Dec. 22, 1936. L. R. MORAY ET AL 2,064,845

PROPELLING DEVICE

Original Filed March 31, 1933 2 Sheets-Sheet 1

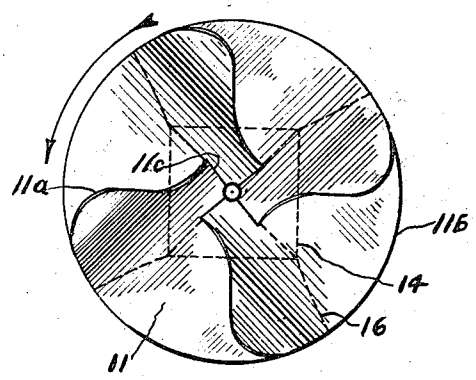


Fig. 2.

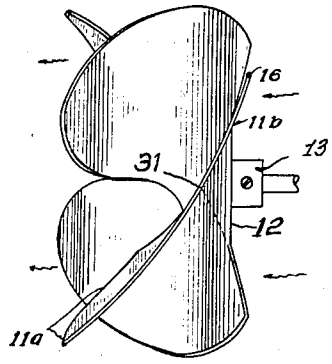


Fig. 3.

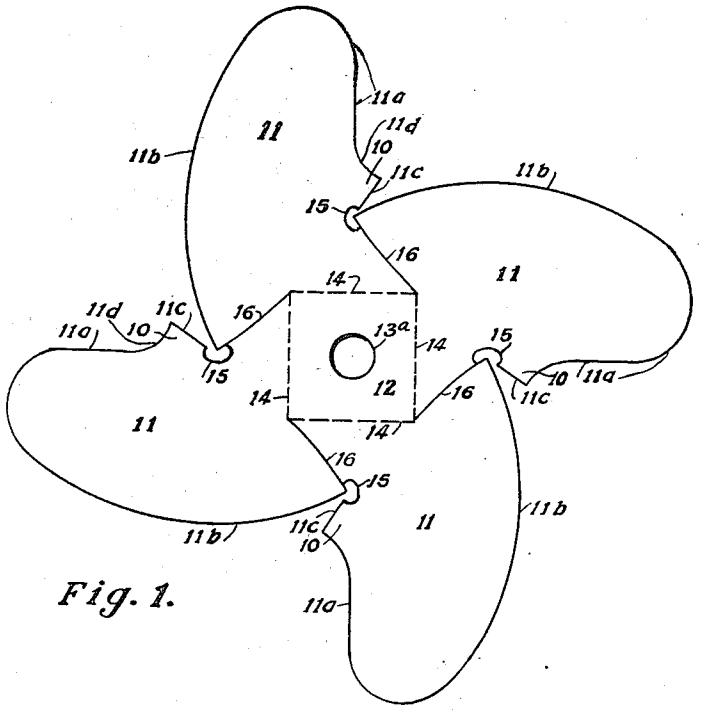


Fig. 1.

INVENTORS
Lawton R. Moray
& Theodore E. Merwin
BY George S. Hastings
ATTORNEY

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PROPELLING DEVICE

Original Filed March 31, 1933 2 Sheets-Sheet 2

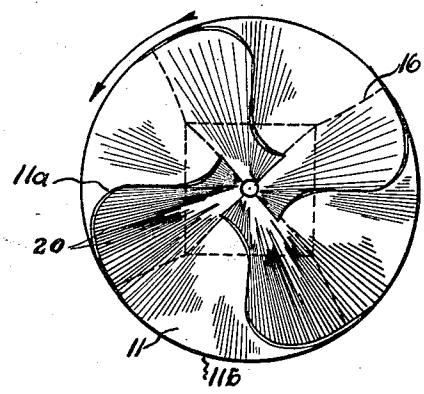


Fig. 4.

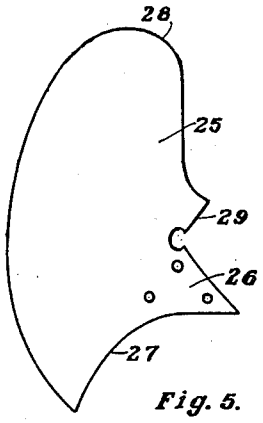


Fig. 5.

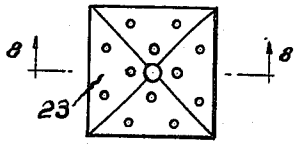


Fig. 7.

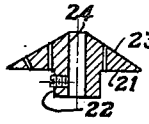


Fig. 8.

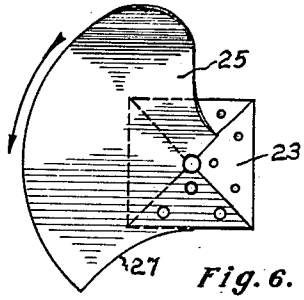


Fig. 6.



Fig. 10.

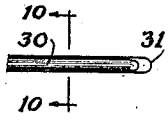


Fig. 9.

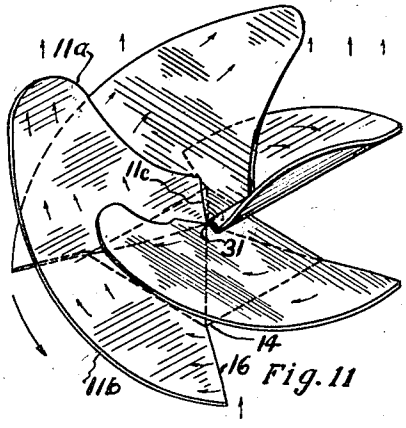


Fig. 11

INVENTORS
Lawton R. Moray
BY Theodore E. Merwin
George S. Hastings
ATTORNEY

Patented Dec. 22, 1936 2,064,845

UNITED STATES PATENT OFFICE

2,064,845

PROPELLING DEVICE

Lawton R. Moray, Croton on Hudson, and Theodore E. Merwin, Harmon-on-Hudson, N. Y.

Application March 31, 1933, Serial No. 663,774
Renewed May 21, 1936

40 Claims. (Cl. 170—159)

This invention relates to devices to propel fluids such as air, water, and substances capable of flowing, which are employed for fans, pumps, boat propellers, windmills, etc., and is particularly well adapted to rotary fans of the propeller type designed for ventilating, air blowing, air circulating and suction work against greater than atmospheric pressures or to produce substantial static pressures.

In disk and propeller fans of the prior art, air and fan noises have played a part in retarding their popularity and usefulness in practice, where a fan is required to develop pressure against resistances such as friction, wind, etc. To be successful in this field a fan must be capable of developing substantial static pressure between its intake and discharge sides without perceptible noise. Fans of the prior art have been unable to perform this task except at comparatively low speeds with resultant loss of air volume and low static pressure. Noise has limited their range of capacities to the extent that larger propeller or centrifugal fans are used, running at comparatively low speeds, necessitating greater expense to the user.

It is the main object of this invention to substantially reduce air noise through and around the fan when same is running at comparatively high speeds, to obtain a greater range of capacities for a given size of propeller type fan when operating either against substantial static pressures or at free delivery.

To the end of minimizing noise and increasing the air volume of the disk and propeller types of fans with maximum efficiency comparable to or beyond centrifugal fan performance, it is an object of this invention to produce a multi-bladed fan, the blades of which are an approximate spiral form. In this connection part of the noiselessness of the present fan is thought to result from the more uniform and gradual acceleration of the air velocity from the intake to the discharge edges of the blades, made possible by the depth and shape of the blade form used especially at the inner core or central position. With greater efficiency and minimizing of noise in view, the intake or cutting edge of the fan blades have a portion below or beyond the plane of the boss and leading the cutting edge of the boss, thus building up and advancing the intake air velocity from said edge.

Another object of the invention is to close the entire fan to daylight by overlapping the blades and by the boss. This is done to prevent air and pressure from leaking back directly through the fan against the flow of the propelled air, resulting in the fan of our invention building up substantial static pressure between the intake and discharge sides of the fan without loss of pressure and air already delivered through the fan.

Another object is to form the blades to overlap one another on the discharge side to cause the air stream from each blade working surface to combine uniformly with the air stream from the adjacent blade working surface to produce a smooth, noiseless, uniform air delivery with minimum spiral air twist directly away on center from the fan with comparatively little spreading out of the air discharged from the fan.

It is an important feature of the invention that the design referred to, makes possible a practical inexpensive form of fan having blades which are relatively large in a cross radial direction with ordinarily comparatively few of these blades, while retaining or adding to the advantages heretofore thought to reside mainly in fans having a large number of blades. Part of the noiselessness of the present fan is attributed to this since it is our belief that the lesser number and extent of the air cutting edges required in the present fan results in a lesser number of sources of noise.

Still another purpose is to provide a simple and inexpensive fan construction for carrying out the above and other fan purposes and one which may be formed in one piece from a disk of sheet material. In this connection it is one aim of the invention to devise a method of making one piece disk fans of this character by cutting and bending sheet metal.

Another object is to produce a fan design in which the central portion of the fan is closed by working air propelling surfaces instead of by a boss or hub alone thus increasing the effectiveness and efficiency of the fan and providing a fan which will not lose pressure through the center even though the boss or hub is eliminated.

Further objects are to provide a flexible design for the disk and propeller types of fans which without sacrificing major advantages can be widely varied in number of blades, blade pitch, blade depth, fan diameter, width of blades, etc., to meet the varying conditions, to produce an air intake cutting edge which will be less noisy than conventional blade edges, to provide a propeller fan of greater depth from front to back than thought workable heretofore, to provide a propeller fan of higher efficiency using smaller and speedier motors of less cost, than found in

practice. With these objects in view as well as a number of others which will appear as the nature of the invention is more fully described, the invention consists in certain constructions and combinations hereinafter set forth and then particularly pointed out in the appended claims.

In the accompanying drawings, which illustrate one of the many forms the invention may take and which form a part of this specification, and in which like characters of reference indicate the same or like parts:

Fig. 1 is a plan view of a fan blank for a one piece fan embodying the invention;

Fig. 2 is a front elevation of the completed fan formed from the blank of Fig. 1, seen from the discharge side;

Fig. 3 is a side elevation of the fan of Fig. 2;

Fig. 4 is a front elevation of modification of the fan shown in Fig. 1, seen from the discharge side;

Fig. 5 is a plan view of one blade of a multi-piece fan;

Fig. 6 is a plan view showing assembly of the fan blank of Fig. 5 with a boss;

Fig. 7 is a detail plan view of the boss shown in Fig. 6;

Fig. 8 is a section on the line 8—8 of Fig. 7 in side elevation of the boss shown in Fig. 6;

Fig. 9 is a detail view in side elevation of one of the forward or cutting edges of the blades shown in Figs. 1 and 4;

Fig. 10 is a detail sectional view on the line 10—10 through the edge portion shown in Fig. 9;

Fig. 11 is a view in perspective of the fan shown in Figs. 1 to 3.

Referring now to the drawings, we will describe in detail an embodiment of our invention it being understood that this specific embodiment while a preferred one, is selected for purposes of illustration only, and then it is only one of a great many forms which the invention may take, and therefore we do not wish to be limited to any particular one of said forms or particular group thereof except as specified in the appended claims.

The blank for forming an air fan embodying the invention is formed as shown in Fig. 1 by stamping or cutting from sheet material such as sheet steel. As shown in Fig. 1, the blank comprises blade portions 11 having a central boss or hub portion 12 having in the center thereof a hub 13 having a shaft receiving opening 13*a*. The blade portions join the boss along the lines on which the blades are subsequently bent as hereinafter described. Looking at Fig. 1, it will be seen that each blade has a short edge 11*a* extending toward the center of the boss in a direction perpendicular to but terminating some distance short of the line 14, and a long convex edge extending in a general direction approximately at right angles to the same line 14. The edge 11*a* when the blank is bent to final form, is the discharge edge of the fan blade. At the inner end of this edge 11*a* is provided a projecting tag 10 the function of which will be later explained, having its edge 11*c* inclined toward the point of intersection of edges 11*a* and 11*b*. At the intersection of the edges 11*a* and 11*b* the blade from which the tag projects has a small circular cutout 15 which when the blank is bent to final form forms the fan shaft opening. The blank is slit along lines 16 from the corners of the boss to the cutout 15. The edge 16 adjoining the long edge 11*b*, later forms an intake edge of the fan.

The fan may be formed now from the blank by bending upwardly (as shown in Fig. 1) on the fold lines 14 and then back over the boss so that the major portion of the blade is on the diametrically opposite side of the axis of the fan from its fold line 14, and extends diagonally from the boss at said fold line at the angle shown in Fig. 3 between the intersecting lines 12 and 11*b* of the boss and blade edge.

From the line 14 and at the intake edge 16 the blade in one preferred construction may have a pitch relative to the boss of approximately 15 degrees, which at the mid-portion of the blade edge may desirably increase to 30 degrees and at the discharge edge of the blade will desirably be greater as for instance 45 degrees, the blade being progressively curved from one pitch to the next. Thus the air or fluid received at the intake is progressively accelerated along the relatively great length of the blade to the discharged edge. This gradual progressive acceleration over a considerable distance while in contact with a continuous surface contributes substantially to the noiselessness of this fan.

When each of the blades are bent on the lines 14 and also bent to curvature as above described, the fan shown in Figs. 2 and 3 is formed with the edges of one blade intersecting and resting against the working surface of the succeeding or following blade (with respect to the direction of rotation) this relation of edge and surface serves to guide the flow of air along the working surface of the following blade toward the outer portion of the blade and away from the center of the fan which as is well known is the weak part of the fan. The inner ends of the inclined surfaces of tag portions 10 intersect at the axis of the portions 10 interlocking holding the blades in position and holding the fan rigid. These portions also serve to protect the center of the fan to prevent back flow and consequent loss of pressure therethrough and is one of the contributing factors to the ability of the present fan to work against relatively high static pressures.

As shown in Figs. 1 and 2, the construction described closes the fan against daylight openings; i. e. from the front no daylight can be seen through the fan; in fact not only is there some overlap against daylight opening from blade tip up to the axis of the fan, but this overlap is greater toward the central portion or portion adjacent the hub or boss, being in the preferred form shown in Figs. 1 and 2 more than twice overlapped to provide additional protection against loss of pressure at the weak center of the fan.

Applicants have found that one of the most noiseless and efficient forms the invention may take is that in which the blades have a spiral form, i. e. the blade form is generated by lines perpendicular to and intersecting the axis so that any line in the plane of the blade perpendicular to the axis will lie in the blade across the entire width of the blade, forming an air screw. This results in what may be termed a perfect spiral fan such as illustrated in Fig. 4. However in the preferred form the blades are exactly spiral midway between the discharge and intake edges but elsewhere vary from true spiral a little but only insofar as is necessitated by the use of flat sheet material which cannot be brought to exact spiral form without stretching the material.

As shown in Figs. 1, 2 and 11, when the blade is bent to form, the triangular projection between line 16, the long edge of the blade, and a projection of line 14 leads and extends below the intake

edge of the boss forming an outlying delivery edge so that some air is taken in ahead of the main intake edge, this progressively and smoothly building up the intake air volume and pressure, another feature believed to contribute to silence as compared with an intake edge striking the air along its entire length at one time. Thereafter the intake air is guided and controlled on the working surface of the blade by the intersecting portion 12 which serves to guide and concentrate the intake toward the outer and (because traveling on a greater radius) more effective part of the blade thus continuing the progressing building up of pressure of the intake fluid until the fluid is finally thrown from the long radius, large pitch discharge edge at its greatest pressure and velocity. The effect of the intake fluid guiding portions seems to be to increase the suction of the fan having, it is thought a Venturi effect at the point where the air acted on passes the edge 11*d* of the tag 10.

From Figs. 1, 2 and 3 it is apparent that the blades have a length considerably greater than the radius of the fan because the blades project from the boss edge 14 on the opposite side of the fan axis from the main portion of the blade thus greatly increasing the working i. e. air throwing surface of the blade and for the same reason the working surface of the blade covers the boss hub or central portion of the blade. For the same reason the blades even though cut from one piece of material have a greater width at any given point than a sector formed by drawing straight lines from the center of the fan along the intake and discharge edges of any blade, i. e. the blades do not radially taper towards the center where width and overlap is most desirable, as with most fans or propellers hitherto used. Such is the flexibility of design possible with the present fan that in the forms shown in the drawings the cross radial dimension of the completed blades is greater than the radius, though it may be less in constructions contemplated having a somewhat larger number of blades.

A feature of the present fan is that it lends itself to a construction having blades which are relatively large particularly in a cross radial direction and in working area, and which are relatively few in number while retaining or improving on the efficiency of fans with a larger number of blades. Part of the noiselessness of the present fan is attributed to this because of the lesser extent of air cutting edges and the less frequent chopping of the air. The long sweep of the blade is such that the air is brought to desired discharge pressure and velocity by continuous contact with one main working surface and is not successively beaten upon by a considerable number of surfaces.

A modified form of the invention is illustrated in Fig. 4 (which shows the fan from the discharge side) is of the perfect spiral type already referred to in which any lines perpendicular to the axis and in any part of the plane of the blade coincide with the blade for the entire width of the blade along said line. This form differs from that shown in Figs. 1, 2 and 3 in that it requires a stamping or casting operation for the purpose of producing the spiral form since flat material cannot be so formed without stretching of the material, and the use of such an operation is contemplated.

Another modification of the invention is illustrated in Figs. 5 to 8 showing a multi-piece fan comprising a boss 21 having a hub 22 with a shaft receiving opening 24, the boss being of pyramid shape with sloping sides 23 to which the separate blade 25 is riveted at the triangular securing portion 26 as shown in Fig. 5, the edge 27 being the intake edge and the edge 28 the discharge edge and the edge 29 corresponding to the tag 10 of the fan in Fig. 1. After four blades identical with 25 have been so secured to each of the four triangular faces of the pyramid a fan results which is identical in shape and in all essential respects except the integral joinder of parts and the solid boss with that shown in Figs. 1 to 3, and therefore will not be described in further detail. The angle between the base and the triangular sides of the boss is made equal to the desired pitch of the blade adjacent the intake edge, in the present instance 15 degrees.

It is obvious that in addition to the modes illustrated that the fan of the invention may be constructed in other ways. For instance, it is contemplated that the fan may be cast either in one piece, with a solid boss or in the multi-piece form shown in Figs. 4 to 8. It is also contemplated that this fan, particularly in the cast form may be made without a boss, the blades being connected at their lines of intersection, or secured together by a spider on a hub.

Figs. 9 and 10 illustrate an edge detail applicable to the intake edges of the blades shown in Figs. 1 to 6 inclusive consisting of elongated cavities or grooves 30 let into the said intake blade edges for the purpose of providing a compressed air cushion at this point to decrease edge noise. This groove is closed adjacent the outer end at 31 to retain the air in the groove.

In the fans shown all of the blades have their working surfaces intersecting substantially at a single point 31 at the axis of the fan and from this point each of the blades have surfaces which flare away towards the intake and discharge of the fan forming together surfaces of generally opposed conical configuration, as of two cones or pyramids tip to tip in hourglass formation with the bases of the cones away from said point of intersection. A boss or cone may be fitted into either one of the conical cavities between said surfaces for greater rigidity or securing the motor shaft which drives the fan.

In the operation of this fan, the extreme depth of the fan from the intersection of the working surfaces with the axis to the rearmost tip of the discharge surface performs an important function not only in continuously and smoothly accelerating and guiding the air, but in directing it at discharge and in throwing together and mixing the discharge from the several blades to form one on center column which flares outwardly very little as it departs from the fan. Moreover since the inner parts of the discharge edges are nearer than the rearmost portions of succeeding blades to said intersection 31, the discharge from these nearer edges is to a considerable extent joined with, and further accelerated by, the discharge from said rearmost portions as well as being acted on by the same. This further builds up discharge pressure and integrates the discharge column and produces a relatively uniform discharge without successive noise producing compressions as in fans of a type in which the air is successively beaten upon by blades which separately act on the air within the fan. Any tendency of the rearwardly extended portions to give the air a twist, or an inward crosscurrent is opposed by the discharge of air against it having approximately equal and

opposite twist or crosscurrent from the diametrically opposite portion so as to throw the discharge air straight along the axis of the fan without twist which is believed to be another source of air noise as well as reduced efficiency.

What is claimed is:

1. In a rotary propeller fan, the combination with a boss, of a series of blades secured to the boss extending from one edge of the boss inwardly to and beyond the axis of the fan with the main portion of the fan on the opposite side of the axis from said edge of the boss.

2. A rotary propeller fan having a hub, a series of fan blades attached to said hub, said blades having working surfaces extending substantially to the axis of the fan, and said blades seen from the front overlapping from tip to axis to provide a fan having no daylight opening, said blades being wider than a sector at the hub whereby the overlap of the blades is greatest near the center.

3. A rotary propeller fan having overlapping air throwing surfaces joined to form a pyramid or cone with its apex substantially at the axis of the fan closing the central portion of the fan.

4. A propeller fan having a plurality of blades arranged around a central axis each blade intersecting the preceding and following blade along a line extending to the axis of the fan, to close the center of the fan in the form of a pyramid.

5. A rotary propeller fan having no daylight opening and having radially extending blades with working surfaces longer from the outer tip to the inner extremity of the blade than the radius of the fan.

6. A one piece fan, comprising a central boss portion adapted for rotation, blades integral with said boss and bent back from the edge of said boss to extend to and beyond the axis of the boss with the main portion of the blade on the opposite side of the axis from its connection with the boss.

7. A fan blade having an air retaining pocket extending along its intake edge, with the open side of the pocket facing the direction of blade movement.

8. A rotary fan having several blades each with continuous working surfaces extending substantially to a common point at the axis of the fan, and a portion of each of said blades extending away from the main portion of the blade beyond said axis to partially surround said axis.

9. A rotary fan having blades with working surfaces extending substantially to a common point at the axis of the fan, each of said blades having two projecting portions extending away from the main portion of the blade one on each side of said axis to partially surround said axis.

10. A rotary fan having a plurality of radially extending blades each blade of which directly joins and intersects along a line the preceding and succeeding blade, the line of intersection of said blade with the preceding blade lying on one side of a plane perpendicular to the fan axis through the middle of the fan and the line of intersection of said blade with the succeeding blade lying on the other side of said plane.

11. A rotary propeller fan having a plurality of blades having intersecting portions at the intake and delivery sides of the fan to form a pair of spaced bosses said blades having pitched air propelling surfaces extending into the space lying between said bosses.

12. A rotary propeller fan having a plurality of blades having intersecting portions at the intake and delivery sides of the fan to form a pair of spaced bosses said blades having pitched air propelling surfaces extending into the space lying between said bosses, said pitched air propelling surfaces occupying substantially the entire projected area between said bosses.

13. A rotary propeller fan having a boss extending transversely across the axis of the fan, and having a plurality of radially extending air propelling blades secured to the boss in circumferentially spaced relation about the same, said boss viewed in an axial direction overlapping a part of the air propelling surface of said blades to protect the fan against loss of pressure at the center.

14. A rotary propeller fan having a plurality of radially extending blades arranged circumferentially about the fan axis, said blades being of generally triangular shape with a long side of the triangle extending along the circumference of the fan, said triangle having a pointed leading and blunt trailing portion, the extreme leading portion of the intake edge of said blades and the extreme trailing portion of the delivery edge having a distance between them greater than the radius of the fan.

15. A rotary fan having several radially extending air propelling blades arranged circumferentially about the axis of the fan, with adjacent blades completely overlapped by a substantial amount to close the fan in an axial direction against daylight, each of said blades having its least pitch at the intake edge and its greatest pitch at the delivery edge with the pitch thereof gradually increasing from the former to the latter.

16. A rotary propeller fan having a central boss and a plurality of air propelling blades extending from said boss, each of said blades having an intake edge extending from the boss to circumference of the fan, said edge being perpendicular to the fan radius adjacent to the boss and extending substantially in the direction of the fan radius at the circumference of the fan.

17. A rotary propeller fan having a central boss and a plurality of air propelling blades extending from said boss, each of said blades having an intake edge extending from the boss to the circumference of the fan, said edge being perpendicular to the fan radius adjacent to the boss and extending substantially in the direction of the fan radius at the circumference of the fan, said boss being a polygon in outline with one of the sides of the polygon substantially coinciding with the adjacent portion of said intake edge.

18. A rotary propeller fan having a boss, several separate radially extending air propelling blades secured circumferentially about the axis of the fan on said boss with air propelling portions of the blade spaced from and overlapping the boss, said blades being substantially overlapped to close the fan against daylight opening in an axial direction, the portion of said blades near the intake and delivery edges being of greater pitch adjacent the axis and lesser pitch adjacent the periphery.

19. A rotary propeller fan having several separate radially extending air propelling blades arranged circumferentially about the axis of the fan, the portion of said blades near the intake and delivery edges being of greater pitch adja-

cent the axis and lesser pitch adjacent the periphery, the pitch of the blade being substantially the same from axial end to periphery along a radius at the middle of the blade.

20. A rotary fan having several pitched blades having pitched portions thereof intersecting and engaging along their axial ends.

21. A rotary fan having a plurality of pitched fluid propelling blades arranged about the axis of the fan, the axial end portion of each blade directly intersecting and engaging the axial end portion of the following blade along a line extending outwardly from the axis toward the periphery of the fan and backwardly relative to the direction of blade movement, to guide the central intake air gradually toward the periphery away from the inner central portion of said following blade as the fan is rotated.

22. A rotary propeller fan having a tapered cupped boss and a series of pitched blades having their pitched portions joined to the tapered portion of said boss, each blade being generated by a straight line perpendicular to the axis.

23. A rotary propeller fan having a cupped boss closing the central portion of the fan to daylight when viewed axially, a series of fan blades attached to said boss, said blades overlapping one another from periphery to boss to provide a fan having its full disk area closed to daylight in an axial direction.

24. A rotary propeller fan having a plurality of pitched blades, having pitched portions thereof directly intersecting and engaging along their axial ends, each of said blades having a generally spiral form about the axis of said blades as a center, said blades being less than the normal pitch of the spiral near the intake edges thereof, and more than the pitch of the spiral at the discharge edge.

25. A rotary propeller fan having a plurality of pitched blades having pitched portions thereof directly intersecting and engaging along their axial ends with each blade having its intake edge on one side of the fan axis and its discharge edge at the other diametrically opposite side of said axis, to provide a fan having radiating blades with fluid propelling surfaces longer along a diameter of the fan than the radius of the fan.

26. A rotary shaft driven fan having a plurality of pitched blades having pitched portions directly intersecting and engaging along their axial ends and closing the entire area between the power shaft or projected power shaft area and the periphery of the blade.

27. A rotary fan having a plurality of pitched blades having pitched portions thereof directly intersecting and engaging along their axial ends and closing the entire area between the power shaft or projected power shaft area and the periphery of the blade, the extreme leading portion of the intake edge and each blade of the extreme trailing portion of the blade edge of each blade having a distance between them greater than the radius of the fan.

28. A rotary fan having a plurality of pitched air propelling blades arranged about the axis of the fan, the axial end portion of each blade directly intersecting at an acute angle the axial end portion of the following blade along a line extending outwardly from the axis and backwardly relative to the direction of blade movement to form an air guiding and compressing channel of V cross section between said blades.

29. A rotary fan having its central portion closed to daylight when viewed in an axial direction, comprising a plurality of overlapping pitched air propelling fan blades and a central boss overlapping pitched portions of said blades.

30. A rotary fan closed to daylight opening when viewed in an axial direction throughout its full disk area, comprising overlapped pitched fluid propelling blades and a boss overlapping pitched portions of the overlapping blades doubly protecting the central portion of the fan against said daylight opening.

31. A rotary fan having a shaft hole and a hollow cupped boss with its open side arranged transversely of the axis, and a plurality of pitched fluid propelling blades arranged in circumferentially spaced relation around the boss, one edge of each blade extending from substantial shaft hole or projected shaft hole to the periphery of the blade and another edge of each blade extending from the edge of said boss to the periphery of the blade.

32. A rotary fan having a plurality of blades radially arranged about the axis of the fan, and a boss extending transversely of the fan axis and having portions extending in between the fan blades viewed in the direction of the axis, the surfaces of the boss in between the blades being joined to and substantially conforming to the surfaces of the fan blades where said boss joins said blades.

33. A rotary fan comprising in combination a plurality of fan blades arranged about the axis of the fan, a boss adapted to serve as a spider to support the fan blades and to which the fan blades are joined with the face of the boss transverse to the fan axis, portions of the boss extending when viewed axially, in between the fan blades, said portions having pitched air propelling working surfaces.

34. A rotary propeller fan having a pyramidal or conical shaped boss located with its apex at the axis of the fan and its base transverse to the axis, said fan having several fluid propelling blades arranged radially about the boss with the inner axial portions of the blades forming the sides of said pyramidal or conical boss.

35. A rotary fan having a pyramidal or conical boss located with its apex at the axis of the fan and its base transverse the axis with several pitched fluid propelling blades forming a continuation of the side surfaces of the pyramidal or conical boss and extending to the periphery of the fan.

36. A rotary fan having its full disk area closed to daylight in an axial direction comprising a plurality of pitched fluid propelling blades overlapping from their periphery to their inner axial ends and having pitched portions thereof directly intersecting and engaging along said axial ends.

37. A rotary fan having a boss tapering axially from a base and a series of fan blades secured to the tapered portion of the boss, each blade with an edge at the base of the boss and with a working surface extending along the tapered surface of the boss.

38. A rotary propeller fan having a boss and a series of fan blades extending outwardly from said boss, the trailing edge of said blades having a double curvature with a convex edge portion and a concave edge portion, the latter of which is located between the boss and the convex edge portion.

39. In a rotary propeller fan, a boss tapering axially from a base towards an apex and a plurality of blades carried by said boss each having working surfaces generated by the movement

about the axis of the fan, of a straight line having one end in the said axis and the other at the periphery of the blade.

40. A rotary fan having a boss, tapering axially from a base towards an apex and blades extending from said boss, said blades having working surfaces generated by a straight line at right angles to the axis moved with the inner end of the generating line lying along the sloping surface of the tapered boss and with the outer end of the line at the periphery of the blade.

LAWTON R. MORAY.
THEODORE E. MERWIN.