June 23, 1936. G. S. FABER 2,045,383

PROPELLER

Filed April 11, 1934 2 Sheets-Sheet 1

Fig. 1.

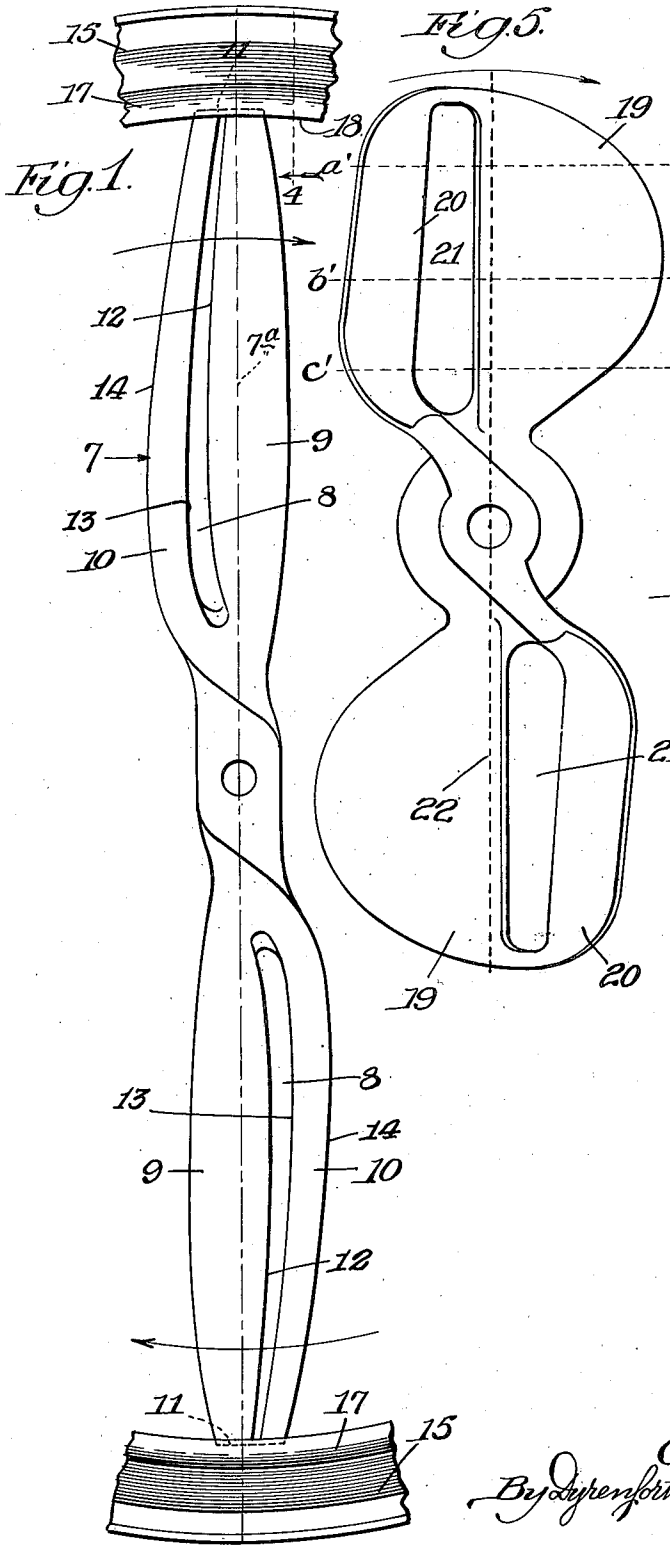


Fig. 5.

Fig. 6.

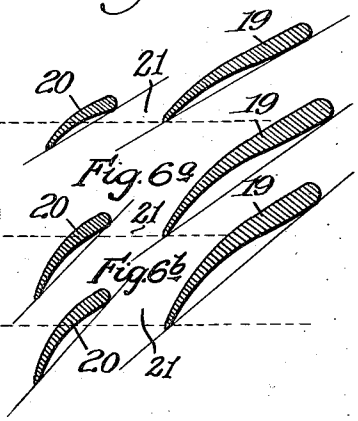
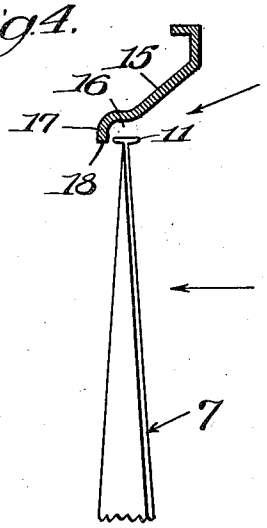


Fig. 6a

Fig. 6b

Fig. 4.



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PROPELLER

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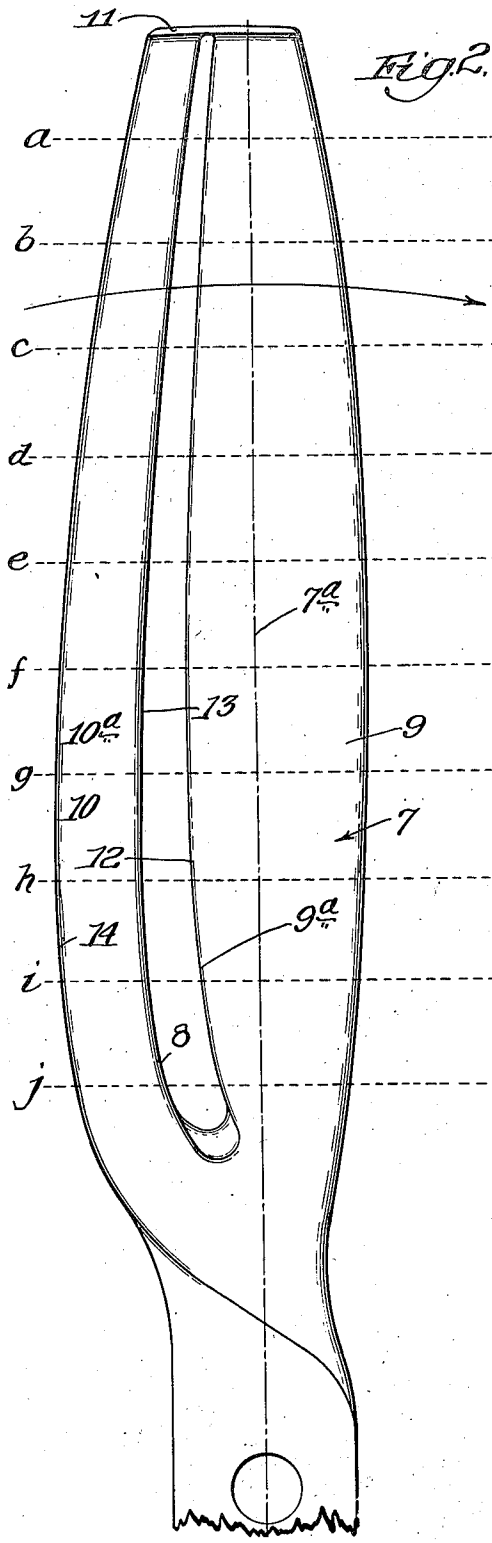
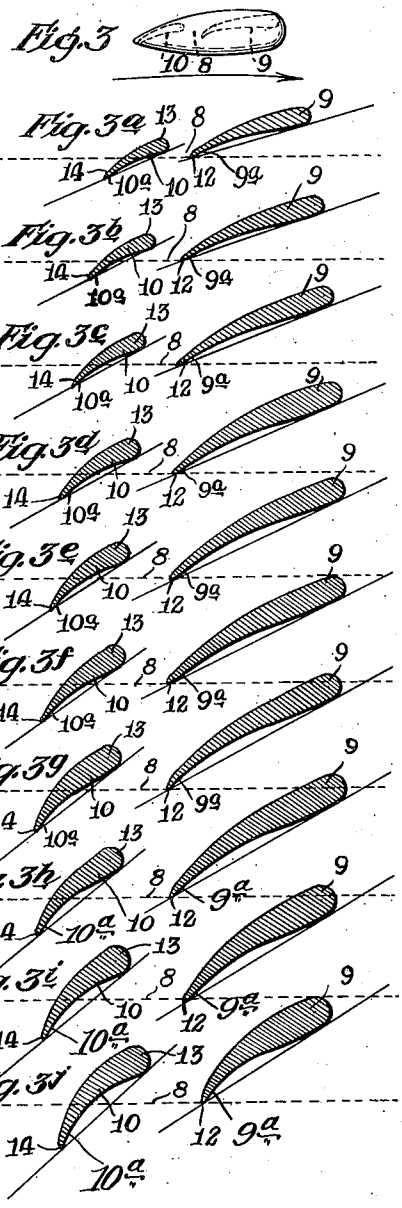


Fig. 2.



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Patented June 23, 1936 2,045,383

UNITED STATES PATENT OFFICE

2,045,383

PROPELLER

Guy S. Faber, Chicago, Ill., assignor to General Regulator Corporation, Chicago, Ill., a corporation of Illinois

Application April 11, 1934, Serial No. 720,127

34 Claims. (Cl. 170—172)

My invention relates to propellers for use as for example as fans, agitators or propellers for boats or aerial craft, and formed of blades radiating from the axis of the propeller-device.

My present invention as to certain phases thereof constitutes an improvement in the construction of device shown and described in my application for United States Letters Patent Serial No. 473,988, filed August 8, 1930, and certain of my objects, generally stated, are to increase the efficiency of such devices whereby a propeller of a smaller size and requiring less power for its operation, may be utilized than heretofore required; to provide a propeller which will be non-overloading regardless of the static pressure against which the propeller operates; to reduce vortexing, or negative end flow, of the air at the tips of the blades; and other objects as will be manifest from the following description.

Referring to the accompanying drawings:

Figure 1 is a front view of a propeller-device shown as a fan, and embodying my invention, portions of the shrouding element for the propeller and forming a part of the particular construction illustrated being shown as broken away.

Figure 2 is an enlarged, similar, view of one of the similar blades of the propeller.

Figure 3 is a plan view of the outer end of the blade.

Figs. 3ª to 3ʲ, inclusive, are plan sections taken at the lines *a* to *j*, inclusive, on Fig. 2.

Figure 4 is a fragmentary section taken at the line 4 on Fig. 1 and viewed in the direction of the arrow.

Figure 5 is a front view of a propeller embodying my invention for use as an agitator or propeller for boats; and—

Figures 6, 6ª and 6ᵇ, plan sections taken at the lines *a'*, *b'* and *c'* respectively on Fig. 5.

Referring to the particular embodiment of my invention illustrated in Figs. 1, 2, 3, 3ª–3ʲ inclusive, and 4 the propeller shown is of the substantially radial two-blade type, though the invention may be embodied in a propeller the number of blades of which may be greater than shown.

The blades of the propeller, represented at 7, are inclined, or pitched, at an angle to their plane of rotation in the usual manner.

Each blade 7, as illustrated, contains an opening 8, shown as a slot extending generally lengthwise thereof substantially throughout the length of the blade, the major portion of each blade and its slot lying to the rear of the direction of rotation of the line radial to the shaft axis which is common to the two opposed blades, this line being represented at 7ª.

Each blade is thus caused to comprise a main, leading, blade section 9 and a trailing, narrower, blade section 10, these blade-sections, which are preferably of streamline form as shown, being so relatively disposed that in acting on the fluid a suction action is produced at the slot 8 operating to draw the fluid through the slot from the rear to the front of the blade.

Each of the blade sections 9 and 10 throughout substantially its entire length tapers toward its tip and the adjacent edges of the blade sections 9 and 10 converge toward the tip of the blade, causing the slot 8 to become gradually narrowing in the plane of the rotation of the propeller, as represented, the tips of the sections 9 and 10 being connected together by a thin streamlined connector portion 11.

The trailing edge 12 of the leading blade section 9 is shown as disposed forwardly, (viewing the propeller from the front thereof as in Fig. 1) of the leading edge 13 of the trailing blade section 10 throughout the length of these blade-sections and to effect the maximum suction action at the slot 8 the edge 12 and the trailing edge 14 of the trailing blade section 10 are deflected more or less sharply in a forward direction as shown in Figs. 3ª to 3ʲ, inclusive, preferably along curved lines to cause the front faces of the blade sections to be of cupped form and present the forwardly extending deflector surfaces 9ª and 10ª, respectively.

Each blade sections 9 and 10 presents a gradual twist from its tip, at which its front face extends at a comparatively sharp angle to the path in which the propeller rotates, toward its inner end at which its face extends at a much greater angle to said plane, as illustrated in Figs. 3ª to 3ʲ, inclusive, the progressive twist of the blade section 10 being of greater degree than that of the blade section 9 as shown in these figures.

Furthermore the blade sections 9 and 10 are so shaped and disposed that the distance, from front to rear, between the trailing edge 12 of the leading blade section 9 and the leading edge 13 of the trailing blade section 10 progressively increases from the tip of the blade to the inner end thereof, whereby these edges converge toward the tip of the blade in the direction of the plane of the axis of the propeller, and the cupping of each blade-section is progressively greater from the tip of each blade section toward its inner end, all as clearly shown in Figs. 3ª to 3ʲ, inclusive.

As will be apparent, the provision of the slots

8 between the blade sections 9 and 10 and the positioning of the trailing edge 12 of the leading blade section 9 and the leading edge 13 of the trailing section 10, to occupy the relative positions shown and above described operates, in the rotation of the propeller in clockwise direction in Fig. 2, to produce a great degree of suction at the slots 8 which action on the fluid at the rear of the propeller produces a marked flow of fluid from the rear to the front of the propeller through these slots.

The several above described features of the propeller which individually contribute to the more efficient performance of the device, serve, when combined in a single structure to render the device of maximum effectiveness for its purpose and attaining, in full, certain objects of the invention as above set forth.

Specifically stated some of the resultants from the employment of these features is the compensating for the more rapid rotation of the blade at its outer, than at its inner, end by forming the blade sections of twisted shape as above referred to whereby the portions of the blade sections nearest the center of the propeller extend at a relatively great angle to the plane of rotation of the propeller compared to the relatively slight angle at which the outer ends of these sections extend relative to said plane, all to the end that the blade will be caused to be substantially equally effective throughout its length; and the drawing of the fluid operated on toward the center of the propeller as it flows through the slot 8, with a tendency to pack the fluid at the center of the propeller, due to the location of the slot 8 relative to the line 7^a as shown and described, resulting in the lowering of the noise level when the propeller is operating on gaseous fluid, as for example air, and minimizing slippage and blade-whip.

Another feature of my invention relates to the prevention of vortexing, or negative end flow, at the blade tips of a propeller, of the fluid acted on thereby and in the case of a blade of the slotted suction type the additional prevention of eddying of the fluid acted on by the suction produced at the slots 8 in the blades, thereby to render the suction action of maximum effectiveness. To this end I provide at the tip of each blade the portion shown at 11 which preferably is relatively thin and of streamline form and of considerably greater width than the thickness of the blade at its top to extend in front, and to the rear, respectively, of the blade as shown, and thus laterally of the blade, the portion 11 connecting together the blade sections and permitting of the extending of the slot 8 closer to the tip of the blade, with the desirable stiffness of blade structure, than in the case of a blade having no such connector portion.

The blades preferably have associated therewith a shroud 15 of ring shape tapering toward the rear side of the propeller (Fig. 4). The inner portion of the shroud 15 is annularly internally grooved as represented at 16 to provide an annular inwardly extending flange 17, the opening therethrough, and forming the shroud-inlet, being represented at 18.

The propeller and shroud are so relatively disposed and proportioned as shown that these parts extend concentric with relation to each other and the portions 11 only of the blades extend into the groove 16, the distance from the center of the propeller to the extreme ends of the blade sections being one-half the diameter of the opening 18 and thus the full effectiveness of the action of the blade sections 9 and 10 is utilized.

The construction shown in Figs. 5, 6, 6A and 6B, for operation in liquids, as stated, either as an agitating mixer, a pump or as a means of propelling a boat, embodies certain features of the various blade sections 9 and 10 of the device of the preceding figures, but with certain proportions of the blade sections herein represented at 19 and 20, altered, as shown to adapt the device for more effective action where liquids are to be operated on, the blade sections 19 and 20 to this end being shorter and wider, the slots between the blade sections and represented at 21 wider, and the leading edges of the leading blade sections 19 extending at a greater distance in advance of the line represented at 22, radial to the shaft axis and common to the two opposed blades. In the case of the use of the device as a propeller for a boat vacuum pockets at the rear of the propeller are eliminated thereby resulting in the greater effectiveness of the propeller as a driving means.

While I have illustrated and described certain particular embodiments of my invention I do not wish to be understood as intending to limit it thereto as the same may be variously modified and altered and the invention embodied in other forms of structure without departing from the spirit of my invention.

What I claim as new, and desire to secure by Letters Patent, is:

1. A propeller the blades of which contain openings extending therethrough from the front to the rear of the blades the angles at which the portions of the blades at opposite sides of the openings extend relative to the path of rotation of the propeller progressively decreasing from the inner ends of the blades, to the tips thereof, said blades being so shaped as to create suction through said openings toward the rear of the propeller in the rotation thereof.

2. A propeller the blades of which contain openings therethrough extending from the front to the rear of the blades and generally lengthwise of the blades and substantially to the tips of the blades, said blades being so shaped as to create suction through said openings toward the rear of the propeller in the rotation thereof, and the walls of said openings converging toward the tips of the blades in the plane of rotation of the propeller.

3. A propeller the blades of which contain openings therethrough extending from the front to the rear of the blades and generally lengthwise of the blades and substantially to the tips of the blades, said blades being so shaped as to create suction through said openings toward the rear of the propeller in the rotation thereof, and the trailing edges of the portions of the blades in advance of the openings therein and the leading edges of the portions of the blades at the other sides of the openings converging from the inner ends of the blades toward the tips thereof in the direction of the plane of the axis of rotation of the propeller.

4. A propeller, the blades of which contain openings therethrough extending generally lengthwise of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein disposed at angles to the plane of rotation of the propeller and operative to produce suction at said open-

ings, the angle at which each deflector surface extends relative to said plane progressively increasing from the tip of the blade toward its inner end.

5. A propeller the blades of which contain openings therethrough extending generally lengthwise of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein operative to produce suction at said openings, and the angles at which the portions of the blades at the opposite sides of the openings extend relative to the path of rotation of the propeller progressively decreasing from the inner ends of the blades to the tips thereof.

6. A propeller the blades of which contain openings therethrough extending generally lengthwise of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein and extending in front of the opposite, leading, edges of the openings substantially throughout the length of the latter and disposed at angles to the plane of rotation of the propeller and operative to produce suction at said openings, the angles at which said deflector surfaces extend relative to said plane progressively increasing from the tips of the blades toward their inner ends.

7. A propeller the blades of which contain openings therethrough extending generally lengthwise of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein operative to produce suction at said openings, and forwardly extending deflector surfaces at the trailing edges of the portions of the blades at the opposite edges of the openings, said deflector surfaces extending at angles to the plane of rotation of the propeller, the angles at which said first-named deflector surfaces extend relative to said plane progressively increasing from the tips of the blades toward their inner ends.

8. A propeller the blades of which contain openings therethrough extending generally lengthwise of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein operative to produce suction at said openings, and forwardly extending deflector surfaces at the trailing edges of the portions of the blades at the opposite edges of the openings, said deflector surfaces extending at angles to the plane of rotation of the propeller the angles at which said deflector surfaces extend relative to said plane progressively increasing from the tips of the blades toward their inner ends.

9. A propeller the blades of which contain openings therethrough extending generally lengthwise of the blades the angles at which the portions of the blades at opposite sides of the openings extend relative to the path of rotation of the propeller progressively decreasing from the inner ends of the blades to the tips thereof, and the angles at which the portions of the blades at the trailing sides of the openings extend relative to the path of rotation of the propeller being greater, at all cross sections through the blades, than the angles at which the portions of the blades at the other sides of the openings extend relative to said path.

10. A propeller the blades of which contain openings therethrough extending generally lengthwise of the blades, said openings progressively decreasing in width toward the tips of the blades, the portions of the blades at the opposite sides of the openings tapering toward the tips of the blades and the angles at which they extend relative to the path of rotation of the propeller progressively decreasing from the inner ends of the blades to the tips thereof, the angles at which the portions of the blades at the trailing sides of the openings extend relative to said path being greater, at all cross sections through the blades, than the angles at which the portions of the blades at the other sides of the openings extend relative to said path, the trailing edges of the leading portions of the blades extending, throughout the lengths of said openings, in front of the leading edges, respectively, of the trailing portions of said blades and the trailing and leading edges of each blade converging from the inner end of the blade toward the tip thereof in the direction of the plane of the axis of rotation of the propeller.

11. A propeller the blades of which contain openings therethrough extending generally lengthwise of the blades, said openings progressively decreasing in width toward the tips of the blades, the portions of the blades at the opposite sides of the openings tapering toward the tips of the blades and the angles at which they extend relative to the path of rotation of the propeller progressively decreasing from the inner ends of the blades to the tips thereof, the trailing edges of the blade portions at the leading sides of said openings having forwardly extending deflector surfaces which extend at progressively decreasing angles to said path from their inner ends to the tips of the blades, the angles at which the portions of the blades at the trailing sides of the openings extend relative to said path being greater, at all cross sections through the blades, than the angles at which the portions of the blades at the other side of the openings extend relative to said path, said deflector surfaces extending at their trailing edges throughout the lengths of said openings in front, respectively, of the leading edges of the trailing portions of the blades at the other side of said openings, and said deflector surface and said leading edge of each blade converging from the inner end of the blade toward the tip thereof in the direction of the plane of the axis of rotation of the propeller.

12. A propeller the blades of which contain openings therethrough extending generally lengthwise of the blades, said openings progressively decreasing in width toward the tips of the blades, the portions of the blades at the opposite sides of the openings tapering toward the tips of the blades and the angles at which they extend relative to the path of rotation of the propeller progressively decreasing from the inner ends of the blades to the tips thereof, the angles at which the portions of the blades at the trailing sides of the openings extend relative to said path being greater, at all cross sections through the blades, than the angles at which the portions of the blades at the other side of the openings extend relative to said path, the trailing edges of the leading portions of the blades extending, through the lengths of said openings, in front of the leading edges, respectively, of the trailing portions of said blades and the trailing and leading edges of each blade converging from the inner end of the blade toward the tip thereof in the direction of the plane of the axis of rotation of the propeller, the trailing edges of said trailing portions having forwardly extending deflector surfaces.

13. A propeller the blades of which contain openings therethrough extending generally lengthwise of the blades, said openings progressively decreasing in width toward the tips of the blades, the portions of the blades at the opposite sides of the openings tapering toward the tips of the blades and the angles at which they extend relative to the path of rotation of the propeller progressively decreasing from the inner ends of the blades to the tips thereof, the trailing edges of the blade portions at the leading sides of said openings having forwardly extending deflector surfaces which extend at progressively decreasing angles to said path from their inner ends to the tips of the blades, the angles at which the portions of the blades at the trailing sides of the openings extend relative to said path being greater, at all cross sections through the blades, than the angles at which the portions of the blades at the other side of the openings extend relative to said path, said deflector surfaces extending at their trailing edges throughout the lengths of said openings in front, respectively, of the leading edges of the trailing portions of the blades at the other side of said openings, and said deflector surface and said leading edge of each blade converging from the inner end of the blade toward the tip thereof in the direction of the plane of the axis of rotation of the propeller, the trailing edges of said trailing portions having forwardly extending deflector surfaces.

14. A propeller the blades of which contain openings therethrough extending generally lengthwise of the blades, said openings progressively decreasing in width toward the tips of the blades, the portions of the blades at the opposite sides of the openings tapering toward the tips of the blades and the angles at which they extend relative to the path of rotation of the propeller progressively decreasing from the inner ends of the blades to the tips thereof, the trailing edges of the blade portions at the leading sides of said openings having forwardly extending deflector surfaces which extend at progressively decreasing angles to said path from their inner ends to the tips of the blades, the angles at which the portions of the blades at the trailing sides of the openings extend relative to said path being greater, at all cross sections through the blades, than the angles at which the portions of the blades at the other side of the openings extend relative to said path, said deflector surfaces extending at their trailing edges throughout the lengths of said openings in front, respectively, of the leading edges of the trailing portions of the blades at the other side of said openings, and said deflector surface and said leading edge of each blade converging from the inner end of the blade toward the tip thereof in the direction of the plane of the axis of rotation of the propeller, the trailing edges of said trailing portions having forwarding extending deflector surfaces and said last-named deflector surfaces extending at greater angles to said plane than said first-named deflector surfaces at all cross sections through the blades.

15. A propeller the blades of which contain slots extending generally lengthwise of the blades and from the front to the rear of the blades, the blades being so shaped as to create suction through said slots toward the rear of the propeller in the rotation thereof, said blades having portions at their tips spanning the slots and extending forwardly and rearwardly beyond said slots.

16. A propeller the blades of which contain openings therethrough the angles at which the portions of the blades at opposite sides of the openings extend relative to the path of rotation of the propeller progressively decreasing from the inner ends of the blades, to the tips thereof, said blades being so shaped as to create suction through said openings toward the rear of the propeller in the rotation thereof, said openings lying to the rear of the direction of rotation of the line radial to the shaft axis which is common to the two opposite blades.

17. A propeller the blades of which contain openings therethrough the angles at which the portions of the blades at opposite sides of the openings extend relative to the path of rotation of the propeller progressively decreasing from the inner ends of the blades, to the tips thereof, said blades being so shaped as to create suction through said openings toward the rear of the propeller in the rotation thereof, the major portions of the blades and the openings therein lying to the rear of the direction of rotation of the line radial to the shaft axis which is common to the two opposite blades.

18. A propeller the blades of which contain slots extending from the front to the rear of the blades and generally lengthwise of the blades, the blades being so shaped as to create suction through said slots toward the rear of the propeller in the rotation thereof, said blades having portions adjacent their tips spanning the slots and extending angularly relative to, and beyond, faces of said blades generally in a direction lengthwise of the axis about which the propeller rotates.

19. A propeller the blades of which contain slots extending from the front to the rear of the blades and generally lengthwise of the blades, the blades being so shaped as to create suction through said slots toward the rear of the propeller in the rotation thereof, said blades having portions adjacent their tips spanning the slots and connected with the portions of the blades at opposite sides of said slots and extending angularly relative to, and beyond, faces of said blades generally in a direction lengthwise of the axis about which the propeller rotates.

20. A propeller the blades of which contain slots extending from the front to the rear of the blades and generally lengthwise of the blades, the blades being so shaped as to create suction through said slots toward the rear of the propeller in the rotation thereof, said blades having portions adjacent their tips spanning the slots and extending angularly relative to, and beyond, the opposite faces of said blades generally in a direction lengthwise of the axis about which the propeller rotates.

21. A propeller the blades of which contain slots extending from the front to the rear of the blades and generally lengthwise of the blades, the blades being so shaped as to create suction through said slots toward the rear of the propeller in the rotation thereof, said blades having portions adjacent their tips spanning the slots and connected with the portions of the blades at opposite sides of said slots and extending angularly relative to, and beyond, the opposite faces of said blades generally in a direction lengthwise of the axis about which the propeller rotates.

22. In combination, a propeller the blades of

which contain slots extending from the front to the rear of the blades and generally lengthwise of the blades, the blades being so shaped as to create suction through said slots toward the rear of the propeller in the rotation thereof, said blades having portions adjacent their tips spanning the slots and extending angularly relative to, and beyond, faces of said blades generally in a direction lengthwise of the axis about which the propeller rotates, and a ring surrounding the propeller and having an annular groove into which said portions extend.

23. In combination, a propeller the blades of which contain slots extending from the front to the rear of the blades and generally lengthwise of the blades, the blades being so shaped as to create suction through said slots toward the rear of the propeller in the rotation thereof, said blades having portions adjacent their tips spanning the slots and extending angularly relative to, and beyond, the opposite faces of said blades generally in a direction lengthwise of the axis about which the propeller rotates, and a ring surrounding the propeller and having an annular groove into which said portions extend.

24. In combination, a propeller the blades of which adjacent their tips are provided with portions extending angularly relative to, and beyond, faces of said blades generally in a direction lengthwise of the axis about which the propeller rotates, and a ring surrounding the propeller and having an annular groove into which said portions extend and a tapered portion tapering in the direction of flow through the ring and toward said groove.

25. A propeller the blades of which contain openings therethrough extending generally lengthwise of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein operative to produce suction at said openings, the walls of said openings converging toward the tips of the blades in the plane of the rotation of the propeller.

26. A propeller the blades of which contain openings therethrough, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein operative to produce suction at said openings, the angles at which the portions of the blades at opposite sides of the openings extend relative to the path of rotation of the propeller progressively decreasing from the inner ends of the blades to the tips thereof.

27. A propeller the blades of which contain openings therethrough extending generally lengthwise of the blades and substantially to the tips of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein operative to produce suction at said openings, the trailing edges of the portions of the blades in advance of the openings therein and the leading edges of the portions of the blades at the other sides of the openings converging from the inner ends of the blades toward the tips thereof in the direction of the plane of the axis of rotation of the propeller.

28. A propeller the blades of which contain slots extending generally lengthwise of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein operative to produce suction at said openings, said blades having portions at their tips spanning the slots and extending forwardly and rearwardly beyond said slots.

29. A propeller the blades of which contain slots extending generally lengthwise of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein operative to produce suction at said openings, said blades having portions adjacent their tips spanning the slots and extending angularly relative to, and beyond, faces of said blades generally in a direction lengthwise of the axis about which the propeller rotates.

30. A propeller the blades of which contain slots extending generally lengthwise of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein operative to produce suction at said openings, said blades having portions adjacent their tips spanning the slots and connected with the portions of the blades at opposite sides of said slots and extending angularly relative to, and beyond, faces of said blades generally in a direction lengthwise of the axis about which the propeller rotates.

31. A propeller the blades of which contain slots extending generally lengthwise of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein and operative to produce suction at said openings, said blades having portions adjacent their tips spanning the slots and extending angularly relative to, and beyond, the opposite faces of said blades generally in a direction lengthwise of the axis about which the propeller rotates.

32. A propeller the blades of which contain slots extending generally lengthwise of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein operative to produce suction at said openings, said blades having portions adjacent their tips spanning the slots and connected with the portions of the blades at opposite sides of said slots and extending angularly relative to, and beyond, the opposite faces of said blades generally in a direction lengthwise of the axis about which the propeller rotates.

33. A propeller the blades of which contain slots extending generally lengthwise of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein operative to produce suction at said openings, said blades having portions adjacent their tips spanning the slots and extending angularly relative to, and beyond, faces of said blades generally in a direction lengthwise of the axis about which the propeller rotates, and a ring surrounding the propeller and having an annular groove into which said portions extend.

34. A propeller the blades of which contain slots extending generally lengthwise of the blades, said blades having forwardly extending deflector surfaces adjacent the advance edges of the openings therein operative to produce suction at said openings, said blades having portions adjacent their tips spanning the slots and extending angularly relative to, and beyond, the opposite faces of said blades generally in a direction lengthwise of the axis about which the propeller rotates, and a ring surrounding the propeller and having an annular groove into which said portions extend.

GUY S. FABER.