

March 2, 1937.

W. L. UPSON

2,072,322

FLUID REACTION APPARATUS

Original Filed Dec. 2, 1935 2 Sheets-Sheet 1

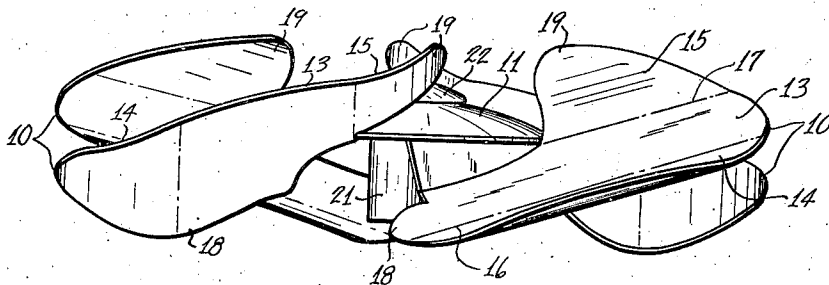
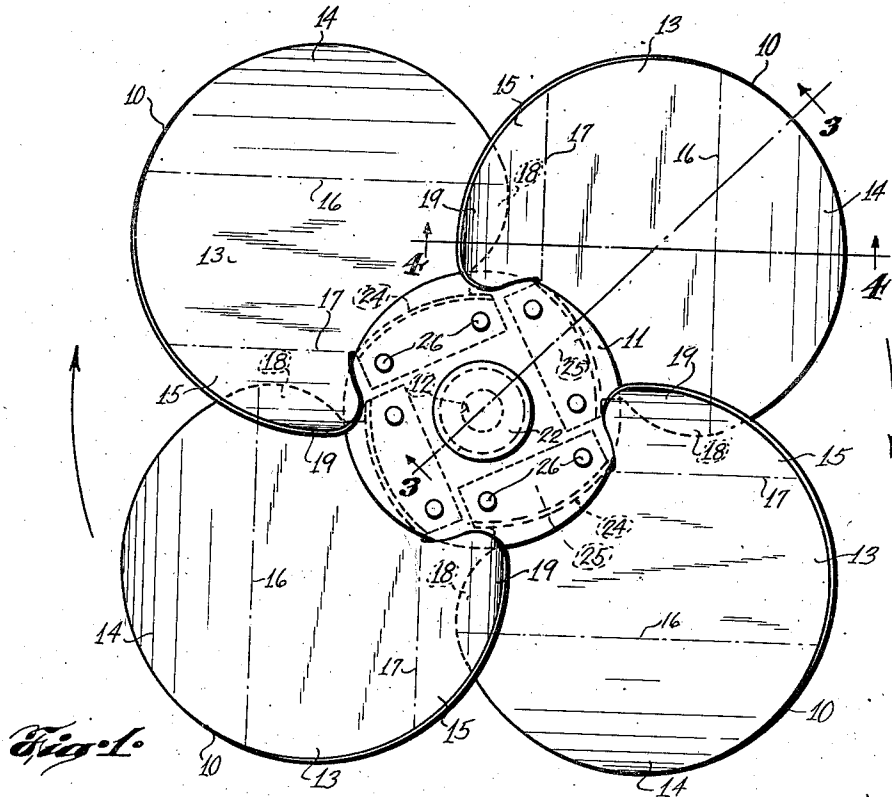


Fig. 2.

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Fig. 3.

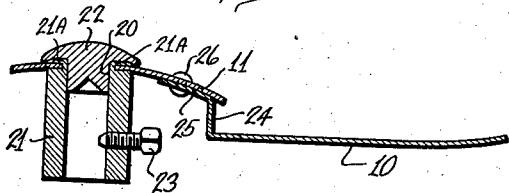


Fig. 4.

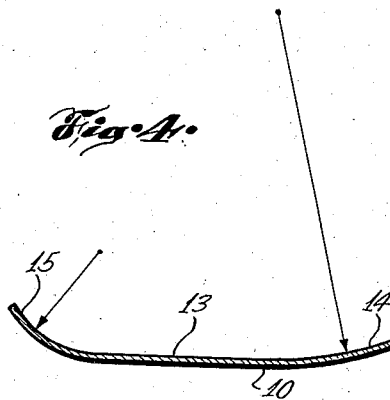


Fig. 5.

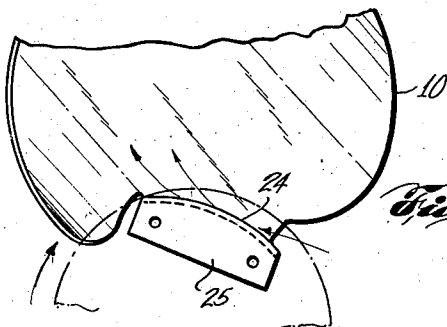


Fig. 6.

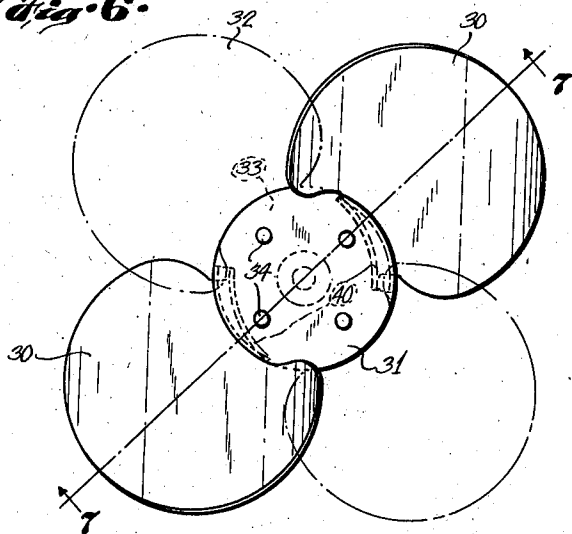
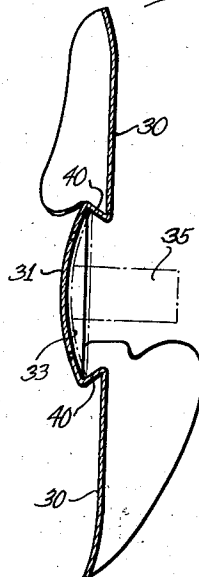


Fig. 7.



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FLUID REACTION APPARATUS

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Application December 2, 1935, Serial No. 52,503
Renewed January 25, 1937

29 Claims. (Cl. 170—159)

This invention relates to improvements in fluid reaction apparatus, and more particularly to improvements in the blade elements of such apparatus, together with improved assembly and mounting means providing for their revolution about an axis.

The principles characterizing the present improvements are applicable with or without modification to fluid-driven apparatus as well as to fluid impelling apparatus, but by way of exemplifying the principles of the invention, it will be described by making reference primarily to an embodiment in a fan, particularly in the construction of fan blades and the mounting arrangement therefor. The present invention possesses certain advantages over the subject matter of Patent No. 2,021,707, issued to this applicant November 19, 1935.

The embodiment of the present invention illustrated and described, is the result of certain modifications of the structure described and claimed in the Letters Patent above referred to. Among the advantages of the present structure over that heretofore disclosed, are an increased sturdiness and desirable rigidity of structure; a fan rotor structure which is more pleasing in appearance, and one which exhibits some degree of improvement in reduction of noise in operation, a decibel test of the fan presently disclosed, showing results somewhat more favorable than any other of the better known fans of so-called noiseless type which have heretofore appeared in the trade, the tests on which such comparisons were predicated, having been conducted at normal or standard speeds of fan operation.

It is accordingly an object of the present invention so to improve a fan rotor, particularly the blades and mounting thereof within accepted requirements, as to result in a fan which operates with even less noise than heretofore prevailing types of comparable dimension, output and power requirements.

An additional, and one of the major objects of the present invention is attained in a fan which combines the principles of a centrifugal type, with those of an impeller type of fan rotor, and in which the elements constituting the centrifugal and impeller type reaction surfaces are or may be constructed of a single piece of material in a given blade.

A still further object of the invention consists in the production of a fan characterized by blades so shaped and mounted as to present, in plan, no area so intervening the blades that the

air stream or parts thereof may be by-passed to the rear of the fan.

Yet another object of the invention is attained in an improved blade-mounting arrangement such that there results a more rigid and sturdy structure which provides for substantially spaced zones of securement of the blade to a central mounting disc, spider or like element.

An additional object of the invention is attained in a fan blade assembly such that the blade-supporting elements or portions thereof may be utilized as displacement or reaction surfaces in a manner to direct the stream engaged by or entering the blade surfaces, toward the impelling surface of the blade, and thus effectively and cooperatively utilizing both centrifugal and impeller-type air reaction surfaces.

Yet another object of the invention is attained in an improved fan structure of such form that a fan, particularly a fan rotor, may be formed of one or more arms each comprising a pair of blades together with a connecting disc or spider portion, and so designed as to enable the superposition of two or more such elements in angularly displaced relation about the axis of revolution, so that a completed fan or fan rotor element may be formed by the use of standardized blanks, such as punchings or stampings.

The foregoing and numerous other objects will appear from the following detailed description of an illustrative embodiment of the invention, considered in connection with the accompanying drawings, in which:

Fig. 1 is a front or plan view of a fan of 4-blade type, constructed in accordance with the present invention; Fig. 2 is a side or edge elevation of the fan appearing in Fig. 1; Fig. 3 is a partial sectional elevation through the axis of revolution and a portion of one of the fan blades of the structure appearing in Fig. 1, and as viewed along line 3—3 thereof; Fig. 4 is a section through one of the blades of the fan of Fig. 1, as viewed along line 4—4 thereof; Fig. 5 is a fragmentary front elevation of one of the blades and showing in broken lines a portion of the central mounting disc or spider, illustrating a preferred arrangement for securing the blade to the disc; Fig. 6 is a front elevation or plan of a somewhat modified structure of fan rotor, certain of the blade portions being shown in broken lines, and Fig. 7 is a sectional elevation as viewed along line 7—7 of Fig. 6.

Referring now by characters of reference to the drawings, the fan illustrated is of 4-blade type, the blades being of uniform structure and each

designated generally by the numeral 10. The blades are mounted, through means hereinafter described, on a central spider or disc 11, mounted for rotation with an axis identified with a shaft 12, being arranged for actuation by the usual driving motor or any other suitable means (not shown). The term "fan" is utilized throughout the specification and claims as denoting the fan rotor or wheel, composed of a plurality of blades and a mounting disc or spider separate from or integral with the blades, and by which the fan rotor structure may be secured to a shaft.

Each of the blades illustrated is characterized by a substantially continuous and substantially uniformly curved convex margin, with the exception of that portion of the blade lying nearest and adjacent the central disc or spider 11, this portion extending inwardly of what would otherwise be the perimeter or periphery of the blade, were it formed to approximate a complete ellipse or circle. Considered in transverse aspect or in cross section, each of the blades 10 is of a shallow trough-like form characterized by a central, substantially plane area 13 and forwardly turned, curved entering and trailing portions 14 and 15 respectively. The flat intermediate or plane central area 13 is bounded from the curved entering and trailing portions by substantially parallel zones the locations of which are shown by lines 16 and 17 respectively. Although these zones are of rectilinear trend, they may be and in fact preferably are of appreciable width, as shown by Fig. 4, and so constitute distinct bounding zones between the areas 13, 14 and 15. It is to be noted that the zones which may for convenience be designated as 16 and 17, are shown as parallel to each other and each parallel to the axis of the trough-like structure produced as a result of forming up each of the blades in channelled section. It is preferred in forming up the blade, that the leading or entering portion 14 be curved on a substantially greater radius than that characterizing the curvature of the trailing portion 15. As an illustrative example, in a blade for a 12", four-blade type of fan, the leading or entering portion 14 may be given a substantially uniform curvature on a 4" radius, while the trailing portion 15 may be curved substantially uniformly on a 2½" radius. It will be noted that the area of the portion 14, while somewhat less than that of the plane intermediate area 13, is still substantially greater than that of the trailing portion 15. In the example disclosed, which may be considered as typical but subject to considerable variation, this proportion of areas is approximately 9:10:5. As will hereinafter more clearly appear, the incomplete, substantially circular aspect in plan, of each of the blades, results in a cut back, reentrant or recessed portion of the effective air-reaction area of the blade, the metal or a portion thereof constituting this particularly formed part of the blade being bent up to form an attachment device or securing lug by which the blade is assembled to the central spider disc 11. There results further from the manner of shaping the blade illustrated, a pair of lobe portions such as 18, located near the inner part of the leading edge portion of the blade, and 19 somewhat similarly located on the trailing edge of the blade. As appears from Fig. 1, the blades are relatively so arranged that the axis of the trough portion of each thereof, lies at a distinctly acute angle to a radius on the axis of rotation; otherwise expressed, the axis of the blade channel, as well as the rectilinear zones 16 and 17, are preferably tangent to a substantial

circle whose center is the axis of revolution of the fan. In a four-blade fan as illustrated, this results in the alternate blade channels being substantially parallel, and in the adjacent blades being so mounted that the axes of the air channels formed thereby, are at substantially right angles. This angular relation will, however, vary according to the number of blades characterizing the fan.

By preference the spider or mounting disc 11 is centrally perforated as at 20 (Fig. 3) and is conveniently mounted to a reduced portion of a hollow hub element 21. This reduced portion 21A, is deformed as by rolling, into securing relation to the disc and hub. A plug 22 extends through the opening 20, and is interiorly secured to the hub, the hub being in turn conveniently assembled as by a set screw 23 to the fan shaft (not shown).

As will appear from the drawings, (Fig. 3), the portion of the fan blade disposed near the perimeter or periphery of the spider disc 11, is bent rearwardly to provide an offset 24, the piece 24 then being bent inwardly toward the hub or axis of revolution as at 25, to form a securing lug and provide an angulate connection between the blade and the disc 11. While the body of the blade 10 is shown as bearing a substantially right angular relation to the connecting piece 24, it will be understood, and as appears from Fig. 2, that the line connecting the parts 10 and 24 lies in a plane at an angle to the disc or spider so as to provide the desired pitch angle. Although a substantial latitude of variation is permissible in this angle according to the speed and other operating and structural characteristics of the fan, portion 25 may be in the nature of a securing ear or tab and attached as by welding (not shown) or rivets 26 to the rear or inner face of the spider disc 11. Obviously, securement of portion 25 may be made to either side of the disc, the rear side being selected chiefly by reason of improved appearance.

The angular portion 24 is of arcuate cross section, preferably shaped substantially as appears in Fig. 5, and is by great preference located somewhat inwardly of and out of parallelism with the curved periphery of the spider disc 11. Considering the portion 24 alone, and separately of its function as a means for supporting and securing the blade proper, it will appear that this portion will engage the air during revolution of the fan about its axis, in a manner closely resembling the function of a backwardly curved multi-blade centrifugal blower wheel, so that in effect the portions 24 evenly spaced about the disc 11 and inwardly of its periphery, serve as true centrifugal reaction elements. They thus serve the dual purpose of a securing or mounting means for the blade body 10, and as centrifugal fan elements, in the manner noted.

From Fig. 1 it will appear from the overlying but spaced relation of the adjacent lobe portions 18 and 19 of adjacent blades, that these elements coact with the spider disc 11 in providing a distinct avenue or throat of air entrance to points just in the path of the centrifugal displacement portions 24. It will further be noted that, as the fan is rotated in the intended direction designated by the arrows in Fig. 1, the air entering that part of the fan between the lobes 18 and 19, will be centrifugally impelled into and along the bottom of the trough-like structure provided by the impeller type fan blade portion 10. The course pursued by the air as a result of the centrifugal effect of each blade, resulting par-

ticularly from the effect of parts 24, is shown by the arrows in Fig. 5.

Reverting further to the shape of the blade proper, it will appear that, as viewed in plan, each blade is formed substantially symmetrically about a single axis of symmetry which approximates coincidence with a radius on the axis of revolution of the fan. This axis, as will have appeared from preceding description, also lies at a substantial angle to, and is not to be confused with, the trough axis of the blade. The angle between the two axes will of course vary according to the number of blades utilized in the fan.

It is a further preference to proportion the blade so that its greatest transverse dimension, which may be considered as substantially at a right angle to a radius on the axis of revolution, substantially exceeds the length of the blade on such radius. In the example of the disclosure, these dimensions are substantially in the ratio of 4 to 3. Obviously, however, a considerable latitude of design is possible as to this characteristic and others, according to the number of blades employed and the type of service to which the fan is subject. It will be noted however that this practice is the converse of that usually prevailing in older types of fans wherein the blades are of substantially greater length than width. The present increase in relative width of blade enables a more effective disposition of the blade area in respect to the full disc area of the fan, and although the blade area is substantially less than that of the full disc area of the fan, this arrangement enables a maximum displacement of air with a minimum blade tip velocity, thus conducing to a minimization of the noises heretofore due to high blade tip speeds. It is to be further noted as a preference that the blade be characterized by an absence of any corners, apices, irregularity of margin of the effective impelling area of the blade, all in a manner conducing to quietness of operation. It will further be noted that the illustrated arrangement of blades and spider disc, practically nullifies any apertures through the central portion of the rotating structure, except as provided between the blades. The air upon being attacked by the blades, is thus prevented from being by-passed backwardly through the fan, and is compelled to be engaged or attacked not only by the leading and trailing portions of the impeller blade areas, but by the centrifugal elements 24 constituted in the present instance by the integral blade-securing lugs which may be considered as constituted by parts 24 and 25. It is seen from Figs. 1 and 5 that the forward or entering edge of each element 24 lies nearer the axis of rotation than its rearward or trailing edge, from which it results that these elements impart a movement to the air as illustrated by the arrows in Fig. 5.

As an alternative arrangement of structural features, but embodying the principles heretofore discussed, there is shown by Figs. 6 and 7 a modification wherein opposed paired blades each indicated generally at 30, are integrally connected or bridged by a spider portion 31. This structure may be formed up as a single blank by stamping or punching although obviously not restricted to such manner of formation. In a four-blade fan for example, an identical paired blade structure is given, for convenience of explanation, separate reference numerals, the opposite blades thereof being designated generally at 32 and connected

by a bridge portion 33. In this manner a pair of the two-blade blanks are superposed, with their spider portions nested, but angularly displaced 90 degrees and secured in assembled relation for example, by rivets 34 or by welding. The bridging portions 31 and 33 are axially apertured for securement to a hub sleeve 35, such securement being conveniently effected as by the parts 21A, etc. of Fig. 3. In the alternative form, the centrifugal elements are indicated at 40, and may be attached as separate elements in the position shown, as by welding.

Although there is illustrated by Figs. 6 and 7, a fan formed up of two blade-forming blanks, each carrying a pair of opposed blades, it will be understood that these blanks may be employed singly to form a two-blade fan, which in section would appear substantially as shown by Fig. 7, and that such two-blade fan would, according to the principles of the structure assembled in the manner shown by Fig. 1, combine the functions of a centrifugal and an impeller type of fan.

The operation of fans constructed in accordance with the foregoing exemplifying disclosure, is thought to be apparent from the description given in connection with the several parts and their functions. It may be noted however that the air particles first engaged by the leading edge portion 14 of the blade 10 are originally attacked at a minimum angle, due to the curvature of this portion on a substantial radius. It is also to be noted that the air is first engaged by that part of the leading edge portion of the blade which is moving at a reduced linear velocity, for example, the lobe 18. The lobe 18, coacting to a certain extent with the lobe 19 of the blade ahead in direction of rotation, will serve to direct the air into engagement with the centrifugal-impelling element 24, thence along the channel or trough of tangential trend following the flat plane portion 13, and outwardly of the rear periphery of the blade where it is given a final thrust by the smoothly but more highly curved trailing portion 15. It will of course be understood that the primary or greater movement of air is forwardly rather than peripherally of the fan as a whole, due to the relatively lesser area of the centrifugal elements 24 and the relatively greater area of the impeller blade body 10.

My preference is to construct the fan with the blades each of somewhat renal or kidney shape, or of shell shape in plan or outline as shown, and by preference to form them of a width substantially greater than the length thereof, the former being considered on a line normal to a radius on the axis of revolution, and the latter substantially coincident with such radius. It will be noted that, in plan, the blade is substantially symmetrically formed with respect to a radius on the axis of revolution, but that its channel is of a trend at an acute angle to such radius.

It will be noted as a distinct advantage in rigidity of securement of the blades in assembly, that each blade is supported or anchored somewhat inwardly of its periphery or perimeter, where it is formed as a true full circle or ellipse. This arrangement provides a securing anchorage closer than usual to the center of mass of each blade and thus imparts a desirable rigidity of mounting. Any tendency of the sheet metal of the blade, when this material is employed therefor, to vibrate or whip and produce excessive noise, is minimized by the noted arrangement.

The structure described by way of exemplifying the invention results in a fan in which the leading

and trailing portions of each blade are most desirably curved and presented at such an angle to the air stream as to conduce to quietness; the formation of securement lugs integral with each blade is a preference which, as will have been noted, results in a further advantage of utilizing these elements for their centrifugal air-displacing effect. It will be further noted that the design of fan herein disclosed lends itself admirably to the production, selectively, of two-blade fans as well as fans having any of the usual reasonable number of blades and likewise possesses a number of advantages in assembly and in economy of forming the blades and spider structure, and in all other important respects more than fully attains each of the objects hereinabove enumerated.

While the invention has been described by making reference to but a few selected embodiments thereof, such description is to be understood as illustrative and not as limiting the possibility of embodiment of the invention, since numerous changes may be made in the parts, and in their combinations and arrangement without departing from the full intended spirit and scope of the invention as defined by the claims hereunto appended.

I claim as my invention:

1. A fluid-reaction blade having a form, in plan, of an incomplete, substantially circular disc, the blade being channelled, the sides of the channel each being of arcuate section and constituting leading and trailing blade portions, and means for mounting the blade for revolution about an axis, with its channel at a substantial angle to a radius on such axis.
2. A fluid-reaction blade having a form, in plan, of a disc the greater portion of the margin of which is of convex contour and the disc being of appreciably greater width than length, and the blade being channelled to comprise a trough-like structure, the sides of which are of arcuate section of relatively greater and lesser areas, and respectively constitute leading and trailing blade portions.
3. A fan blade having a form, in plan, of a disc the greater portion of the margin of which is of convex contour and the disc being of appreciably greater width than length, the blade being channelled to comprise a trough-like structure, the sides of which are each of arcuate section and constitute leading and trailing blade portions, the leading portion being of greater area, and curved on greater radius than the trailing portion, and the portion intervening said sides being of substantially planar aspect.
4. A revolvable fluid-reaction blade of substantially renal outline, being substantially symmetrically formed in plan about an axis, and being rectilinearly channelled and so of trough-like aspect, with the sides of the channel constituting leading and trailing portions of differential sectional curvature, and mounting means disposing the blade with its channel tangent to a substantial circle on the axis of revolution.
5. A rotary fluid reaction member including a plurality of spaced centrifugal reaction elements, each presenting an outwardly convex surface extending along and about the axis of rotation, a spider member for mounting said elements, and impeller type reaction elements of a generally radial trend beyond, and having their radially inner portions located near the centrifugal elements.
6. In a fan, the combination with an impeller type fan blade, of a centrifugal type reaction

element characterized by an outer convex surface disposed to direct air along the impeller reaction surfaces of the blade, and means for mounting the centrifugal element and blade for revolution about a common axis.

7. In a rotary fluid-reaction structure, an element mounted to function as a centrifugal reaction member and an element extending at a sharp angle outwardly from the first said element and pitched to constitute an impeller type fluid-reaction surface, the first element being convexly curved, and so located that its convex portion directs air along the impeller element.

8. In a rotary fan, a fan blade characterized by a central channel tangential to a circle on the fan axis, a spider by which the blade is mounted for revolution and a securement element connecting the blade and spider and having an angulate portion so curved and located as to operate as a centrifugal air-reaction member adjacent the inner end of the blade channel.

9. In a revolvable fan, a fan blade, a spider by which the blade is mounted for revolution and a securement element connecting the blade and spider and having an angulate portion curved and so located as to function as a centrifugal air-reaction member, the blade being tangentially channelled and the centrifugal member being further so located as to direct air into the inner end of said channel, and along a portion of the blade intermediate the leading and trailing areas thereof.

10. A fluid-reaction blade characterized by distinct angulately related fluid-reaction portions respectively formed to constitute centrifugal and impeller type reaction surfaces, the centrifugal reaction surface being curved, and located so as to direct fluid along the impeller type reaction surface.

11. A revolvable fluid-reaction structure formed of blades constructed in accordance with the preceding claim, and in which the blades are mounted to provide between the entering portion of one blade and the trailing portion of a preceding blade, an air-receiving throat bounded in part by the centrifugal element of the trailing blade.

12. A fluid-reaction blade substantially symmetrically formed with respect to one axis and characterized by an elongate intermediate planar surface, and leading and trailing surfaces of arcuate section, and respectively of greater and lesser area, and means for mounting the blade for revolution with the center line of its planar surface at a substantial angle to a radius on the axis of revolution.

13. A fan blade of channelled aspect and regular convex outline, the margins of the blade being curved on radii on points within the confines of the blade, the channelled aspect of the blade resulting from a substantially planar intermediate portion and differentially curved leading and trailing portions, and means for mounting the blade for revolution with its channel tangential to a substantial circle on the axis.

14. A fan formed of a plurality of blades and a spider, the blades being so secured to the spider that their margins are in overlying relation and serve to define a throat for the introduction of air to a zone near the inner end of each blade, and a centrifugal air-impelling element of outwardly convex curvature, disposed in such zone and adapted to direct the air in a generally radial direction onto the associated blade.

15. A fan formed of a pair of opposed blades and mounting means therefor, the blades each

being of substantial regular convex outline in plan, characterized by leading and trailing lobe portions, each blade being of a width at least equal to the length on a radius on the axis of revolution, and the blades being channelled tangentially to a substantial circle on the axis of revolution.

16. A fan formed of a plurality of blades constructed in accordance with claim 15, and provided with elements in the nature of curved centrifugal vanes, one disposed near the inner margin of each blade.

17. In a fluid displacement device, a plurality of spaced blades or vanes each including three distinct connected portions, comprising curved leading and trailing areas, and an intermediate planar portion disposed at a substantial angle to the other portions, and at least one of said portions being substantially pitched with respect to a plane normal to the axis of revolution, each blade being so formed that its three said portions define a channel, and means for revolvably mounting the blades with the channel of each thereof at an acute angle to a radius on the axis of revolution.

18. A fluid reaction blade adapted to be mounted for rotation about an external axis, the blade being characterized by an axis of symmetry as viewed in plan, and including three adjacent connected portions, the outermost portions being of arcuate section and substantially differing areas, and connected to the other portion along rectilinear zones, substantially at an acute angle to said blade axis, and the free margins of the blade being arcuately formed entirely on centers within the blade.

19. In a rotary fluid reaction device, a plurality of spaced blades mounted for revolution about an axis, each of said blades being formed in plan substantially symmetrically with respect to one axis therethrough, and including three substantially defined portions coacting to form a blade channel, certain of which are of curved section, the portions being connected together along rectilinear zones extending at an angle to the said axis of the blade, said portions arranged in the order of leading, intermediate and trailing parts of the blade, the leading portion being curved on a greater radius and being of greater area than the trailing portion, and each of said blades being mounted with its channel directed at an angle to a radius on the axis of revolution.

20. A fluid-reaction blade adapted to be mounted for revolution about an axis external thereto, the reaction surfaces of the blade including a leading portion, an intermediate portion and a trailing portion, the intermediate portion constituting the major reaction area, and each of said portions lying adjacent substantially different planes, the leading and trailing portions being of arcuate section and projected from the intermediate portion in the direction of the air stream, the blade being of substantially greater width than length and substantially symmetrically formed with respect to a blade axis intersecting at an acute angle the center line of said intermediate portion.

21. A blade for a fluid displacement device, arranged for revolution about an axis, the blade being of substantially renal configuration, and constructed to present in plan, an axis of symmetry, the blade including a central substantially planar portion of a trend at an acute angle to said axis, and constituting the major displacement area of the blade, and substantially curved

marginal leading and trailing portions, each projecting from the central portion in the direction of the fluid-stream.

22. A fan characterized by a plurality of spaced blades, each constructed in substantial accordance with the preceding claim and in which the center line of the said central portion of each blade is disposed at an angle to a radius on the axis of revolution.

23. A fan blade adapted to be revolvably mounted, and including a substantially planar intermediate area, the blade being bent along lines each tangential to a circle on the axis of blade revolution, so as to form a pair of lips curved on different radii and projecting laterally of the intermediate area, and forwardly thereof in the direction of the air stream, the blade being adapted for mounting with the center line of the planar area at a substantial angle to a radius on its axis of revolution.

24. A four-blade revolvable fluid-reaction device, each blade of which is longitudinally channelled on its forward face, and substantially symmetrically formed, in plan, about an axis at a substantially acute angle to its channel, the blades being assembled with their channels each at an acute angle to a radius on the axis of revolution, and with the corresponding channels of adjacent blades substantially at a right angle to each other.

25. A fluid reaction wheel formed of a plurality of blades arranged for revolution about an axis, each of said blades being of disc-like form, characterized by a center area approximating a planar surface, a pair of lips disposed laterally of the center area and curved in the same direction therefrom, one of said lips being characterized by a relatively lesser degree of curvature, and the other said lips by a relatively greater degree of curvature, the lips serving with the central area, to define a fluid channel; each of the blades being so mounted with respect to the axis of revolution of the wheel, that the channels formed by the several blades are each distinctly offset from a radius on the axis of revolution.

26. In a revolvable fluid reaction device, a plurality of spaced blades or vanes, each of disc-like form and including three connected portions comprising leading and trailing areas, at least one of which is appreciably curved in section, and an intermediate portion disposed at a substantial angle to the other portions, at least one of said portions being substantially pitched with respect to a plane normal to the axis of revolution, and each blade being so formed that its three said portions define a channel; and means for revolvably mounting the blades with their channels each substantially offset from a radius on the axis of revolution.

27. In a revolvable fluid reaction device, a plurality of spaced blades or vanes, each of disc-like form and including three connected portions comprising leading and trailing areas, at least one of which is appreciably curved in section, and an intermediate portion disposed at a substantial angle to the other portions, at least one of said portions being substantially pitched with respect to a plane normal to the axis of revolution, and each blade being so formed that its three said portions define a channel, the margin of each of the blades lying near the outermost portion of the disc area of the device, being of a substantial and approximately uniform curvature in plan, and curved approximately on a single axis well within the confines of the blade; and means for revolvably mounting the blades

with their channels each substantially offset from a radius on the axis of revolution.

28. A fan blade adapted to be revolvably mounted, and including a relatively flat intermediate area, the blade being bent along lines each tangential to a circle on the axis of blade revolution, so as to form a pair of lips projecting laterally of the intermediate area, and forwardly thereof in the direction of the air stream, one of the said lips projecting in a general direction from the intermediate area toward the trailing edge of the blade, being appreciably curved, and pitched forwardly of the blade in the direction of the air stream to a substantially greater degree than either the intermediate area or the other said lip; the blade being so formed in plan as to present a broadly and regularly curved outer margin, of at least 180 degrees in extent, and the axial center or centers of the curved margin being disposed well within the confines of the blade, the blade being adapted for mounting with the center line of its intermediate area disposed at

a substantial angle to a radius on the axis of revolution.

29. A four-blade revolvable fluid-reaction device, each blade of which is longitudinally channeled on its forward face, one of the sides of the channel constituting a trailing portion of the blade and being appreciably curved forwardly of the blade, the outer part of each blade being substantially semi-circular in plan, with its margin curved on an axial center or centers well within the confines of the blade, so that a substantially regular curve defines a large part of the leading margin of the leading portion of the blade, extends thence to bound the outer end of the blade channel, thence defines a substantial part of the trailing edge of the trailing area of the blade; the several blades being assembled with their channels each at a substantial angle to a radius on the axis of revolution, and with the corresponding channels of adjacent blades approximating a right angle to each other.

WALTER L. UPSON.

Disclaimer

2,072,322.—*Walter L. Upson*, University City, Mo. FLUID REACTION APPARATUS.
Patent dated Mar. 2, 1937. Disclaimer filed Feb. 5, 1948, by the assignee,
The Torrington Manufacturing Company; the inventor consenting.

Hereby disclaims from the scope of each of claims 1 to 4 inclusive, 12, 13, 15 and 17 to 29 inclusive, any fluid reaction device other than a fan comprising a plurality of distinct, wide blades each of a generally symmetrical shape in plan, each blade being bounded over a predominant portion of its margin by convexly curvilinear edge portions and formed to provide a wide, open end, substantially pitched channel extending outwardly of the axis of fan rotation and rearwardly with respect to the direction of rotation, and with the blades so mounted for rotation about a common axis that the channel of each blade is distinctly divergently related to the axis of blade symmetry.

[*Official Gazette Mar. 2, 1948.*]