Fig. 14.

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This invention relates to a propeller for propelling a fluid relatively forwardly.

One of the features of this invention is the provision of an improved propeller for more efficiently propelling a fluid, such as air, in a relatively forward direction to provide a more uniform volume of fluid flow and a deeper fluid beam penetration; another feature of the invention is the provision of such a propeller including a plurality of blades operably attached around a mounting member and an annular ring substantially concentric with the axis of rotation of the mounting member and blades and mounted for rotation with the blades, this ring being located at the rear of the blades and preferably adjacent the leading edges of the blades, and the rear surface of the ring being sloped inwardly and forwardly; still another feature of the invention is the provision of such a propeller wherein the blades are located substantially entirely beyond the periphery of the mounting member and have their trailing edges approximately aligned with the mounting member and their leading edges spaced rearwardly thereof; another feature of the invention is the provision of such a propeller wherein said annular ring is located adjacent the innermost portions of the leading edges of the blades and the rear surface of the ring is curved inwardly and forwardly with the outer edge portion of this curved surface being substantially radial; yet another feature of the invention is the provision of a propeller having a plurality of blades operably attached around a mounting member with each of the trailing edges of the blades having a convex portion of a relatively small radius at the outer end thereof, a concave portion located inwardly of the convex portion and a second convex portion located inwardly of the concave portion and adjacent the inner end of said trailing edge with the second convex portion extending beyond a radial line passing through the extreme tip of the first convex portion; another feature of the invention is the provision of such a propeller wherein each leading edge has a convex portion at the outer end thereof and a concave portion located inwardly of the convex portion, with the convex portion extending beyond a radial line passing through the outermost part of the concave portion; a further feature of the invention is the provision of such a propeller wherein the convex portion of the leading edge of a blade is located opposite the concave portion of the trailing edge of the adjacent blade when viewed from the front and the concave portion of the leading edge is similarly located opposite the second convex portion of the trailing edge; a still further feature of the invention is the provision of such a propeller wherein the leading edge of one blade is spaced from the adjacent trailing edge of the next blade when the blades are arranged at zero pitch; another feature of the invention is the provision of a propeller comprising a plurality of blades operably attached around a rotatable mounting member with the total number of blades being an odd number; a further feature of the invention is the provision of a propeller having a plurality of blades operably attached around a rotatable mounting member with the propeller having a plurality of balancing members spaced around the propeller with each of the balancing members being connected to the propeller through a relatively fragile portion to permit ready removal of a balancing member to achieve balance in the propeller; another feature of this invention is the provision of an improved flexible mounting means for a propeller. Other features and advantages of the invention will become apparent from the following description when considered with the accompanying drawings. Of the drawings:

Fig. 1 is a front elevational view of a propeller embodying the present invention.

Fig. 2 is a side elevational view of the propeller of Fig. 1 and showing a motor for use in driving the propeller.

Fig. 3 is a fragmentary front elevational view of a portion of the propeller illustrating the relative areas of the blades and the spaces between adjacent blades.

Fig. 4 is a rear elevational view of the propeller of Figs. 1 and 2.

Fig. 5 is a semi-diagrammatic side elevational view of a propeller embodying the invention.

Fig. 6 is a fragmentary side elevational view partially in section showing a second embodiment of the invention.

Fig. 7 is an elevational view of a stamped metal blank used in making a third embodiment of the invention.

Fig. 8 is a front elevation of a propeller, partially broken away, constructed from the blank of Fig. 7.

Fig. 9 is a rear elevational view partially broken away of the propeller of Fig. 8.

Fig. 10 is a side elevational view of the propeller of Figs. 8 and 9.

Fig. 11 is a fragmentary side elevational view partially in section showing another embodiment.
of the invention and the preferred structure for attaching a propeller to a shaft.

Fig. 12 is a front elevational view partially broken away of the embodiment of Fig. 11.

Fig. 13 is a side elevation of the propeller of Fig. 12 and showing a motor for driving the propeller.

Fig. 14 is a rear elevational view, partially broken away, of the embodiment of Fig. 11.

The propeller shown in Figs. 1 to 4, inclusive, comprises a rotator member 20 in the form of a sheet metal disc, a plurality of blades 21 substantially equally spaced therearound and an annular ring 22 serving as a Venturi ring and spaced rearwardly of the mounting member 20 and adjacent the leading edges 2ia of the blades. In the embodiment of Figs. 1 to 4 the mounting member disc 20 also serves as a spider for mounting the blades 21. This mounting member 20 is substantially equally spaced around the perimeter of the mounting member. As shown in Fig. 4, these arms 20b are each of substantially L-shape with the short leg of the L being preferably integral with the mounting member 20 and the long leg extending substantially parallel to the periphery of the mounting member. Each arm 20b lies in a single plane and stands substantially at a desired angle with respect to the axis of rotation of the propeller. Each arm 20b is used for mounting a blade 21. The blade may be attached to the arm by means of rivets 23, soldering or the like. Although the arms 20b are preferably integral with the mounting disc 20, they also may be attached by rivets and the like.

The annular Venturi ring 22, as shown in Fig. 2, is attached to the inner ends of the leading edges 2ia of the blades 21. The annular Venturi ring 22, which is substantially concentric with the axis of rotation of the propeller, has an outer diameter that is preferably not substantially greater than the diameter of the mounting disc 20 and that is substantially concentric therewith. The ring may be attached to the blades 21 by means of rivets 24 or the like. These rings are of sufficient size to give rigidity to the blades 21 and the annular Venturi ring 22 also adds rigidity to the blades at the leading edges thereof. The blades 23 are inclined in the same direction with respect to the axis of rotation of the propeller and are preferably arranged at substantially the same pitch. A motor 25 may be used for rotating the propeller. This motor is preferably arranged behind the mounting disc 20 and within the annular ring 22.

As shown in Fig. 3, the leading edge 2ia of a blade is spaced from the trailing edge 2ib of the next blade. This total spacing, as indicated at 26, should be at least 10% of the total disc area. This spacing will, of course, depend upon the pitch of the blades. Even when the blades are arranged at zero pitch, however, the leading and trailing edges are spaced from each other a substantial distance over their entire length. As shown diagrammatically in Fig. 5, each blade 21 is substantially planar over its entire length and width.

Each trailing edge 2ib is provided with a convex portion 2ic of a relatively small radius at the outer end thereof, a concave portion 2id located inwardly of the convex portion and a second convex portion 2ie located inwardly of the concave portion 2id. This second convex portion 2ie extends beyond a radial line passing through the extreme tip of the first convex portion 2ic. The convex and concave portions 2ic, 2id and 2ie blend smoothly into each adjacent portion to provide a smooth curve. The concave portion 2id has an average radius of curvature that is greater than the average radius of curvature of the convex portion 2ie. The second convex portion 2ie has an average radius of curvature greater than the average radius of curvature of the concave portion 2id. Each of the portions 2ic, 2id and 2ie have gradually decreasing radii of curvature when progressing from the outer end to the inner end of each portion.

Each leading edge 2ia has a convex portion 2ia at the outer end thereof and a concave portion 2ig located inwardly of the convex portion. The convex portion 2ia extends beyond the radial line passing through the outermost part of the concave portion 2ig. The convex and concave portions blend smoothly into each other to form a smooth curve. The average radius of the concave portion 2ia is greater than the average radius of the convex portion 2iia. The radii of curvature of each of the concave and convex portions 2ia and 2ig gradually decrease as progressing from the outer to the inner end of each portion.

When the blades are assembled, as shown in the drawings, the convex portion 2ia of the leading edge be bent to a desired angle with respect to the axis of rotation of the propeller. Each arm 20b is used for mounting a blade 21. The blade may be attached to the arm by means of rivets 23, soldering or the like. Although the arms 20b are preferably integral with the mounting disc 20, they also may be attached by rivets and the like. The annular Venturi ring 22, as shown in Fig. 2, is attached to the inner ends of the leading edges 2ia of the blades 21. The annular Venturi ring 22, which is substantially concentric with the axis of rotation of the propeller, has an outer diameter that is preferably not substantially greater than the diameter of the mounting disc 20 and that is substantially concentric therewith. The ring may be attached to the blades 21 by means of rivets 24 or the like. These rings are of sufficient size to give rigidity to the blades 21 and the annular Venturi ring 22 also adds rigidity to the blades at the leading edges thereof. The blades 23 are inclined in the same direction with respect to the axis of rotation of the propeller and are preferably arranged at substantially the same pitch. A motor 25 may be used for rotating the propeller. This motor is preferably arranged behind the mounting disc 20 and within the annular ring 22.

As shown in Fig. 3, the leading edge 2ia of a blade is spaced from the trailing edge 2ib of the next blade. This total spacing, as indicated at 26, should be at least 10% of the total disc area. This spacing will, of course, depend upon the pitch of the blades. Even when the blades are arranged at zero pitch, however, the leading and trailing edges are spaced from each other a substantial distance over their entire length. As shown diagrammatically in Fig. 5, each blade 21 is substantially planar over its entire length and width.
the blade. The inner extended area, indicated by the second convex portion 21e, serves to compensate for the lesser lineal velocity of this portion of the blade so that the velocity of air or other fluid contacted by this portion of the blade will be substantially equal to the velocity of the air on the outer portions of the blade. Thus the particular curvature of the trailing edge of each blade shown and described herein provides a substantially uniform velocity in the fluid, such as air, over substantially the entire blade area. Their uniform velocity materially reduces the friction losses and eddy currents created by the ordinary fluid propellers and produces a greater volume of flow for any given propeller. All these effects combine to create a propeller having a higher efficiency of operation and that is very quiet.

The leading edge 21e of each blade is provided with a tip having an average radius of curvature appreciably greater than the average radius of curvature of the tip 21c of the trailing edge. This leading edge tip, as indicated by the convex portion 21f, serves to provide airflow across the revolving blades. The trailing edge of one blade and the leading edge of the next blade cooperate with each other to propel the fluid at substantially uniform velocity as has been described.

Each blade is made substantially planar over its entire width and length as indicated at Fig. 5. These planar blades serve to increase the efficiency of the propeller still further and reduce the tendency toward forming eddy currents with their resulting noise. The planar blades also require less power than equivalent blades of curved shape. The rotating annular Venturi ring 22, which is preferably fixed to the leading edge of the blade, cooperates with the external trailing tip 21c to produce a centrifugal force effect directing the air outwardly against the blades. This rotating ring avoids the eddy currents which occur when a non-rotating ring is employed. The ring also serves to reduce further the noise in the propeller as it aids in guiding the air substantially uniformly in an outward direction against the full areas of the blades. The ring also directs the fluid over a motor 25 located within the ring and thus cools the motor so that it operates more efficiently. The rotating ring eliminates the necessity of providing guiding vanes for forcing air outwardly against the blades and serves, in the preferred embodiment, as a blade support for giving greater rigidity to the blades. The rotating Venturi ring 22 cooperates with the mounting disc 26 to aid the centrifugal blower action in forcing air outwardly behind the disc and against the blades. This provides a positive outward pressure and the combination cooperates with the blades, particularly at the trailing edges thereof, to avoid vortexing at the outer edges of the blades. This avoidance of vortexing reduces materially the noise, increases the efficiency of the propeller and reduces potential power losses.

The mounting disc 20, which is preferably made of slight cup shape with the convex surface on the side opposite the blades 21, is preferably of relatively large diameter as shown in the drawings. This mounting disc prevents the return of air at the center of the propeller when the propeller is operated. This prevention is especially important when the propeller is operating against a relatively high pressure, or static resistance, such as when forcing air through a ventilator. The mounting disc also results in a strong sturdy propeller which is of especial importance in high speed propellers. The combination of the disc and the blades having the particular shapes described herein also produces a very pleasing appearance.

The new propeller is extremely quiet without sacrificing efficiency. When used in cooling a space such as a room, the propeller provides a smooth flow of air in large volume. The area that is cooled is extremely large as the air expands as it flows from the propeller. The propeller may be used in a deck fan as it provides a large amount of air at relatively low velocity pressure and thus provides a cooling effect without creating excessively strong drafts. The spacing that is provided between the leading edge of one blade and the trailing edge of the next blade cooperates with the rotating Venturi ring to draw air or other fluid from the back of the propeller over its entire diameter. This arrangement and operation assures no loss in fluid attraction and provides a cooling fluid flow over the motor.

The propeller is preferably provided with a plurality of balancing members spaced around the propeller with each of these balancing members being connected to the propeller through a relatively fragile portion to permit ready removal of one or more balancing members in order to achieve balance in the propeller. As shown in Fig. 4, these balancing members comprise a small portion of metal 27 connected to an arm 28 through a thin neck portion 27a. It is preferred that these portions of metal be provided in clusters as shown. In the embodiment of Fig. 4, there are two of these portions provided at the extreme end of each arm 20. In balancing the propeller, one or more of these portions 27 may be broken off at the neck portion 27a.

In order to rotate the propeller the center of the rotatable mounting disc 26 is provided with a hole in which is clamped or otherwise attached a shaft 28. This shaft may be directly connected to the motor shaft as shown in Fig. 2. In the embodiment shown in Fig. 6, the motor 26 is located in front of the rotatable mounting member disc 120. This disc, as shown, has a curvature opposite to that of the mounting disc 20.

In the embodiment shown in Figs. 7 to 10, inclusive, the propeller is of relatively small diameter and the mounting disc and blades are made in one piece. In Fig. 7 there is shown the blank for making the propeller. This blank is formed from a flat sheet that is punched and sheared, as indicated, to make the mounting disc 220 and blades 221. Adjacent the inner end of each trailing edge of a blade there is provided a small portion of metal 227 which serves as a balancing member, as previously described. In constructing the propeller from the blank shown in Fig. 7, the mounting disc is given a slight cup shape so as to have a form similar to the disc 20 shown in the first embodiment and the blades 221 are bent back behind the disc 220 to the desired pitch. The leading edges of the blades are then attached as by riveting to an annular Venturi ring 222, as shown in Figs. 8, 9 and 10. The Venturi ring 22 serves to support the leading edges of the blades and give rigidity to the entire structure.

In the embodiment shown in Figs. 11 to 14, inclusive, the blades 231 are stamped individually from a sheet of metal and have their trailing edges attached to the mounting member disc 320 by small rivets 29 or the like. The trailing edge
of each disc near the inner end thereof is provided with a plurality of small portions 321 of metal serving as balancing members. The first portion is attached through a reduced neck portion 327a to the main body of the blade. The next portions are preferably attached through a reduced neck to the portion of metal preceding it as shown in Fig. 12. Although only two portions 327 of metal are shown, it is obvious that more than two or one only could be provided if desired. The leading edge of each portion is attached to an annular Venturi ring 22 by a rivet 30 or the like. The ring 22 serves to support the leading edges of the blades and to give rigidity to the entire assembly.

As shown in Fig. 11, the propeller is preferably mounted on the motor shaft by means of a resilient mounting. As shown, the mounting for the propeller comprises a tubular member 31 of relatively large diameter that may be attached directly to the shaft of the motor 25. This tubular member has an outer end 31a of expanded diameter and has an outer surface of a contour substantially the same as the contour of the inner surface of the mounting disc 320 adjacent the center thereof. The mounting member 31 is provided with an axial threaded hole at the outer end thereof which is adapted to receive the threaded bolt end of a cap member 32. This cap member has an expanded head 32b of substantially the same diameter as that of the outer end 31a of the tubular member 31. This expanded head 32b is provided with an annular recessed portion 32b at the inner surface thereof extending around the threaded portion of the cap member. This annular recessed portion 32b provides space for containing an outwardly turned flange 320a around an opening in the mounting disc 320 through which the cap member 32 extends. Sheets 33 and 34 of rubber or other resilient material are provided on either side of the mounting disc 320 and are compressed between the tubular member 31 and the cap member 32.

In the new propeller it is preferred that an odd number of blades greater than one be provided. When a fan having an even number of blades is employed on alternating current, the alternating sine wave of the current sets up a synchronous resonance in the propeller. Alternating propellers having an even number of blades are satisfactory for direct current, when the blades total an odd number the propeller may be used on either direct or alternating current without being subject to this synchronous resonance.

Having described my invention in considerable detail as related to several embodiments of the same, it is my intention that the invention be not limited by these details but rather be construed broadly within its spirit and scope as set out in the accompanying claims.

I claim:

1. A propeller for propelling a fluid relatively forwardly comprising: a rotatable mounting member of relatively large diameter; a plurality of blades having their trailing edges attached to said mounting member and spaced rearwardly thereof, said blades being located radially beyond the mounting member and inclined in the same direction with respect to the axis of rotation of said mounting member; and an annular ring substantially concentric with said axis and blade is attached by said blades, said ring being located inwardly of but adjacent to the innermost portions of the leading edges of said blades, and the rear surface of said ring being sloped inwardly and forwardly toward the axis of rotation.

2. A propeller for propelling a fluid relatively forwardly comprising: a rotatable mounting member of relatively large diameter; a plurality of blades having their trailing edges attached to said mounting member and spaced rearwardly thereof, said blades being located radially beyond the mounting member and inclined in the same direction with respect to the axis of rotation of said mounting member; and an annular ring substantially concentric with said axis and blade is attached by said blades, said ring being located inwardly of but adjacent to the innermost portions of the leading edges of said blades, and the rear surface of said ring being sloped inwardly and forwardly toward the axis of rotation.

3. A propeller for propelling a fluid relatively forwardly comprising: a rotatable mounting member of relatively large diameter; a plurality of blades having their trailing edges attached to said mounting member and their leading edges spaced rearwardly thereof, said blades being located radially beyond the mounting member and inclined in the same direction with respect to the axis of rotation of said mounting member; and an annular ring substantially concentric with said axis and blade is attached by said blades, said ring being located inwardly of but adjacent to the innermost portions of the leading edges of said blades, and the rear surface of said ring being sloped inwardly and forwardly toward the axis of rotation.

4. A propeller for propelling a fluid relatively forwardly comprising: a rotatable mounting member; a plurality of blades having leading and trailing edges and oppositely attached around said mounting member and inclined in the same direction with respect to the axis of rotation of said mounting member, each of said trailing edges having a relatively small radius at the outer end thereof, a concave portion located inwardly of said convex portion and a second convex portion located inwardly of said convex portion and adjacent the inner end of said trailing edge, said second convex portion being a radial line passing through the extreme tip of said first convex portion, each of said concave and convex portions blending smoothly into each adjacent portion, each of said leading edges having a convex portion at the outer end thereof and a concave portion located inwardly of said convex portion, said convex portion extending beyond a radial line passing through the outermost part of said concave portion, and said convex and concave portions forming a smooth curve on said leading edge, said convex portion of the leading edge being located opposite the concave portions of the trailing edge and having an average radius of curvature less than that of said concave portion and the concave portion of the leading edge being located opposite the second convex portion of the trailing edge and having an average radius of curvature smaller than that of said convex portion.

5. A propeller for propelling a fluid relatively forwardly comprising: a rotatable sheet metal mounting member disc; a plurality of blades located radially beyond the mounting member and having their trailing edges attached to said mounting member and their leading edges spaced
rearwardly thereof, said blades being inclined in the same direction with respect to the axis of rotation of said mounting member and being located substantially entirely beyond the periphery of said mounting member; and an annular ring substantially concentric with said axis and mounted for rotation with said blades, said ring being located inwardly of but adjacent to the leading edges of said blades and having its rear surface sloped inwardly and forwardly, each of said trailing edges having a convex portion of a relatively small radius at the outer end thereof, a concave portion located inwardly of said convex portion and a second convex portion located inwardly of said concave portion and adjacent to the inner end of said trailing edge, said second convex portion extending beyond a radial line passing through the extreme tip of said first convex portion, each of said concave and convex portions blending smoothly into each adjacent portion, each of said leading edges having a convex portion at the outer end thereof and a concave portion located inwardly of said convex portion, said convex portion extending beyond a radial line passing through the outermost part of said concave portion, and said convex and concave portions forming a smooth curve on said leading edge, said convex portion of the leading edge being located opposite the concave portion of the trailing edge and having an average radius of curvature less than that of said concave portion, and the concave portion of the leading edge being located opposite the second convex portion of the trailing edge and having an average radius of curvature smaller than that of said convex portion.

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