

March 11, 1941.

E. S. PRESTON

2,234,319

FAN BLADE AND HUB ASSEMBLY

Filed Oct. 3, 1936

3 Sheets-Sheet 1

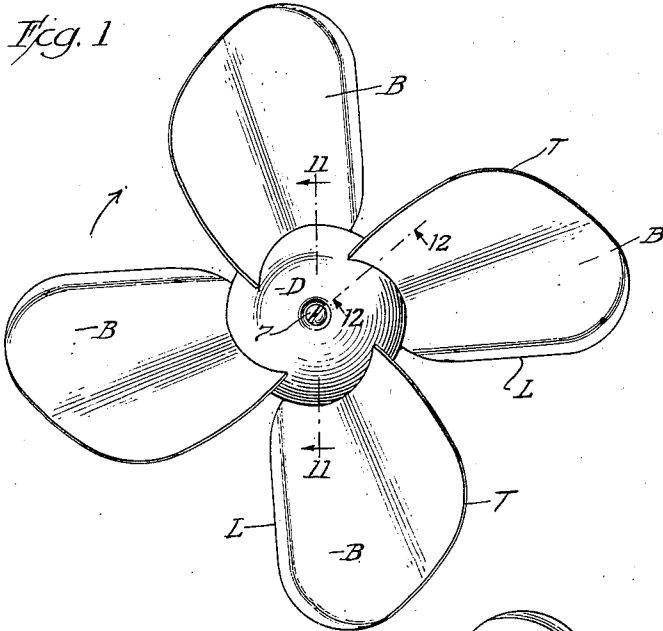


Fig. 2

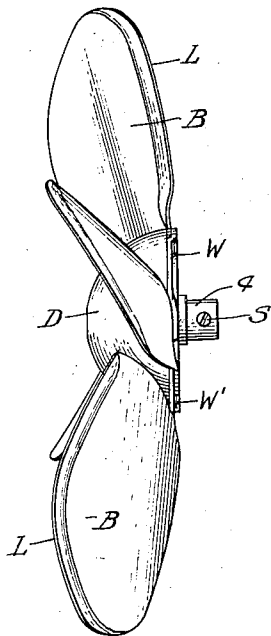
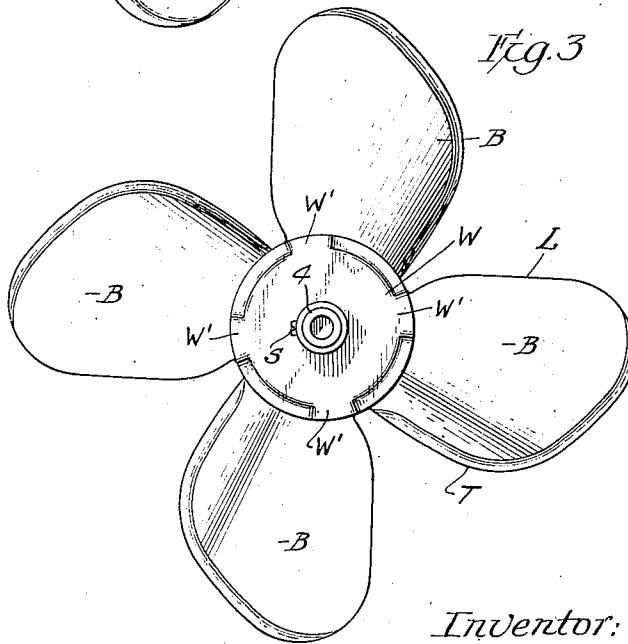


Fig. 3



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3 Sheets-Sheet 2

Fig. 6

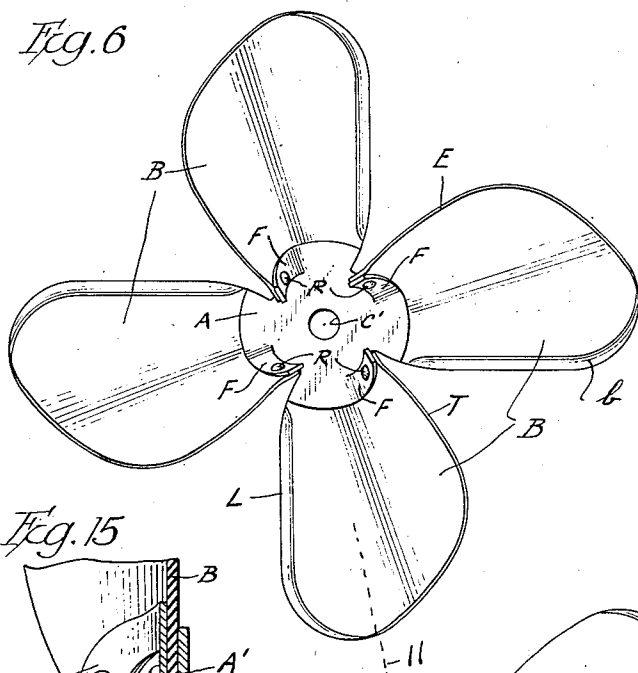


Fig. 13

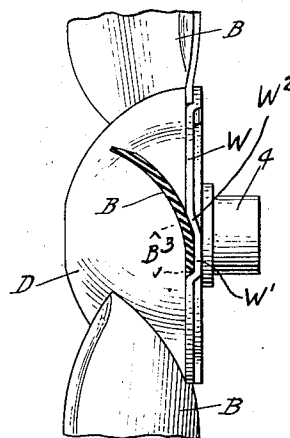


Fig. 15

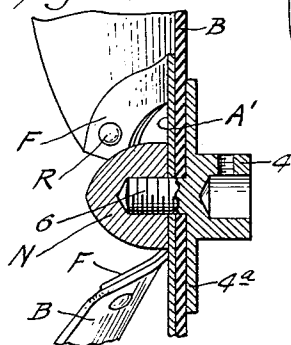


Fig. 4

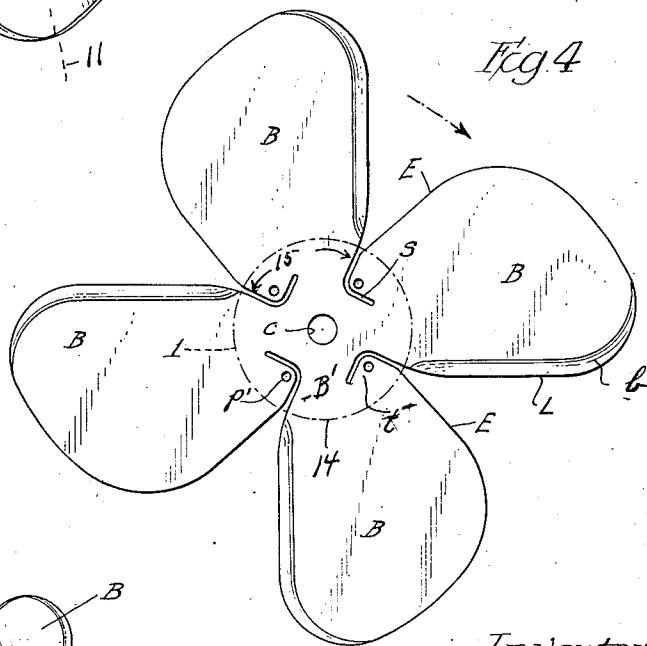


Fig. 5

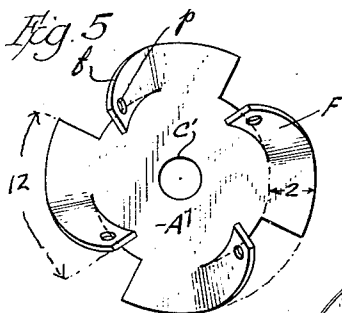
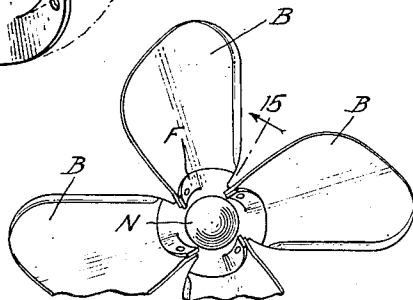


Fig. 14



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FAN BLADE AND HUB ASSEMBLY

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3 Sheets-Sheet 3

Fig. 11

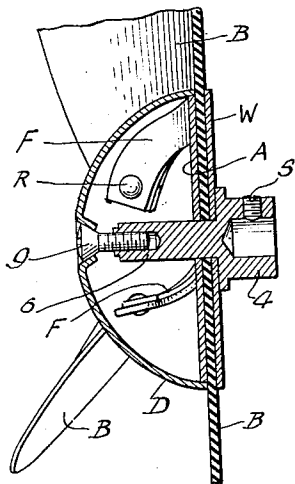


Fig. 7

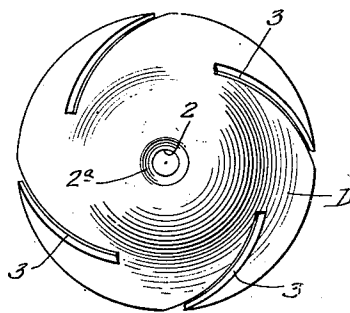


Fig. 8

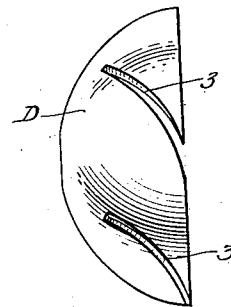


Fig. 9

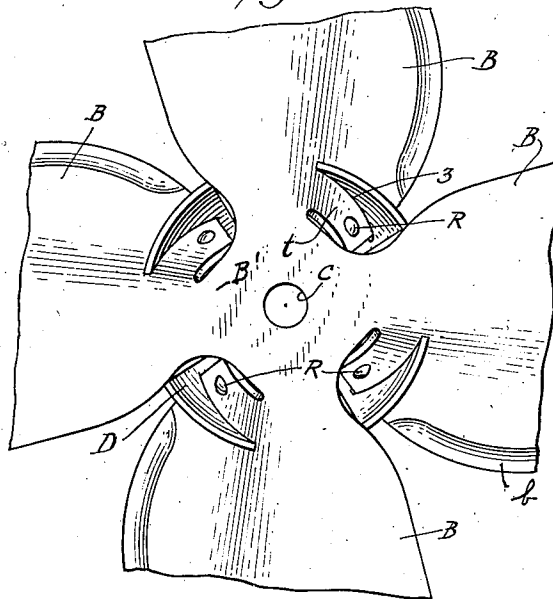


Fig. 12

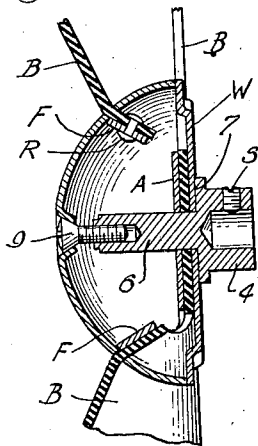
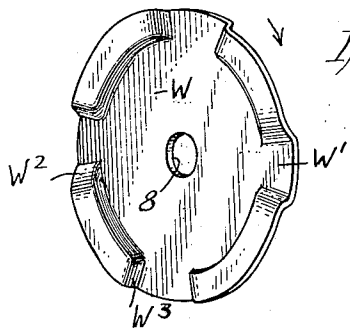


Fig. 10



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UNITED STATES PATENT OFFICE

2,234,319

FAN BLADE AND HUB ASSEMBLY

Edward S. Preston, Hinsdale, Ill., assignor to Chicago Electric Manufacturing Company, Chicago, Ill., a corporation of Illinois

Application October 3, 1936, Serial No. 103,804

18 Claims. (Cl. 170-173)

My invention relates to a flexible bladed impeller (or fan blade and hub assemblage) particularly suited for use in household electric fans, and for this purpose aims to provide an easily assembled and inexpensive impeller which will permit all of the blades to be integral parts of an initially sheet-like blade member, which will definitely determine the curvature of radially extending blades, which will positively position the blades in balanced disposition, and which will present no sharp projecting parts adapted to injure a hand striking the impeller.

In one of its fundamental aspects, my invention aims to provide an impeller construction of the above characteristics in which the radially extending blades are integral with a central blade-connecting part of the flexible sheet from which the blade member of the impeller is formed, and in which the blades are curved by fastening counterpart portions thereof to suitably formed portions of a rigid blade carrier, so that the assembly of this blade carrier with the blade member affords a unit which in itself can be used as the impeller for an inexpensive electric fan. In this aspect, my invention also aims to arrange such a unit so that the mere clamping of it to a stem by which it can be rotated will cooperate with the said fastenings for maintaining the blades in balanced position without requiring other fastening elements.

In a second fundamental aspect, my invention aims to provide an impeller construction in which the aforesaid assembly is augmented by having other counterpart blade portions of the said unit extend into spiraling and rearwardly open slots in a hollow member which conceals the said fastened portions, so that the walls of the said slots cooperate in defining and maintaining the concaving of the blades, the slots being arranged so that all blades can have their said other counterpart portions inserted in the said slots by a single movement of the said unit with respect to the said hollow member. In this aspect, my invention aims to permit the use of a simple hollow dome for the slotted hollow member, and to allow the use of such a dome without having any parts other than the effective blades to project from the convex exterior of the dome.

In still another aspect, my invention aims to provide an impeller in which radially extending blades have portions thereof extending through rearwardly open spiral slots in a hollow member, in which the blades also have other blade portions engaging the rear end of the said hollow

member, and in which the last named blade portions are clamped between the rear end of this member and a part of a stem member which is adapted to be attached to a rotating shaft. For this purpose, my invention also aims to provide a simple construction of the just recited part of the stem member which will also allow that part to bear directly against portions of the rear end of the said hollow member, for the threefold purpose of increasing the rigidity of the assembly, excluding dust from the interior of the hollow member when the latter is a forwardly convex dome, and modifying the concaving of the part of the blade adjacent to the leading edge of the blade.

Furthermore, my invention aims to avoid the following shortcomings of heretofore proposed flexible bladed impellers suitable for use in household electric fans:

(a) When such impellers have separately formed blades attached to a central dome or the like, variations in the attaching of the several blades, or slippage in case of lost play in the fastening means, is apt to unbalance the fan so as to cause it to vibrate when running. Moreover, any projecting parts of the fastening means may injure a hand striking the dome.

(b) If each blade has only a relatively narrow part extending through a slot in a dome, these narrow parts are apt to be inadequate for the strains imposed on them when the fan is running, and particularly so if the assembly requires sharp bends in such parts.

(c) The separate attaching of each blade to a central dome or other hub member also requires skilled labor, thereby increasing the cost, and the lay user generally is not competent for substituting a new blade in case one has become injured.

My present invention aims to overcome the above recited objections by providing an impeller in which flexible blades extend through slots in a dome which has no exposed blade-fastening parts or other elements projecting from its convex forward face; in which the clamping of each blade extends over a quite wide part of the blade for adequately distributing the strain; and in which even a lay user can readily substitute a blade and blade carrier unit for a damaged one.

Illustrative of the manner in which I accomplish the above recited objects—

Figs. 1, 2 and 3 are respectively front, side and rear elevation of an embodiment of my invention suitable for use in household electric fans.

Fig. 4 is an enlarged front elevation of the blade member alone, as it appears when flat.

Fig. 5 is a more enlarged front elevation of the blade carrier which is disposed in front of the central portion of the said blade member, showing the curved fingers to which the non-central perforated portions of blade member are fastened for imparting a forward curvature to the blades.

Fig. 6 is a front elevation of the assembly of the blade carrier with the blade member, drawn on the same scale as Fig. 4.

Figs. 7 and 8 are respectively front and side elevations of the spirally slotted dome which is thereafter disposed in front of the blade carrier, drawn on the same scale as Fig. 5.

Fig. 9 is a fragmentary rear elevation of the resulting assemblage of the blade member, the blade carrier and the dome.

Fig. 10 is a perspective view of the clamping washer which is thereafter disposed behind the said assemblage.

Figs. 11 and 12 are sections, respectively along the correspondingly numbered lines in Fig. 1 but drawn on the same scale as Figs. 5 and 7, taken after the assembling of the impeller of Fig. 1 has been completed by forwardly inserting a shaft-attachable stem into the previously recited assembly and clamping the assembled parts into a rigid unit by a screw extending rearwardly through the dome and into the said stem.

Fig. 13 is a fragmentary side elevation, similar to a part of Fig. 2 but drawn on the same scale as Fig. 11, with one blade sectioned along the exterior surface of the dome.

Fig. 14 is a fragmentary front elevation of a more simple impeller embodying certain features of my invention.

Fig. 15 is an enlarged and fragmentary section taken along the line 15-15 of Fig. 14.

In my impeller, the blade member consists of four counterpart and consecutively equally spaced blades B integral with and radiating from a central blade-connecting part B¹, the leading edge L of each blade being desirably chamfered as shown at b in Figs. 4 and 9. This blade member, which can readily be blanked out from a sheet of suitably flexible rubber, has an L-shaped slot formed in it adjacent to the juncture of the inner ends of each two consecutive blades, with one shank of the L-formation extending radially part way toward a central perforation C in the said member and the other shank extending from the inner end of the aforesaid shank toward the leading edge of a blade. Thus arranged, each such slot defines the outer edges of a tab T which can readily be flexed and which tab is disposed within the dotted-line circle I shown in Fig. 4.

For a fan which is to blow air forwardly, each blade is concaved forwardly by fastening each such tab to a forwardly curved and circumferentially extending finger F on a generally disk-like metal blade carrier A, which is shown separately in Fig. 5 and which has a central perforation C¹ corresponding in diameter to that in the blade member. For this purpose, the blade carrier is merely set against the forward face of the blade member in suitable central and rotational alinement, and each blade tab t is then flexed and fastened to the corresponding carrier finger by a rivet R extending through aligned perforations p and p¹ of said tab and carrier finger, thereby forming the initial assemblage of Fig. 6 in which the carrier fingers predetermine the concaving of each blade about an axis 11 ex-

tending radially of the initially assembled fan member.

This initial assembly can then be handled as a unit and rotated by any suitable supporting means coaxial with it. Thus Fig. 15 shows the just described unit as augmented by a stem member which includes a rearward portion 4 (axially bored for attachment to a rotating shaft) and a forward stem 6 which extends slidably through the said central bores in the blade member and the blade carrier, the blade member being thereafter pressed rearwardly (by a nut N threaded on the forward end of the stem 6) so that the central portion of the blade carrier clamps the central portion B¹ on the blade member against a peripheral flange 4a provided at the forward end of the rearward portion of the stem member.

This flange preferably is at least as large in diameter as the part of the blade carrier around portions of which the fingers on that carrier extend, thereby affording a rigid assembly and one in which each blade is clamped (partly by the fastening rivet and partly by the pressure of the stem flange 4a against it) for the entire circumferential length 12 (Fig. 5) of the zone section from a part of which each carrier finger F is formed. In practice, the nut N is preferably of a forwardly convex shape, as for example illustrated conoidal shape, so that the air flowing past it aids in avoiding the creation of a vacuum near the axis of the said unit. Thus constructed, the just described simple and inexpensive unit has been found effective when constructed in small sizes.

For larger sizes, I preferably supplement the above recited blade curving action by also having a part of each blade, radially outward of and near the radially outer edge of each carrier finger F, extend slidably also through a spiral slot 3 in a rearwardly open hollow member which desirably is a forwardly convex hollow metal dome D as shown in Figs. 7 and 8. Each of the said dome slots is curved to dispose its rearward longitudinal wall in the same surface with the forward face of a carrier finger F, and each such slot preferably is of less length than the arcuate spread (along the dotted line 14) of the blade part housed by that slot, the bore of the dome being such that it will readily house the blade carrier.

For economically and effectively using such a dome D, I desirably provide a generally flat washer W corresponding in diameter to the exterior diameter of the dome and having a central bore 8 corresponding in diameter to the central perforations C and C¹ in the blade carrier and the blade member. Next I provide a stem member which has its forward part 6 slidably insertable forwardly and consecutively through the said central perforations in the washer, the blade member and the blade carrier until the washer seats against a forwardly facing shoulder 7 (Fig. 12) at the juncture of the said stem part 6 with a relatively larger diametered rearward part 4 of the stem member. The just named rearward part desirably is axially bored for receiving the forward end of a (not illustrated) rotating shaft and has a screw S extending radially into it for gripping such a shaft.

Then I clamp the dome D rearwardly by a screw 9 extending through an axial bore 2 in the dome and threaded into an axial bore in the forward end portion of the said stem member,

thereby causing the dome to clamp the blade carrier and the blade member conjointly against the washer W, and also clamping the washer rearwardly against the said annular shoulder 7.

5 If the washer were flat, the blade portions B³ of Fig. 13 which extend beyond the corresponding slots and behind portions of the mouth end of the dome would space the washer from the parts of the dome between the slot mouth, thereby
10 marring the appearance and permitting dust to enter the dome. To avoid this when using blades which project laterally of the blades beyond the slot mouths, I preferably emboss equally spaced radially outward portions W¹ of this washer rear-
15 wardly for a distance closely approximating the thickness of the rubber sheet from which the blade member was formed, each such portion W¹ having a spread sufficient for housing the portion of a blade which projects beyond the mouth end of one of the dome slots 3. Since this projecting
20 blade part is contiguous to an extension of the leading edge L of the blade, the flatwise clamping of that blade part against the mouth of the dome particularly imparts firmness to the leading edge
25 portions of the blade and enables me to dispose these blade portions in a common plane, at right angles to axis of my impeller.

Each such rearwardly embossed portion of the washer preferably has its rotationally rearward
30 end W² sloping rearward also, thereby avoiding a sharp curving of the blade at the juncture of the parts of that blade which extend respectively into the adjacent dome slot and behind the rear end of the dome, the other end W³ being disposed for
35 engaging the adjacent edge of the blade for definitely fixing the rotational position of the washer with respect to the dome.

However, if the parts of the blades which extend through the slots correspond in width only
40 to the lengths of the slots, it should be obvious without further illustration that a flat washer can be used, since this can then bear against all portions of the rear end of the dome excepting the mouths of the said slots.

45 With the elements of my impeller thus constructed and assembled, each blade is substantially gripped over the entire width of the blade along the arc 15 of Fig. 4, thereby distributing the strains so as to insure a long life of the blade
50 even if the portion of the blade outside the dome should occasionally be severely flexed or twisted by the impact of objects against it. Indeed, the fastening of a part of each blade to a carrier
55 finger cooperates with the clamping of another part of the same blade between the dome and washer, so that each blade is effectively fastened and definitely curved even when the blade part
60 housed by the slot is not quite as thick as the width of the slot.

Moreover, the only permanent fastenings—
65 namely those of the blade tabs T to the carrier fingers F—can speedily be made at the factory; and with an accurately contoured blade member the positive gripping of this member, which is
70 centered for that purpose by a part of the metal stem, allows the assembling of an accurately balanced impeller to be readily completed by unskilled labor, so that the entire manufacturing
75 cost is quite low.

In the completed impeller, the dome guides the
80 air flow to avoid creation of a vacuum near the axis of the propelled stream of air, and also decidedly enhances the appearance of the impeller, particularly when the dome is of polished metal.
85 Moreover, when the fastening screw S has a rear-

wardly tapering head seated in correspondingly tapering dome part contiguous to the central perforation in the dome, no sharp parts of any kind project from the dome, so that even a child's hand will not be injured by striking against this
90 dome.

In Figs. 1 and 12, it will be noted that the washer or clamping flange W, although formed separately from the axial stem of the impeller, serves the same purpose as the integral peripheral flange 4a
95 on the stem 4 in the more simple embodiment of Figs. 14 and 15. Hence the term "stem member," as used in certain claims, is to be understood as applying regardless of whether such a flange or
100 washer portion is integral with the stem with 15 which it is associated.

However, while I have heretofore described my impeller in connection with two embodiments each of which includes numerous desirable details of construction and arrangement, many 20 changes might be made without departing either from the spirit of my invention or from the appended claims.

I claim as my invention:

1. In an impeller, a single-piece blade member 25 formed of flexible material of generally uniform thickness, the said member comprising a plurality of counterpart and equally spaced blades radiating from a centrally perforated central portion of the blade member; a forwardly convexed
30 dome coaxial with the blade member and having its rear end of larger diameter than the central portion of the blade member, the said dome having counterpart slots extending forwardly into it from the rear end of the dome, the slots spiraling
35 in the same direction rotationally of the said dome; the said slots being equal in number to the said blades, and each blade having a similar portion thereof extending through and engaging the forward end of one of the said slots; a stem mem-
40 ber coaxial with and extending forwardly through the central perforation in the blade member and into the dome; and means associated with the said dome and stem for rigidly clamping the dome and the central part of the blade member to the
45 said stem member.

2. In an impeller, a single-piece blade member formed of flexible material of generally uniform thickness, the said member comprising a plural-
50 ity of counterpart and equally spaced blades radiating from a centrally perforated central portion of the blade member; a forwardly convexed dome coaxial with the blade member and having its rear end of larger diameter than the central portion of the blade member, the dome having
55 counterpart slots extending forwardly into it and spiraling in the same direction rotationally of the dome, the said slots being equal in number to the said blades, each blade having a similar portion thereof extending through and engaging the for-
60 ward end of one of the said slots, and presenting an adjacent blade portion behind the dome; a rigid blade carrier housed by the dome and having spaced portions respectively fastened to the several blades, the blade carrier having a central
65 portion bearing rearwardly against the central portion of the blade member; a stem member coaxial with the said dome and including a shank disposed rearwardly of the blade member and constructed for attachment to a rotating shaft;
70 and means interposed between the dome and the stem member for clamping the said adjacent blade portions against the rear end of the dome.

3. An impeller as per claim 2, in which each of the said spaced portions of the blade carrier 75

extends circumferentially of the blade carrier and adjacent to one of the said slots, and is curved similarly to the adjacent slot.

4. An impeller comprising an integral blade member formed of flexible and resilient material, the said member comprising a plurality of counterpart and equally spaced blades connected by and radiating from a central portion; a forwardly convexed metal dome having its mouth end coaxial with and of larger diameter than the said central portion of the blade member; the dome having counterpart slots of the same number as the said blades extending into it from its rear end, all of which slots spiral in the same direction rotationally of the dome and opening at the rear end of the dome; each blade having a similar portion thereof extending through one of the said slots and engaging the end of the slot through which it extends and having an adjacent portion projecting beyond the mouth end of the slot; a stem member coaxial with the said dome; and means operatively interposed between the dome and the stem member adapted to cause the said projecting parts of the blades to be clamped between the rear end of the dome and a part of the stem member.

5. An impeller as per claim 4, including means housed by the dome and centered by the stem member for rigidly spacing blade portions which are disposed within the dome and respectively adjacent to the forward ends of the said slots in the dome.

6. In a fan blade and hub assembly, an integral blade member formed of flexible and resilient material, the said member comprising a plurality of counterpart and equally spaced blades connected by and radiating from a central portion; a forwardly convexed metal dome having its rear end of larger diameter than the central portion of the blade member, the dome having spiral slots of the same number as the said blades extending into it from the mouth end of the dome, each blade having a similar portion thereof extending through one of the said slots and engaging the end of the slot through which it extends; each blade also having a second portion thereof engaging a mouth end portion of the dome adjacent to the mouth end of the slot through which the first named portion of that blade extends; a stem member coaxial with the said dome and including a radial flange bearing forwardly against the said other parts of each blade; and means interposed between the dome and the stem member for clamping the said second portions of the blades between the radial flange and the rear end of the dome.

7. An impeller comprising in rigid assembly a single-piece blade member of flexible material including counterpart blades radiating from a central blade-connecting part, a dome aligning axially with the said central part and bearing rearwardly against a portion of each blade which is adjacent to the juncture of that blade with the next rotationally forward blade; the dome having spiral slots, corresponding in number to the blades, extending forwardly into it and sloping forwardly rotationally rearwardly of the blades; each blade extending through and engaging the forward end of one of the said slots, whereby the spiraling of the slots twists the blades out of the plane of the central portion of the blade member; a stem member coaxial with the dome and extending forwardly centrally through the blade member, the stem member including a peripheral flange disposed behind the said central blade-

connecting part and also behind the portion of each blade which is adjacent to the rear end of one of said dome slots, the last named means serving to draw the stem forwardly with respect to the dome for uniting the heretofore recited elements in a rigid assembly.

8. An impeller as per claim 7, in which each blade is of such width that a part thereof projects, in the direction in which the slot spirals rearwardly, beyond the mouth end of the slot through which that slot extends, thereby disposing the said projecting blade part behind the rear end of the dome; and in which the said flange has rearwardly offset forward face portions respectively engaging the said projecting blade parts to clamp these blade parts against the dome.

9. An impeller as per claim 7, including an auxiliary rigid member housed by the dome and having parts thereof rigidly fastened to blade portions each of which is adjacent to the juncture of that portion of the blade with the next rotationally rearward blade; the said parts of the rigid member being disposed so that each thereof curves the blade portion fastened to it to substantially the same curvature as the forward portion of the slot through which a part of the same blade extends.

10. An impeller including in rigid assembly a flexible and single-piece blade member comprising a plurality of counterpart and uniformly spaced blades radiating from a central blade-connecting part, the said member being integrally blanked from a sheet of flexible material; and two cooperating means for concaving each blade forwardly about an axis approximately radially of the axis of the said blade-connecting part; one of the said means being a forwardly convexed dome coaxial with the said blade-connecting part and provided with slots through which the blades respectively extend, each of the said slots spiraling in the same rotational direction; the other of the said means being a rigid blade carrier freely housed by the dome and having rigidly connected counterpart portions each of which is fastened to a blade portion adjacent to the part of the same blade which extends through one of the said slots.

11. An impeller as per claim 10, in which the blade member is formed so as to present tab-like corner portions each of which is bent out of the general plane of that member and constitutes one of the said fastened blade portions.

12. An impeller as per claim 10, in which the blade member is formed so as to present tab-like corner portions each of which is bent out of the general plane of that member and constitutes one of the said fastened blade portions, each such tab-like corner portion being defined by an L-shaped slot in the blade member, which slot has one shank thereof extending toward the axis of that member from the juncture of two consecutive blades, and which has its other shank extending from the inner end of the said shank toward the leading edge of the blade in which that slot shank extends.

13. In a flexible-bladed impeller, a single-piece blade member of flexible material comprising a plurality of counterpart and uniformly spaced blades radiating from a central blade-connecting part; a forwardly convexed blade-curvature-maintaining dome coaxial with the said member and having counterpart spiral slots extending forwardly into it from its rear end, all of which slots spiral in the same direction rotationally of the dome and through each of which slots a part

of a blade extends, the said blade part being adjacent to the juncture of the blade with the next adjacent blade, and the blade member having an angular slot at each such juncture to permit the inner end of the trailing edge of the blade to be bent out of the common plane of the leading edges of the blades; a rigid blade carrier housed by the dome and having counterpart and spaced portions respectively fastened to the parts of the blades which are thus adapted to be bent, the said portions of the blade carrier being formed for holding each such bent part of a blade in alignment with the slot through which another part extends; and means operatively interposed between the blade carrier and the dome for maintaining the blade carrier in its said blade-aligning disposition with respect to the dome.

14. In a flexible-bladed impeller, a forwardly convexed dome having counterpart and equally spaced slots extending spirally into it from its rear ends; a single-piece blade member comprising a central part connecting the inner ends of counterpart blades of the same number as the said blades, the said member being formed of a sheet of flexible material corresponding in thickness to the width of the slots; and a blade-carrier coaxial with the blade member and insertible in the dome and having circumferentially spaced parts respectively fastened to counterpart portions of the blades which portions are adjacent to the central part of the blade member; each of said parts of the blade carrier sloping spirally at a pitch corresponding to that of one of the slots, whereby all of the said blades are adapted to be slid simultaneously edgewise into the said slots by rotating the blade carrier with respect to the dome; a stem member coaxial with the dome and including a radial flange extending behind a portion of each blade; and means interposed between the dome and the stem member for pressing the said flange forwardly against the said blade portions to retain the blades in the said slots.

15. An impeller as per claim 7, in which each slot in the dome is of less length than the width of the part of the blade extending through that slot, whereby each blade also presents a portion adjacent to the mouth end of the corresponding slot and disposed behind the rear end of the dome; and in which the said flange has rearwardly offset portions respectively engaging the last named blade portions, and also has other flange portions engaging the rear end of the dome.

16. An impeller as per claim 10, in which the hollow member is a forwardly convexed dome, and in which the said slots open at the rear end of the dome to permit the blade member to be attached to the dome by a forwardly spiraling movement during which the blades enter the said slots.

17. An impeller as per claim 10, in which the hollow member is a forwardly convexed dome, and in which the said slots open at the rear end of the dome to permit the blade member to be attached to the dome by a forwardly spiraling movement during which the blades enter the said slots; and in which the impeller includes a rotatable member extending coaxially with the dome through the dome, the blade carrier and the central part of the blade member for aligning the last recited three elements.

18. In a fan structure, a faring member having slots therein and shaped to the desired pitch angle for the fan blades and a fan blade member having a plurality of flexible blades received in said slots, a cover member for said base of said faring member, a headed element and a screw threaded therinto, said headed element and said screw extending through said faring member and said cover member and constituting tie means for holding them assembled relative to each other and as a means to retain said fan blades in said slots.

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