casing arranged within and spaced from the outer casing to form a circumferential passage for air and including a stationary substantially semi-spherically-shaped part having a convex end arranged in alignment with the axis of the outlet duct means and a second rotatable semispherically-shaped part having a convex end arranged in alignment with the axis of the inlet duct means, means for rotating the second part of the inner casing and maintaining it in spaced relation to the second part of the inner casing, a plurality of spaced driving blades, each having its root portion secured to the outer periphery of the rotatable part of the inner casing and its tip arranged in close proximity to the inner surface of the second part of the outer casing, each of which blades originates at a spaced distance from the convex end part of the inner casing and terminate at a substantial distance from the enlarged end thereof and each of said blades being arranged to extend substantially diagonally on the rotatable part of the inner casing in such relation to each other that during the rotation of the second part of the inner casing, air striking each blade will flow between that blade and the next succeeding blade in the order of revolution and will be directed in a substantially linear direction through the circumferential space between the inner and outer casings, a plurality of air turning vanes, each having an arcuate-shaped portion arranged between and connected to the conically shaped first part of the outer casing and the stationary part of the inner casing at a substantial distance from the air driving blades to thereby provide a plenum chamber between the inner and outer casings and the air driving blades and the air turning vanes, and

15

the cross sectional area of said plenum chamber being substantially the same as the cross sectional area of each of the inlet and outlet duct means so that air passing through the unit will have a substantially constant pressure and velocity.

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