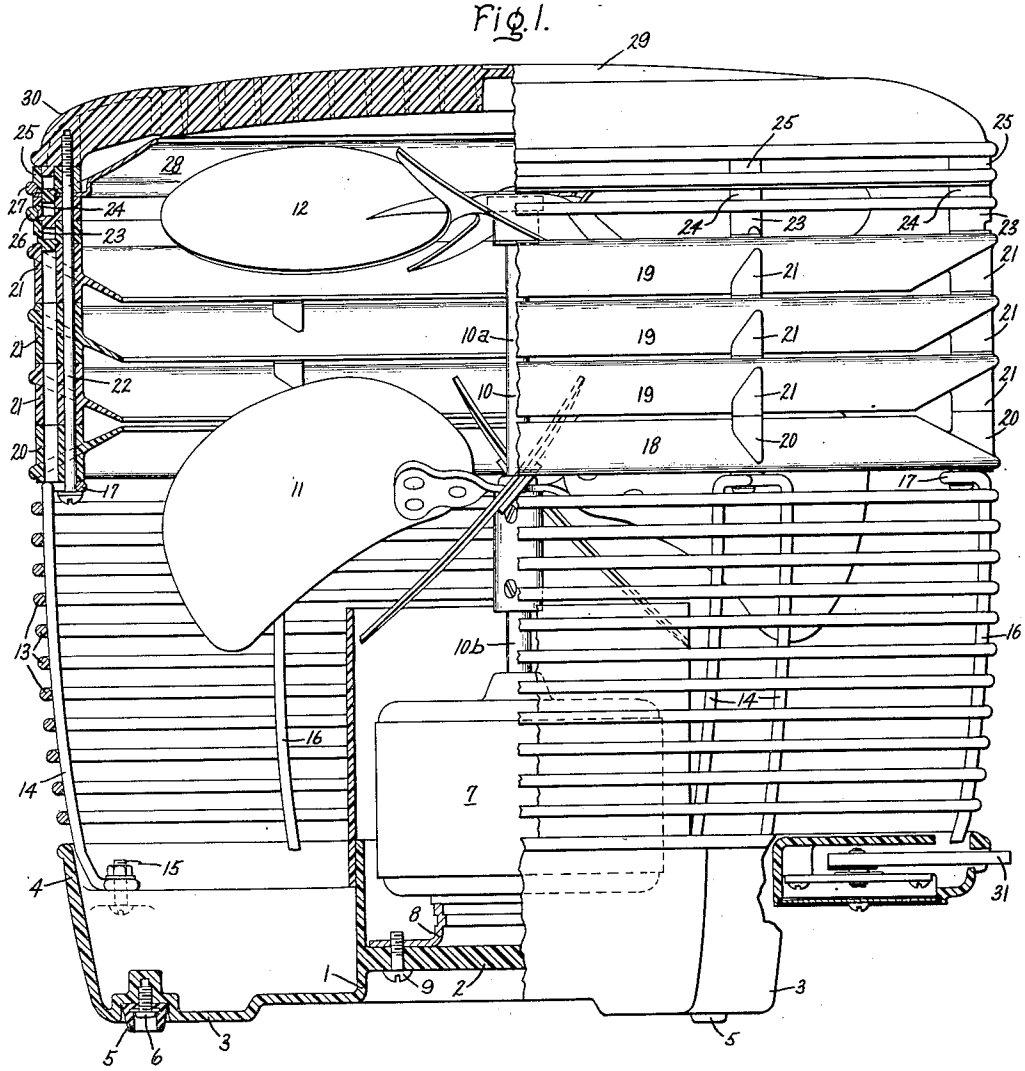
March 3, 1953 A. G. OSTROGNAI 2,630,267

RADIAL FLOW FAN

Filed May 8, 1951 2 SHEETS—SHEET 1

Fig. 1.



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Filed May 8, 1951 2 SHEETS—SHEET 2

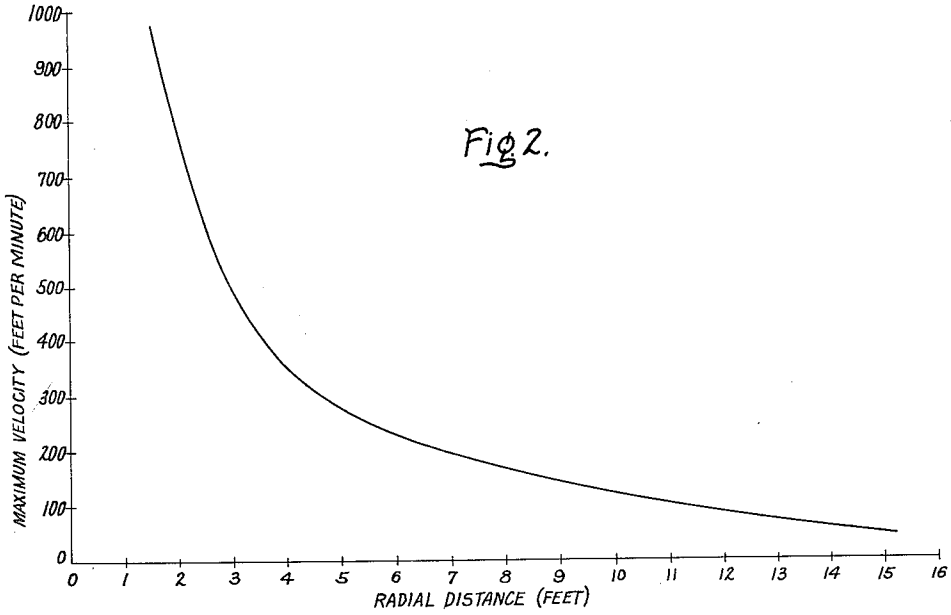


Fig. 2.

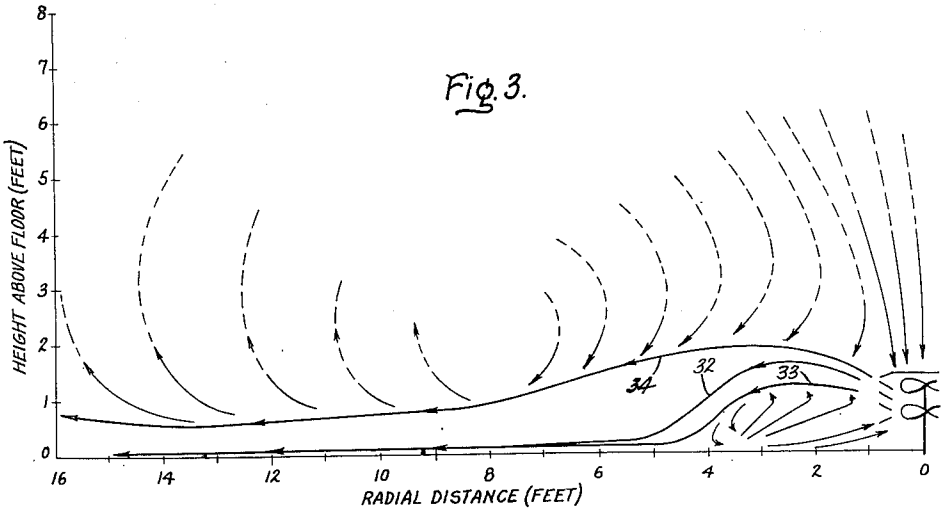


Fig. 3.

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RADIAL FLOW FAN

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This invention relates to rotary-driven, air-moving fans and more particularly to such fans in which the air is discharged radially with respect to the rotating members.

Radial flow fans are particularly suited to be used as floor-type fans, since if a radial flow fan is mounted with its rotating shaft extending vertically with respect to the floor, it tends to produce air streams flowing in all directions along the floor. These air streams will in turn cause a rolling circulation of the air lying above them and thus produce a ventilating effect throughout the room in which the fan is positioned. Naturally, the stronger the floor air streams, the better will be over-all ventilation of the room.

It is a general object of this invention, therefore, to provide a new and improved radial flow fan which, for a given power input, will produce stronger radial air streams than those fans heretofore available; and it is a more specific object of the invention to provide a new and improved radial flow fan particularly adapted for use as a floor-type fan.

In accordance with the foregoing objectives, there is provided a fan having a vertically disposed shaft on which two sets of fan blades are mounted in spaced vertical relationship. The lower set of blades discharges air upwardly along the shaft while the upper set of blades discharges air downwardly along the shaft. These air streams oppose each other so that they both tend to combine and discharge outwardly from the shaft in the space lying between the two sets of blades. This radial discharge effect may be aided by positioning special orifice members around each of the sets of blades to aid in shaping their discharge patterns, and also by constructing one set of blades with a blade surface curvature in reverse to the normal curvature for its direction of axial discharge. In order to confine the radial discharge of the combined air streams to a particularly desirous vertical angle, a plurality of vertically spaced annular louvers are employed. These louvers are positioned so that the air in flowing outwardly passes between them and is guided thereby to the correct angle. Not only does this fan produce a stronger radial air stream than conventional floor-type fans of the same size, but it also obtains a better rolling circulation of the room air for a given output air stream because it takes its suction on both sides of the output air stream, i. e., it sucks in air at its top for one set of blades and at its bottom for the other set of blades.

The features of this invention, which are believed to be novel, are set forth with particularity in the appended claims. The invention itself, however, both as to organization and mode of operation, together with further objects and advantages thereof, may be best understood by reference to the following description, to be taken in conjunction with the accompanying drawing in which:

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Fig. 1 is a front elevation view, partially in section, of a floor-type fan embodying this invention;

Fig. 2 is a performance curve for a given size fan similar in construction to that illustrated in Fig. 1, showing the maximum velocity of the radial air stream produced by the fan versus radial distance from the fan; and

Fig. 3 is another performance diagram for the same fan as the curve of Fig. 2, showing the height of the radial air stream above the floor versus radial distance from the fan.

Referring to Fig. 1, the base 1 of a floor-type fan embodying this invention includes a disk-like motor mounting plate 2, three supporting legs 3 which extend outwardly from the plate, and an annular rim member 4 which joins together the outer ends of legs 3. In order to vibration-insulate the fan from the floor, a resilient foot 5, preferably formed of rubber, is mounted under each of legs 3 by a screw 6. The fan drive motor 7 is secured to the base by a support bracket 8 and a plurality of screws 9, and its shaft 10 extends vertically upward away from the base. As shown, shaft 10 need not be one piece, but may consist of an extension shaft 10*a* coupled to the actual motor drive shaft 10*b*.

Mounted in spaced vertical relationship on shaft 10 are two sets of essentially axial flow fan blades 11 and 12. The lower set of blades 11 discharges air upwardly along shaft 10 while the upper set of blades 12 discharges air downwardly along shaft 10. These streams of air thus oppose each other in the space lying between the two sets of blades and tend to discharge radially outward from shaft 10.

The fan housing which encloses the motor and the fan blades includes means which aid in forming this radial air discharge. The lower portion of the fan housing comprises a cage formed of a plurality of vertically spaced rings 13 which are secured on supporting struts 14 by welding or other suitable means, the struts themselves being mounted on base 1 by bolts 15. Besides the actual supporting struts 14, additional struts 16 are secured to rings 13 so as to stiffen the cage. This lower cage portion extends upwardly from rim

4 to a point slightly below the neutral plane of blades 11. In other words, the cage encloses the lower portion of blades 11 but not their upper portion, and it is through the opening between the cage rings that blades 11 take the major portion of their suction.

Struts 14 and 16 extend upwardly slightly beyond the uppermost ring 13 and have horizontal loops 17 formed at their upper extremities. It is on these loops that the aforementioned air-directing means are mounted. Thus, positioned directly above loops 17 is an annular orifice member 18 while mounted on top of member 18 are a plurality of annular louvers 19. Orifice member 18 is provided with a number of spacing bosses or projections 20, and louvers 19 are provided with similar bosses 21. Bosses 20 and 21 each contain a vertically extending hole or aperture through which extends a retaining bolt 22, the bosses thereby serving not only to space orifice member 18 and louvers 19 vertically from each other but also to secure them firmly in place. In order to reduce their resistance to air flow, bosses 20 and 21 should preferably have either a parallel-sided oval or a tear-drop shaped cross sectional area.

Orifice member 18, in effect, forms an air passageway which encloses most of the upper portion of blades 11 and is tapered from its bottom to its top. In other words, the horizontal diameter of the passageway decreases with vertical distance from base 1. This tapered passageway of member 18 aids in shaping the discharge from blades 11 into an axial flow moving upwardly along shaft 10.

Louvers 19 are spaced vertically from the upper edge of orifice member 18 to a point near the lower edges of blades 12. The louvers thus enclose the space in which the separate air streams from blades 11 and 12 interact and combine to form one radially moving air stream. To obtain the best circulation of room air, it is desirable that this output air stream be directed slightly upwardly as it leaves the fan, as will be more fully explained hereinafter, and to accomplish that result louvers 19 are constructed so that their upper and lower surfaces form acute angles with their horizontal transverse diameters. Naturally, it is important that the louvers present as little resistance as possible to the air flow and for that purpose they are preferably formed with a parallel-sided oval or tear-drop shaped cross section.

Mounted above the uppermost louver on each of the bolts 22 are spacing members 23, 24 and 25 which are substantially identical in shape, each being of a parallel-sided oval cross section and each having a small recess formed in the lower portion of its outer edge. In the case of members 24 and 25 these recesses are used to mount protective or safety rings 26 and 27, ring 26 being mounted in the recesses of members 24 and ring 27 being mounted in the recesses of members 25. Ring 26 is, however, close enough to the outer edge of the uppermost louver that no protective ring need be mounted in the recesses of members 23. Besides mounting protective rings 26 and 27, spacing members 24 and 25 also serve to hold in place an orifice member 28, the lower edge of member 28 being secured between members 24 and 25. From its lower edge which thus lies approximately at the neutral plane of blades 12, member 28 extends upwardly to a point slightly above the upper edges of the blades and thereby forms an air passageway enclosing the upper portion of the blades. The passageway is tapered from top to bottom so that its horizontal diameter decreases with vertical distance from base 1, and this taper helps to produce the desired flow pattern for the air stream leaving blades 12.

Positioned over orifice member 28 is a grill cover 29 which has a solid rim 30 resting directly on members 25. Bolts 22 are threaded into tapped apertures formed in rim 30 so as to secure in place the entire upper portion of the fan housing. As its name indicates, grill cover 30 is provided with numerous openings, and it is through those openings that blades 12 take their suction.

The speed at which the fan blades rotate and thus, the strength of the output air stream of the fan may be varied by means of a multi-position switch 31 which is connected in the drive motor circuit. Switch 31 has an "off" position and a plurality of "on" positions whereby the motor may be made to rotate at various speeds.

As previously mentioned, orifice members 18 and 28 are included in the fan structure so as to aid in producing such discharge patterns in the opposing axially flowing air streams that they will combine efficiently to produce one radially flowing air stream. These discharge patterns are also, of course, dependent upon both the pitch and the surface curvatures of blades 11 and 12. Thus, viewing the fan from its top end and assuming its direction of rotation to be clockwise as so viewed, the leading or air-impelling surfaces of blades 11 extend rearwardly and upwardly from their leading edges to their trailing edges so that they will propel air upwardly, while the leading or air-impelling surfaces of blades 12 extend rearwardly and downwardly from their leading edges to their trailing edges so that they will propel air downwardly. The air-impelling surfaces of blades 11 are provided with the normal surface curvature for axial flow fan blades being concave in the direction of air flow from their leading to trailing edges, i. e., being concave in the direction of blades 12; but, in accordance with this invention, the air-impelling surfaces of blades 12 are provided with a curvature in reverse to the normal curvature for axial flow fan blades, being convex in the direction of air flow from their leading to their trailing edges, i. e., being convex in the direction of blades 11. By forming blades 12 with this reverse curvature, appreciably better results are obtained from the fan as a whole.

The reverse curvature of blades 12 causes the air stream leaving them to diverge outwardly as it moves down shaft 10. The shape of orifice member 28 also aids in causing the discharge of blades 12 to have radial as well as axial components of direction. The normal curvature of blades 11, however, together with the shape of orifice 18 causes the air leaving blades 11 to have substantially only axial components. The result of the downwardly moving stream having radial as well as axial components of direction and the upwardly moving stream having only axial components is that when the two streams of air meet in the space enclosed by the louvers, they combine with a minimum of turbulence into a stream of air moving substantially radially but also moving somewhat upwardly. The combined air stream is then able to pass between louvers 19 with a minimum of contact, and thus, a minimum loss of speed due to any surface drag of the louvers.

This feature of the invention should not, however, be construed as limited to a fan in which the

upper set of blades is provided with a reverse surface curvature and the lower set of blades is provided with a normal surface curvature. Equally good results may be obtained by providing the lower set of blades with the reverse surface curvature and the upper set of blades with the normal surface curvature. In this case, the lower blades would be convex from their leading to trailing edges in the direction of the upper blades, while the upper blades would be concave from their leading to trailing edges in the direction of the lower blades.

Even if neither set of blades has a reverse curvature, the opposing streams of air still combine into one radially moving stream but the turbulent effect is much greater so that the efficiency of the fan is lowered. Louvers 19, of course, insure that the combined air stream leaves the fan at the correct angle even if both sets of blades have a normal surface curvature. In any case, no matter what the surface curvature of the blades may be, an upward as well as an outward movement of the combined air stream into the louvers may be accomplished by making the lower blades more powerful than the upper blades.

The reason why the discharge of the fan should have upward as well as radial components of direction may be understood by reference to the air stream lines shown in Fig. 3, which are for a fan of the type shown in Fig. 1 standing approximately 15¾ inches high and having an outer housing diameter of approximately 16¾ inches at its widest point. Such a fan draws about 48 watts power input when creating its maximum velocity output air stream. As the air stream leaves the fan, as indicated by stream lines 32, 33 and 34, it creates beneath it a low pressure area so that it tends to dip toward the floor. By directing the air stream slightly upwardly as it leaves the fan, the dip is made to occur at a point more distant from the fan than that point at which it would occur if the air stream were directed outwardly from the fan in a horizontal plane. The more remote point of dip is desirable, since if the dip occurs too close to the fan, a large portion of the output air stream is drawn right back into the lower fan blades. The dip itself is desirable because it causes the output air stream to form a jet along the floor.

As the air stream flows along the floor, it picks up and accelerates the air adjacent to its flow path so that a rolling action of the air occurs in the space above the flow path. This rolling action causes a circulation of air which is indicated by the dotted lines in Fig. 3 and tends to ventilate the entire room in which the fan is positioned. The maximum velocity of the output air stream, which occurs approximately along stream line 32, is plotted in Fig. 2. For example, at about 1½ feet from the fan the maximum velocity of the air stream is 950 feet per minute, while at 15 feet it is approximately 60 feet per minute. This means that even at a distance of 15 feet from the fan, there is an appreciable ventilating effect.

Besides the improved jet action of its output air stream, the fan also has another important advantage in that it delivers a larger volume of air at a greater velocity than do conventional floor-type fans of similar size. Naturally, the greater the volume of air flow, the better ventilating effect is obtained in the room. Moreover, the rolling circulation of the air and, thus, the ventilating effect is augmented by the fan taking a portion of its suction from above the output air stream. Of course, as a result of part of the air entering the top of the fan, less air need be drawn in at the bottom of the fan so that the velocity of the air entering the bottom for a given output air flow is less than in most conventional fans. This decreases the likelihood of lint, dust, ashes, etc., being drawn into the fan by the return air so as to be dispersed throughout the room. Thus, even though the fan produces an increased velocity, jet action output for a better ventilating effect, it has little tendency to introduce foreign matter such as dust into the air stream.

While there has been described what at present is considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that numerous alterations and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such alterations and modifications as fall within the true spirit and scope of this invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A fan including a supporting base, a motor mounted on said base having a vertically extending shaft, a first fan blade mounted on said shaft for discharging a stream of air upwardly along said shaft, a second fan blade mounted on said shaft above said first blade for discharging a stream of air downwardly along said shaft, one of said blades having a surface curvature from its leading to its trailing edge convex in the direction of the other of said blades and said other blade having a surface curvature from its leading to its trailing edge concave in the direction of said one blade whereby said air streams are shaped to combine and discharge radially from said shaft upon their meeting in the space between said blades.

2. A fan including a supporting base, a motor mounted on said base having a vertically extending shaft, a first set of fan blades mounted on said shaft for discharging a stream of air upwardly along said shaft, a second set of fan blades mounted on said shaft above said first set of fan blades for discharging a stream of air downwardly along said shaft to meet said upwardly discharged stream, the blades of said first set having a surface curvature from their leading to their trailing edges concave in the direction of said second set and the blades of said second set having a surface curvature from their leading to their trailing edges convex in the direction of said first set to cause said streams of air to combine and discharge outwardly from the space between said sets of blades.

3. A fan comprising a supporting base, a motor mounted on said base having a vertically extending shaft, a pair of orifice members mounted on said base in spaced vertical relationship, each of said members having a vertically extending tapered passageway enclosing said shaft, both of said passageways being tapered to have an increasing horizontal diameter in the same vertical direction, a first fan blade mounted on said shaft in one of said passageways for discharging a stream of air upwardly along said shaft, and a second fan blade mounted on said shaft above said first fan blade in the other of said passageways for discharging a stream of air downwardly along said shaft to strike said upwardly discharged stream in the space between said orifice members, the taper of said passageways aiding in shaping said streams of air to cause them to com-

bine and discharge radially from the shaft in the space between said orifice members.

4. A floor-type fan including a supporting base, a motor mounted on said base having a vertically extending shaft, a pair of vertically spaced orifice members mounted on said base, each of said members having a vertically extending tapered passageway enclosing said shaft, a first fan blade mounted on said shaft in one of said passageways for discharging a stream of air upwardly along said shaft, a second fan blade mounted on said shaft above said first fan blade in the other of said passageways for discharging a stream of air downwardly along said shaft to meet said upwardly discharged stream, one of said blades having a surface curvature from its leading to its trailing edge convex in the direction of the other of said blades and said other blade having a surface curvature from its leading to its trailing edge concave in the direction of said one blade, whereby said passageway and said blades coact to shape said streams of air to effect a combined radial discharge thereof upon their meeting in the space between said blades.

5. A fan including a supporting base, a motor mounted on said base having a vertically extending shaft, a first fan blade mounted on said shaft for discharging a stream of air upwardly along said shaft, a second fan blade mounted on said shaft above said first blade for discharging a stream of air downwardly along said shaft to meet said upwardly discharged stream, one of said blades having a surface curvature from its leading to its trailing edge convex in the direction of the other of said blades and said other blade having a surface curvature from its leading to its trailing edge concave in the direction of said one blade, and a plurality of annular louvers mounted on said base and disposed around said shaft and blades in an area horizontally opposite the space between said blades for directing said streams of air away from said shaft upon their meeting in the space between said blades.

6. A floor-type fan including a supporting base, a motor mounted on said base having a vertically extending shaft, a pair of orifice members mounted on said base in spaced vertical relationship, each of said members having a vertically extending tapered passageway enclosing said shaft, both of said passageways being tapered to have an increasing horizontal diameter in the same vertical direction, a first fan blade mounted on said shaft in one of said passageways for discharging a stream of air upwardly along said shaft, a second fan blade mounted on said shaft above said first fan blade in the other of said passageways for discharging a stream of air downwardly along said shaft to meet said upwardly discharged stream, the taper of said passageways aiding in shaping said streams of air to cause them to combine and discharge radially from the shaft in the space between said orifice members, and a plurality of annular louvers secured between said orifice members for directing said streams of air outwardly at a predetermined angle.

7. A fan comprising a supporting base, a motor mounted on said base having a vertically extending shaft, a pair of orifice members mounted on said base in spaced vertical relationship, each of said members having a vertically extending passageway enclosing said shaft, both of said passageways being tapered to have an increasing horizontal diameter in the same vertical direction, a first fan blade mounted on said shaft in one of said passageways for discharging a stream of air upwardly along said shaft and a second fan blade mounted on said shaft in the other of said passageways above said first blade for discharging a stream of air downwardly along said shaft to strike said upwardly moving stream, one of said blades having a surface curvature from its leading to its trailing edge convex in the direction of the other of said blades and said other blade having a surface curvature from its leading to its trailing edge concave in the direction of said one blade, the curvature of said blades and the taper of said passageways shaping said streams of air to cause them to combine and discharge radially from the shaft in the space between said orifice members, and a plurality of annular louvers secured between said orifice members for directing said streams of air outwardly at a predetermined angle.

8. A floor type fan including a supporting base, a motor mounted on said base having a vertically extending shaft, a pair of vertically spaced orifice members mounted on said base, each of said members having a vertically extending tapered passageway enclosing said shaft, a first fan blade mounted on said shaft in one of said passageways for discharging a stream of air upwardly along said shaft, and a second fan blade mounted on said shaft above said first fan blade in the other of said passageways for discharging a stream of air downwardly along said shaft to strike said upwardly discharged stream in the space between said orifice members, the taper of said passageways aiding in shaping said streams of air to cause them to combine and discharge radially from the shaft in the space between said orifice members.

9. A floor type fan including a supporting base, a motor mounted on said base having a vertically extending shaft, a first fan blade mounted on said shaft near the bottom thereof for discharging a stream of air upwardly along said shaft, a second fan blade mounted on said shaft near the top thereof and spaced above said first fan blade for discharging a stream of air downwardly along said shaft to meet said upwardly discharged stream, and a plurality of annular louvers mounted on said base and disposed around said shaft and blades in an area horizontally opposite the space between said blades for directing said streams of air away from said shaft and outwardly at a predetermined angle upon their meeting in the space between said blades.

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No references cited.