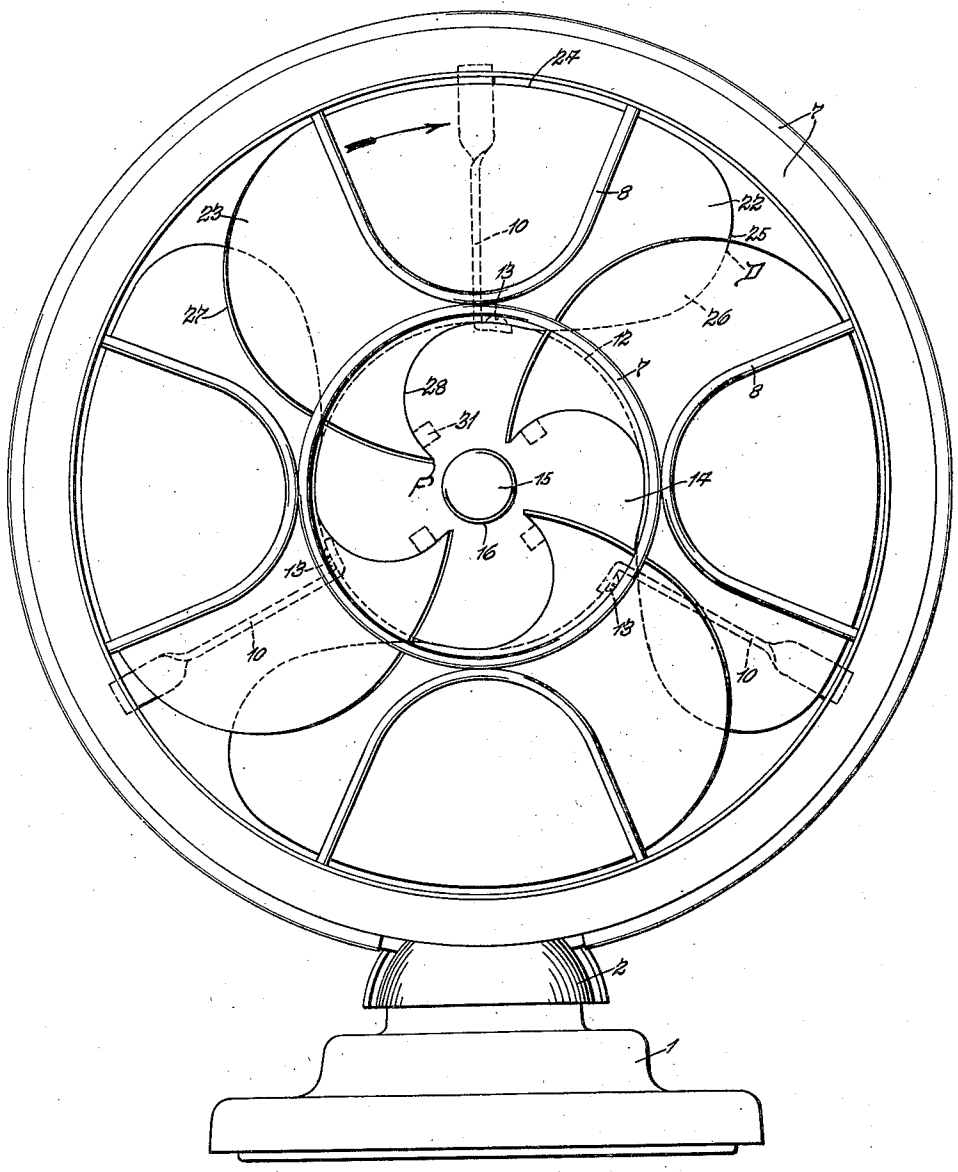
Oct. 6, 1936. V. WEBER 2,056,547

CIRCULATING FAN

Filed Sept. 1, 1934 3 Sheets-Sheet 1

Fig. 1.



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Filed Sept. 1, 1934 3 Sheets-Sheet 2

Fig. 2.

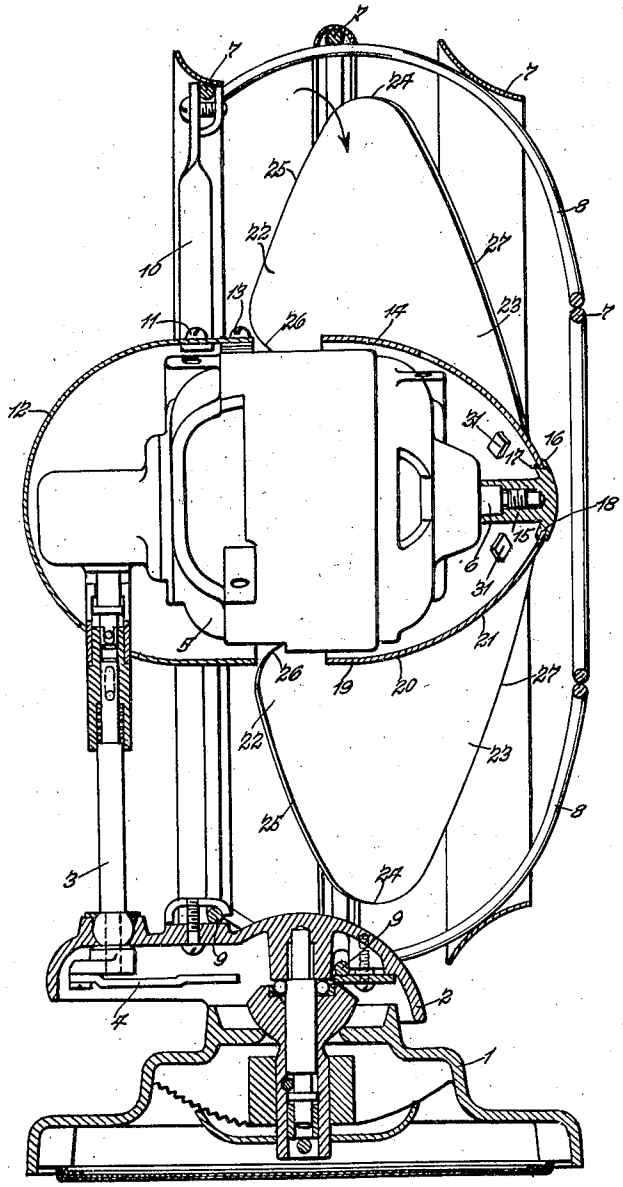

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Fig. 3.

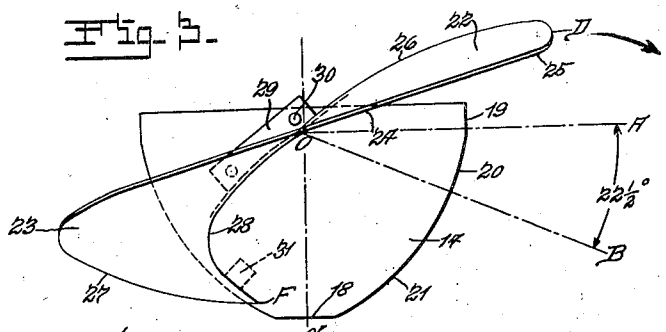


Fig. 4.

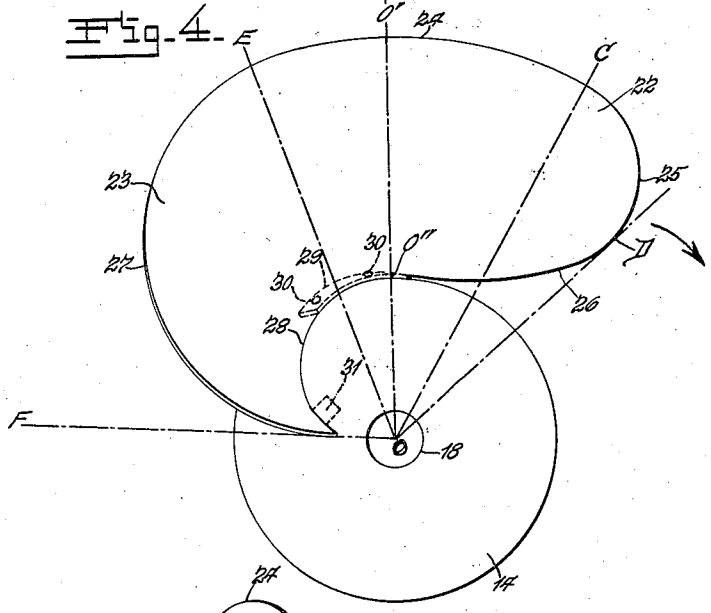
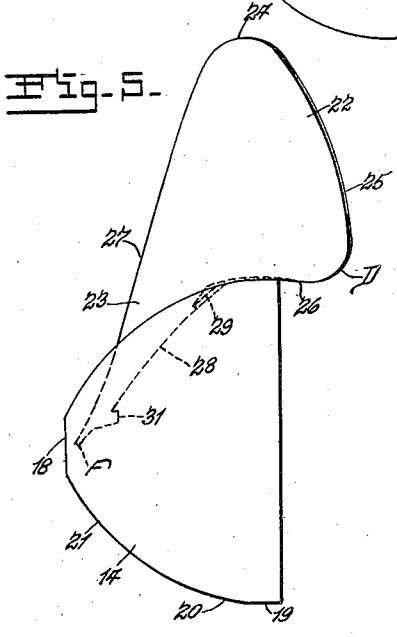


Fig. 5.



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Patented Oct. 6, 1936 2,056,547

UNITED STATES PATENT OFFICE

2,056,547

CIRCULATING FAN

Victor Weber, St. Louis, Mo., assignor to The Emerson Electric Mfg. Co., St. Louis, Mo., a corporation of Missouri

Application September 1, 1934, Serial No. 741,645

19 Claims. (Cl. 170—159)

This invention relates to circulating fans and particularly to the impeller itself.

An object of the invention is to provide a fan which will be nearly noiseless in operation, which will have high efficiency, which will lend itself to a pleasing design, which will be economical of construction, and which will be durable in operation.

Other and specific objects will be apparent from the following detail description, taken in connection with the accompanying drawings, in which—

Fig. 1 is a front elevation of a complete circulating fan embodying the invention;

Fig. 2 is a vertical section of the structure illustrated in Fig. 1; and

Figs. 3, 4, and 5 are diagrams showing the arrangement of the fan blades on the hub, one blade only being shown attached to a hub cup, which is in turn secured to a propelling shaft; Fig. 3 being a plan view, Fig. 4 a front elevation, and Fig. 5 a side elevation.

As shown in Fig. 1 the fan, when viewed from the front, presents substantially a closed circle with the trailing edge of a blade somewhat overlapping the leading edge of the adjacent blades. In the construction specifically shown in the drawings four blades are used, although it will be obvious that a more or less number may be employed. However that may be, the area of each blade will be at least nearly equal to the total area traversed divided by the number of blades, such area being sometimes termed herein, fan disc.

The invention contemplates the use of a convex hub cup which may be hemispherical in form, or conical in form, or a variation of the two, attached at its apex to a driving shaft with the blades secured to the outer periphery of the cup and with a substantial portion of the inner edge of the blade conforming to the surface of the cup. Or, otherwise described, the cup includes a forward surface which converges forwardly and inwardly with reference to its axis.

The blades when attached to the cup are in the form of a uniformly developed helix, with a constant pitch, with the effective or front surface of the blade coinciding with lines which are radial from and perpendicular to the axis of revolution.

As best shown in Fig. 4, a blade may be considered as divided into two parts almost equal in extent, a leading end and a trailing end, the leading end being free and extending rearwardly from the cup and the trailing end having an inner edge secured to and adjacent the periphery of the cup.

The arrangement is such that a cylindrical air stream is developed having a uniform velocity throughout the cylinder with a constant and uniform thrust being applied to the air stream. This function results in an increased efficiency in a fan because of the avoidance of circumferential currents and eddy currents, and also results in quietness of operation.

It is thought that in the fan employed, the air stream is accelerated materially and to a greater extent than in conventional fan structures by the vacuum produced at the rear of the fan. On this account and because there is a uniform thrust throughout the surface of the blade with no particular part performing an increased duty over other parts, vibration and noise are reduced to a minimum.

The invention has now been described generally and its essential characteristics are pointed out in the appended claims, but a more detailed description of the specific device illustrated in the drawings is now attempted to assist in understanding and practicing the invention.

The mounting of the fan may be generally described because it is particularly adapted to this specific purpose, although it is no part of this invention and is more particularly illustrated and described in a copending application by my collaborator, Herbert I. Finch, Serial No. 699,499, filed November 24, 1933.

The mounting of the fan includes a base 1, to which is attached a plate 2, which is adjustable with reference to the base 1 and which is adapted to oscillate by appropriate mechanism including a crank shaft 3 which drives a pitman 4. The shaft 3 is driven through appropriate reducing mechanism by a motor 5, whose shaft 6 is the driving shaft of the fan and to which the fan structure is attached.

The structure includes a unitary guard and support, which has a plurality of circular members 7 and a plurality of transverse members 8 fabricated together in open pattern work. Two of the members 7 are securely clamped to the plate 2 as shown at 9, and the unitary guard and support is thereby secured in upstanding fashion with reference to the plate 2 and with reference to the base 1.

The motor and fan, which is attached to the motor shaft, is supported within and by the guard by a plurality of radial straps 10 which have their outer ends clamped to the guard, to one of the circular members as specifically shown, and their inner ends secured directly or indirectly to the motor frame. In the structure as specifi-

cally shown the inner end of the straps 10 are secured by screws 11 to a cup 12 which is attached by screws 13 at the rear of the motor frame.

The result of this particular construction is that the motor and impeller are supported within the guard by the guard itself, and, since the guard is fabricated of resilient members, the motor and impeller are thus resiliently supported so as to reduce the amount of vibration transmitted from the motor and impeller to the base. Furthermore, since the fan blades overhang a substantial part of the motor frame, as will be understood from the following description, the ordinary conventional mounting is not suitable and the mounting which has been illustrated and just described permits the motor and impeller to be supported from the rear end of the motor frame and to the rear of the fan blades.

The fan or impeller includes a plurality of blades which are attached to a hub cup 14, which is secured to the shaft 6 by a sleeve member 15. In the specific construction as shown, the member 15 is internally threaded to engage a threaded end of the shaft 6. The member 15 has a rounded circular head which carries a circumferential outer flange 16 and an inner flange 17, as shown in Fig. 2, between which flanges the apex of the cup 14 is secured, the cup 14 having a suitable circular hole 18 for this purpose.

The exact geometrical form of the cup 14 is not important, it being essential only that it be concave or converge toward the front, for instance, as a hemisphere or cone. In the device as specifically illustrated in the drawings, the cup 14 includes a rim 19, which is a cylinder, a portion 20 on one degree of curvature and a portion 21 on a different degree of curvature. The portion 19 extends from the rear of the cup, as shown in Fig. 3, to a line OA, the portion 20 extends from the line OA 22½° to a line OB, and the portion 21 extends from the line OB to the margin of the hole 18. Although the exact dimensions and exact curvature are not essential, for the purpose of ready understanding of the drawings and of the invention and to permit its ready application, typical dimensions and curvatures, as specifically illustrated in the drawings, will be given. The cup 14 has an external diameter at the portion 19 of 4" and that portion extends axially for a distance of 9/32". The portion 20 is a spherical section on the same radius as the cup, that is 2", and extends from the line OA to the line OB, a distance of 22½°. The portion 21 extends from the line OB to the margin of the hole 18 and is on a radius of 2$\frac{1}{16}$".

It will thus be seen that the cup 14 may be considered either as a modified hemisphere or as a modified cone, but it is to be understood that further modifications of either would be entirely suitable as an embodiment of the invention. The entire axial length of the cup, exclusive of the member 15, is 2½".

As previously explained, the fan blade is arranged along the path of a uniformly developed helix and the surface of the fan blade constitutes, or coincides with, a plurality of radial lines extending from and perpendicular to the axis. An explanation of the contour of the blade can best be made by reference to a number of such radial lines shown in Fig. 4.

The point O is any appropriate point in the axis of revolution. The line O—O' is the line dividing the blade into two parts, a leading end 22 and a trailing end 23. The line OC intersects the leading end and is approximately 30° from the line O—O'. The line OD is tangent to the leading extremity and is 49° from the line O—O'. The line OE intersects the trailing edge and is approximately 20° from the line O—O'. The line OF touches the trailing tip and is 65° from the line O—O'.

With the use of the radial lines just described a description of the contour of the blade may be more easily made. A part 24 of the outer contour or edge of the blade from the point C to the point E, a distance of approximately 50°, is the circumference of the disc of the fan. Taking the actual exemplification, this may be a radius of 5". The part 25 on the leading edge, extending from the point C to the point D, is on a much less radius, for example 1$\frac{7}{32}$". The part 26 of the inner edge from the point D to the point approximately O" is on a radius of 3¾", following the example given. That part 27 of the outer edge on the trailing end of the fan, extending from the point E to the point F, a distance of approximately 65°, is on a radius of 2$\frac{13}{32}$". The inner edge 28 of the fan extending from the trailing tip F to the point O" is cut to fit the cup member 14 when the fan blade is attached, as explained, that is along a uniform helix.

It will be observed, therefore, that the outer edge of the blade is convex from the leading extremity to the trailing tip, including a substantial part in both the leading end and the trailing end, that is the same curvature as the circumference of the fan disc. The inner edge from the leading extremity to the trailing tip extends continuously forwardly and inwardly with reference to the axis of revolution throughout its entire length. Of the inner edge one part, which is approximately that adjacent the leading end, is convex, and the other part, which is adjacent the trailing end, is concave and contacts, or follows, the contour of the hub cup.

The helix in the example given is on a 9" pitch. That is to say, for each 10° the blade advances one quarter inch in an axial direction. Thus, the trailing tip F, being 35° in advance of the line O—O' is 2⅛" forwardly of that line. The leading edge D, being 49° rearwardly from the line O—O', is 1¼" (almost) behind that line, and the blade extends, therefore, a distance of 3⅜" (almost) axially from the leading edge to the trailing tip.

The fan is attached to the cup 14 by means of a flange 29, integral with the fan blade, which is secured to the cup 14 by rivets 30. A lug 31 which fits in an appropriate socket in the cup 14 serves to hold the trailing tip in position and prevents its vibration.

It will be understood that where specific dimensions and specific degrees of curvature are mentioned they are mentioned only for the purpose of exemplification and explanation, and the invention is not to be limited to any precise dimensions or curvatures. These dimensions, of course, must be varied for different sizes of propellers, and the dimensions and curvatures will be varied where the number of fan blades employed differ from that shown in the specific embodiment. Furthermore, the structure may be varied in some respects and degrees without materially changing the result, and otherwise to secure additional or modified results. Such modifications, within the scope of the appended claims, are contemplated and are within the spirit of this invention.

I claim:

1. In a fan, a plurality of blades, each lying along a uniformly developed helix about the axis of rotation and having its effective surface formed on radial lines extending from and perpendicular to the axis of rotation, the combined area of the blades being at least equal to the disc area of the fan.

2. A fan blade having a leading extremity a substantial distance from the axis of rotation and a trailing tip close to said axis, and an inner edge extending forwardly with respect to the front of the fan and inwardly with reference to its axis of rotation from its leading extremity to its trailing tip, having an arcuate dimension measured in a plane perpendicular to its axis at least greater than 90°.

3. In a fan, a plurality of blades having a leading extremity a substantial distance from the axis of rotation, and a trailing tip close to said axis, and each having a convex outer edge extending from its leading extremity to its trailing tip and having an inner edge extending forwardly with respect to the front of the fan and inwardly with reference to its axis of rotation from the leading extremity to the trailing tip, the combined area of the blades being at least equal to the disc area of the fan.

4. A fan blade of a configuration lying along a helix about its normal axis of rotation having a leading end and a trailing end with the inner edge of the trailing end extending continuously forwardly with respect to the front of the fan and inwardly with reference to its axis of rotation, having its outer edge convex from its leading extremity to its trailing tip.

5. A fan blade having a leading end and a trailing end with the inner edge of the leading end convex and the inner edge of the trailing end concave to extend from the leading extremity forwardly with respect to the front of the fan and inwardly with reference to the axis of rotation, the convex portion and the concave portion meeting and extending from the leading extremity of the blade to the trailing tip.

6. A fan blade having a leading end and a trailing end with the inner edge of the leading end convex and the inner edge of the trailing end concave to extend from the leading extremity forwardly with respect to the front of the fan and inwardly with reference to the axis of rotation, the convex portion and the concave portion meeting and extending from the leading extremity of the blade to the trailing tip, and having an outer edge convex from the leading extremity to the trailing tip.

7. In a fan, a hub cup having a convex surface converging forwardly, and a plurality of fan blades attached to the cup, each having its trailing end contiguous to the convex surface for a substantial distance, extending forwardly and inwardly along said surface with reference to the axis of rotation, and having its leading end free and extending rearwardly from the rear edge of the cup.

8. In a fan, a hub cup having a surface converging inwardly and forwardly from its rim with reference to the axis of rotation, and a plurality of blades attached to said cup, each lying along a uniformly developed helix and having an inner edge contiguous to said surface for a substantial distance, and terminating close to the axis of rotation.

9. In a fan, a hub cup having a surface converging inwardly and forwardly with reference to the axis of rotation, and a plurality of blades attached to said cup, each having a leading end and a trailing end with the inner edge of the trailing end contiguous to said converging surface and its leading end extending rearwardly beyond said cup over a substantial portion of the motor frame.

10. In a fan, a hub cup having a surface converging inwardly and forwardly with reference to the axis of rotation, and a plurality of blades attached to said cup, each having a leading end and a trailing end with the inner edge of the leading end convex and the inner edge of the trailing end concave and in conformity with the surface of the cup to which it is contiguous, the convex portion and the concave portion meeting and extending from the leading extremity of the blade to the trailing tip, the combined area of the blades being at least equal to the disc area of the fan.

11. In a fan, a hub cup having a surface converging inwardly and forwardly with reference to the axis of rotation, and a plurality of blades attached to said cup, each lying along a uniformly developed helix and each having a trailing end with a concave inner edge contiguous to said converging surface for a substantial distance, the combined area of the fan blades being at least equal to the fan disc.

12. In a fan, a hub cup having a surface converging inwardly and forwardly with reference to the axis of rotation, and a plurality of blades attached to said cup, each having a trailing end with a concave inner edge contiguous to said converging surface for a substantial distance adjacent the trailing edge, lying along a uniformly developed helix, and having its effective surface coinciding with lines radial from and perpendicular to the axis of rotation, the combined area of the fan blades being at least equal to the disc area of the fan.

13. In a device of the kind described, a motor, an impeller, a cup-like element the open end of which extends over the motor, and said element being rotated by said motor, the impeller being mounted on the cup-like element, extending a predetermined axial distance therealong, and projecting beyond an axial limit of said cup-like element.

14. In a device of the kind described, a motor, an impeller, a hollow hub element rotated by said motor, the motor extending into the hollow portion, impeller blades mounted on said hub, and each extending from a point thereon remote from motor end thereof backwardly toward the motor, and the extremity thereof projecting beyond the hub element and over the motor.

15. In a fan, a motor, a hub extending over said motor, a helical blade on said hub, said blade having a leading end projecting from said hub back over the motor, and a trailing edge extending forwardly along the hub.

16. A fan impeller including a hub and a blade, the blade extending rearwardly and outwardly from said hub to a leading point, thence forwardly and outwardly from said leading point to a given point, whereby to define a leading end of substantial peripheral extent having a convex leading edge, and the trailing end being formed of a spiral originating approximately at the axis and extending out to the maximum radial dimension of the blade.

17. A fan including a hub, four blades mounted

on said hub, said blades each lying along a helix about the axis of rotation of the hub, and the combined area of the blades being substantially equal to the disc area of the fan.

18. A fan including a hub having a surface converging toward the axis of rotation, four helicoidal blades on said hub, the combined area of the blades being substantially equal to the disc area of the fan, and one end of each blade following the contour of the hub and terminating close to the axis of rotation.

19. In a fan, a plurality of blades, each lying along a helix about the axis of rotation and having its effective surface formed on radial lines extending from the axis of rotation, the combined area of the blades being at least equal to the disc area of the fan.

VICTOR WEBER.