

July 19, 1932.

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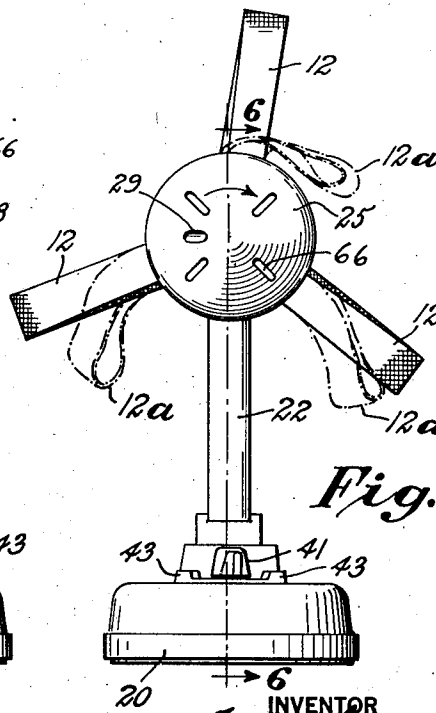
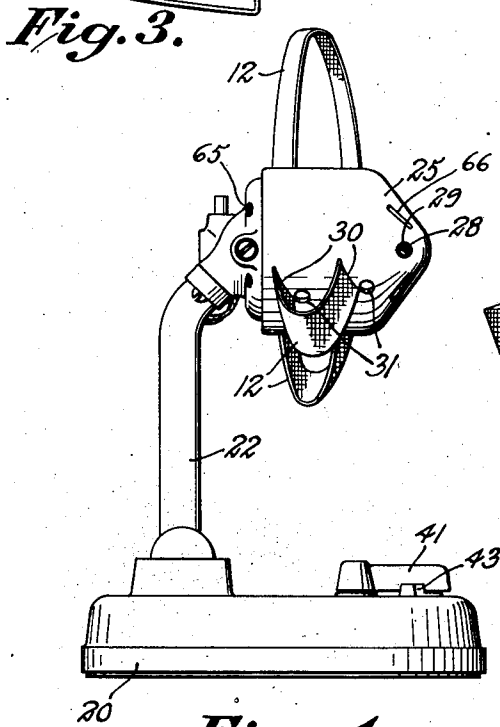
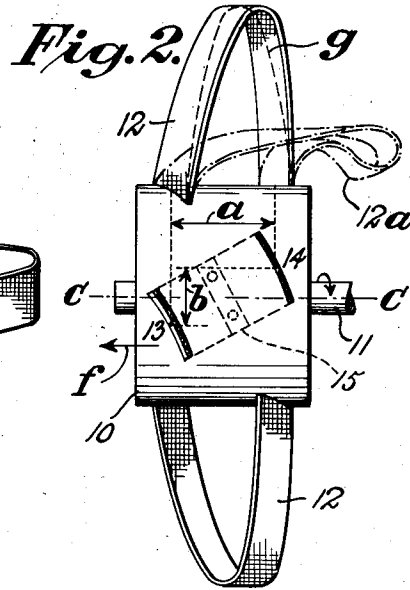
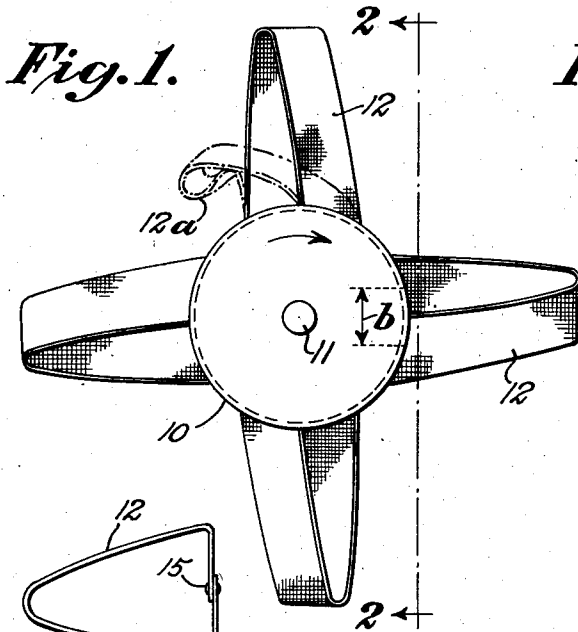


Fig. 5.

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Fig. 6.

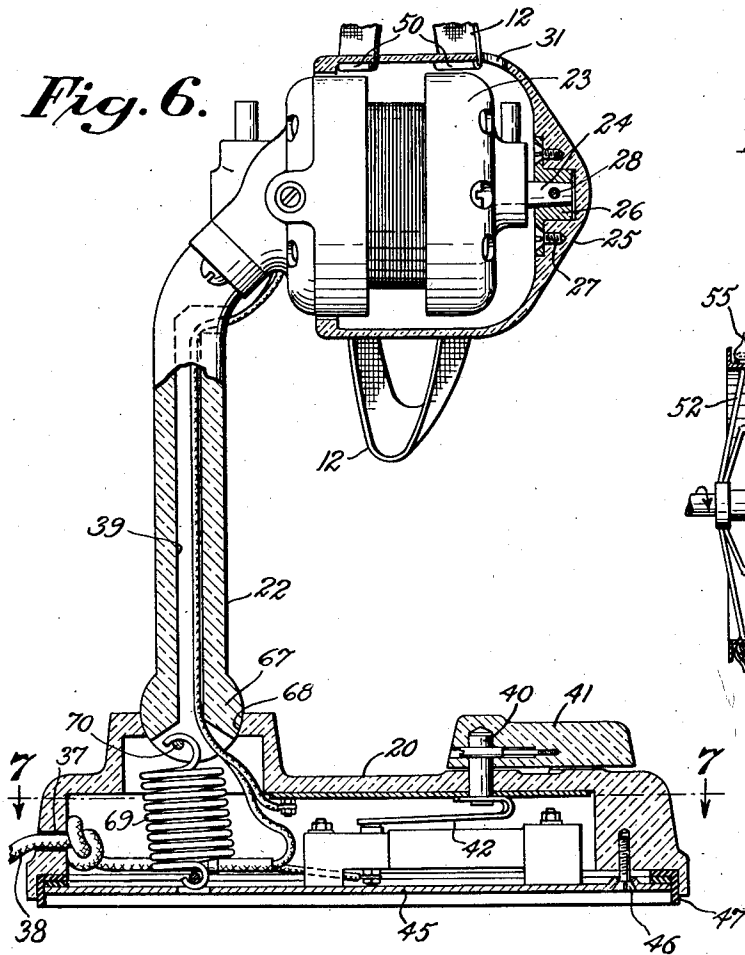


Fig. 8.

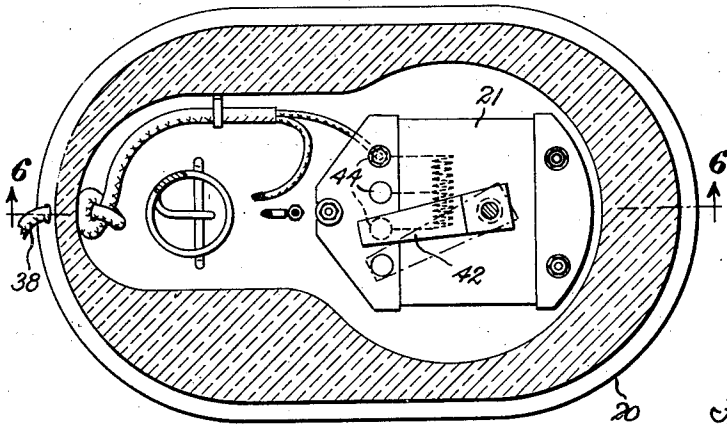
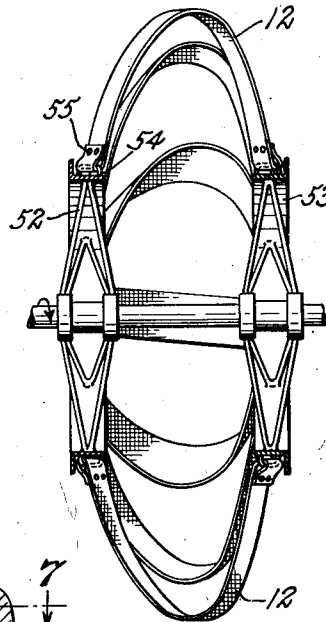
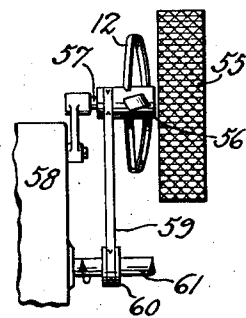


Fig. 7.

Fig. 9.



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Application filed May 29, 1931, Serial No. 540,931, and in Sweden September 22, 1930.

My invention relates to fans and more particularly to the type of fan or diffuser which is used in a room, such as a room of a home or an office, for producing a movement of air for cooling purposes, which type of fan may be referred to as domestic. However, my improved fan is not limited to domestic use, but is also applicable to commercial uses.

10 The average electric fan of the domestic type comprises stiff metal blades. Invariably these fans are surrounded by a guard for the reason that an unprotected fan is a source of danger. It is one object of my invention to do away with a guard for a fan. To accomplish this I have devised a fan including blades or vanes or wings of non-elastic flexible material. At the same time the aim of the invention is to provide a fan which is stable and steady in operation. To this end, I combine with the soft flexible vanes a form of construction which gives stability to the fan structure.

25 Not alone in domestic fans, but in commercial fans of larger size, there is a danger of accident from the use of rigid fan blades. This is true, for example, of automobiles and air planes. My improved fan is applicable to various uses where it is desirable to eliminate risk of accident due to a fan and at the same time to have a fan which is stable in operation.

35 A further object of my invention is to provide a portable fan which requires the minimum of space and which can be folded up for carrying purposes to small size.

40 In the preferred form of my invention I provide vanes made of ribbons or strips of cloth, chamois skin, canvas, duck or other flexible and limp or non-elastic material. These ribbons are attached to a hub at axially disposed points and are loose or slack between their places of attachment to provide loop blades adapted to be thrown out by centrifugal force in a manner analogous to that of a jump rope as used by children. In general, it may be said that this causes the ribbons or vanes or blades to take on a shape which may be appropriately called a

centrifugal catenary. Assume a chain or rope secured at its ends at spaced points on a rotating shaft. The curve of the rope or chain is determined essentially by the resultant of the centrifugal force and the tensile forces within the rope or chain. If a number of chains or ropes are so arranged and side by side with respect to each other so as to simulate a number of jump ropes of similar length held by a child at play, it will be understood that the group of ropes or chains together form a surface which is determined by centrifugal force and tensile stresses within the rope or chain aggregate. If these ropes or chains are imagined woven together into a strip or band and the ends thereof are held obliquely in like sense with respect to the axis of rotation, there is obtained a picture of a rotating blade such as proposed by the invention. It is also appropriate to say that such a strip takes on a shape defined by the term centrifugal catenary.

75 If this rotating wing or blade is subjected to lateral pressure, for example, air pressure, the catenary curve is displaced somewhat from its symmetrical balanced position with respect to the two points of support at the end of the curve, but if the rope, or chain, or strip, is of sufficiently heavy material, this displacement of the catenary curve becomes small because the centrifugal force, when the catenary curve assumes an oblique position, counteracts the displacing force in such manner that the internal tensile stresses oppose the external displacement forces. If a fan blade, constructed according to this principle, be studied, it will be found that when the speed is changed, the fan is always able to permit an increased lateral pressure on the blade, inasmuch as the centrifugal force, as well as the air pressure produced on the blade, increases in accordance with the square of the velocity.

95 My invention will be made clear by reference to the accompanying drawings, forming part of this specification and in which are illustrated preferred forms and adaptations of the invention.

Referring to the drawings:

Fig. 1 is a front view of a fan in accordance with the invention;

Fig. 2 is a side view taken on the line 2—2 of Fig. 1;

Fig. 3 shows one manner of fastening together the ends of the ribbon forming the blade;

Fig. 4 is a side view of a portable or domestic electric fan embodying the invention;

Fig. 5 is a front view of the fan shown in Fig. 4;

Fig. 6 is a cross-sectional view taken on the line 6—6 of Figs. 5 and 7;

Fig. 7 is a horizontal cross-sectional view taken on the line 7—7 of Fig. 6;

Fig. 8 shows another form of fan embodying the invention; and

Fig. 9 shows a fan embodying the invention applied to the cooling of the radiator of an automobile.

Referring more particularly to Figs. 1, 2 and 3, reference character 10 designates a cylindrical hub having an appreciable axial extent. Hub 10 is mounted on a shaft 11, which may be rotated by any suitable prime mover. Secured to the hub 10 are a plurality of vanes or blades 12. These blades are made of strips or ribbons of limp or non-elastic flexible material, the weight and strength of which may vary with different sizes of fans. Preferably the material is relatively strong and sturdy such as heavy cloth or it may be made of what is known as canvas or duck. As shown, the strips used are parallel edged, but this not a prime requisite.

Strips 12 are secured to the hub 10 at spaced points or plates (13 and 14). In the form shown, these points are spaced both axially and circumferentially. The average axial displacement is indicated by a . The average peripheral or circumferential displacement is indicated by b . The places of attachment 13 and 14 are determined by slots in the hub. The strips pass through these slots and are riveted or sewed together at 15. The slots, as shown in Fig. 2, are oblique to the axis of rotation $c-c$. It follows, from what has been said above, that the slots are axially and circumferentially disposed by the distances a and b , respectively. As shown in Fig. 2, the slots are somewhat curved. This, it will be understood, is in accordance with recognized fan blade or propeller design since the ribbons are to act like rigid blades to cause a current of air in the general direction of the arrow f . The slots at 13 and 14 need not be exactly parallel, but the slot at 13 may be slightly more inclined to the axis than the slot at 14, to take care of the increase in velocity of the air stream after leaving what may be termed the forward blade section at 14 and approaching the after blade section at 13.

When the fan is at rest the blades are limp, being made of soft material, such, for example, as herringbone-woven coarse cloth, and may assume position such as indicated at 12a. When the hub is rotated, the blades are thrown out, due to centrifugal force, and assume a form substantially as shown in full lines in the drawing. It will be seen that the curve is substantially a centrifugal catenary, as above defined, being slightly displaced oppositely with respect to the direction of air flow on account of the lateral air pressure. The symmetrical position is shown in a dotted line g . The actual position deviates slightly from this dotted line g . The extent of displacement is not great and may vary somewhat in accordance with the kind of material used for the ribbon blades. The axial displacement of the points of attachment causes the blade structure to become relatively rigid. It will be seen that if a single straight piece made of soft material were used, as in an ordinary fan blade made of soft material, it would be bent backwards by the reactionary force of the air pressure and would not have stability. The arched construction obtained by the axial displacement of the points of attachment of the ribbon provides a support for the fan blade. In the arrangement shown in Figs. 1 and 2, the effective lengths of the blade, that is, the arched portions, are at least three times as long as the distance between the slots. This proportion may be varied and different characteristics may be obtained by varying the free length of ribbon with respect to the distance between slots. If desired, the cloth ribbon may be suitably edged.

It will be seen that no guard is provided for the reason that no guard is necessary. Even though the fan is rotated at high speed by an electric motor, a finger may be inserted or caught in the ribbon vane and no injury will be done. Even if there is a direct mechanical connection to a powerful prime mover, the fan blade may strike an object and yet there is no danger of injury to materials since the fan blade, being made of soft material, can be deflected. A fan of this type can be made with much greater diameter than an ordinary rigid fan. Consequently it can circulate larger quantities of air than a smaller fan with speedier and more intensive air circulation, and it is better suited to spread a pleasant breeze in a room of a dwelling.

In Figs. 4 to 7, inclusive, is shown a complete portable or domestic electric fan embodying the invention. This fan comprises a base 20. Pivotaly secured to the base 20 is an upwardly extending arm 22, to the upper end of which is secured an electric motor 23. Motor 23 is provided with an armature shaft 24 to which is secured a hollow hub 25. Hub 25 is of such dimensions and so formed as to substantially enclose motor 23. Hub 25 is

provided with a bushing 26 secured thereto by means of screws 27, which bushing is in turn secured to shaft 24 by means of a set screw 28, which may be made accessible from outside the hub through a hole 29. Hub 25 is preferably made of a phenol condensation product which is incapable of conducting electricity, should the motor become grounded to the shaft. The hub has a relatively long axially extending portion laterally of the motor.

The fan of this embodiment is provided with three blades or vanes 12. It will be understood that the number of vanes may be varied. The hub is provided with pairs of slots 30 for receiving the ribbons 12. In this case, the vanes are secured to the hub by being folded over and sewed at the ends 50. It will be obvious that various ways may be used to secure the vanes in the hub. The slots 30 are shown as arcuate, but it will be understood that they may be straight. The slots are axially and circumferentially spaced and extend obliquely with respect to the axis of the hub. It will be understood that axial displacement is more important than peripheral displacement, and though peripheral displacement is preferable, it is not necessary. Each slot terminates in a circular hole 31, which makes it possible to insert or remove a vane without removing the hub from the motor and for the purpose of facilitating replacement. It may be advisable in certain cases to use glue or other material for more firmly holding the vanes in the slots. Instead of sewing over the ends, it is also possible to provide other securing means as by bending over the ends of the ribbons and fastening them to the hub or using metal fasteners having teeth.

The base 20 is provided with an opening 37 through which passes an electric cord 38 comprising two conductors. One of the conductors passes directly to a passageway 39 within arm 22 to one terminal of motor 23. The other conductor is led to a terminal of a rheostat 21 within base 22. The other terminal of the rheostat 21 is connected to the motor 23 by a second conductor passing through arm 22. Rheostat 21 may be of any desired type and is here shown as being provided with three contact points 44. Journalled in base 20 is a vertical pin 40 to the upper end of which is secured a handle 41 and to the lower end of which is a spring contact member 42. Handle 41 is adapted to be rotated or turned between points limited by stops 43. Upon rotation of handle 41, member 42 is caused to successively contact the points 44 on the rheostat. When member 42 is in the position shown in dot and dash lines in Fig. 7, the circuit is open and the fan is not operating. Upon movement of member 42 into contact with the first point 44, as shown in full in Fig. 7, the circuit is closed through the

rheostat, all the resistance of the rheostat being in the circuit, and the motor operates at low speed. Upon movement of the member 42 into contact with the next point, a portion of the resistance is shunted and the speed of the motor increased. Upon contact with the next point, further resistance is shunted, while contact with the last point shunts the entire rheostat and the motor operates at full speed. Obviously, the invention may be embodied in a fan which does not use a rheostat.

The bottom of base 20 is closed by means of a plate 45 which may be secured to the base by screws 46. Around the lower edge of the base is placed a ring 47 of rubber or the like which rests upon the surface, such as a table, which supports the fan.

When the fan is not operating, the blades are limp, as described in connection with the embodiment of Figs. 1 and 2. Upon rotation of the fan, the blades assume a position substantially as shown. The operation of the fan is the same as described in connection with Figs. 1 and 2 and it is not necessary to here repeat it.

If necessary, in order to cool the electric motor, the windings may be designed to give a fan action and holes as at 65 and 66 may be provided for allowing passage of air. If desired, a separate fan element may be used for cooling the motor or the hub 25 may be so made as to produce air circulation, as with integral oblique vanes inside the openings in the cone-shaped head.

The arm 22 is formed with a rounded bottom portion 67 which seats in a correspondingly curved recess 68 in an upper extension of the base member 20. A spring 69 pivoted to the base member and to a pin 70 in the arm 22 serves to pull arm 22 downwardly into the opening 68. Friction of the parts holds arm 22 in any position in which it is placed by hand. The joint formed by the part 67 and the journalled surface 68 is preferably such that the motor may be folded downwardly close to the base member. Since the fan has no guard member, it will be seen that this provides a unit which can be readily carried and packed for traveling purposes.

The base and arm are indicated as made of a phenol condensation product such as bakelite, but it will be understood that they may be made of other substances such as metal or wood.

In Fig. 8 I have shown a fan in which the hub is made up of two axially displaced wheels 52 and 53. The blades in this case are secured to the wheels by U-shaped metal pieces 54 secured to the wheels. The ribbons are threaded through the members 54 and are riveted or sewed at 55. The vane 12 may be of leather or material similar to that previously described. It will be seen that my invention is also applicable to fans of the

radial flow type as well as the axial flow type. The arrangements herein described are of the axial flow type.

In Fig. 9 I have shown my new fan adapted to the cooling of an automobile radiator 55. The fan blades 12 of non-elastic flexible material are mounted in an extended hub 56. This hub is mounted on a shaft 57 suitably secured to the engine 58. The fan may be rotated by the usual belt 59 running over a pulley 60 on the crank shaft 61. It is well known that the breakage of a rigid fan blade in an automobile fan may cause injury to a radiator since radiators are generally made of light construction. With my fan it will be seen that there is no danger of this.

From the foregoing description and accompanying drawings, it will be evident that fans embodying the invention may have widely varying physical forms and that a wide variety of materials may be used which may differ in some of their characteristics provided they are pliable, that is, easily bent or twisted and are of such shape, preferably flat or ribbon-like, as to be suitable for blading and having an operating contour influenced by the action of centrifugal force.

It will further be understood that the scope of my invention is not to be limited to the embodiments illustrated by way of example, but is to be determined by the scope of the appended claims when considered in the light of the prior art.

What I claim is:

1. A fan comprising a rotatable member and a blade comprising a strip of pliable material mounted on said member in slack condition between spaced places thereon, said strip being bowed outwardly from said member between said spaced places due to centrifugal force on rotation of said member and being mounted so that portions thereof provide axially spaced air propelling surfaces.

2. A fan comprising a rotatable member and a blade comprising an elongated strip of pliable material mounted at longitudinally remote places of said strip on said member in slack condition between spaced places of said member, the side edges of said strip being of substantially the same length between the places of mounting, part of said strip being constrained by said member to have substantially fixed position angularly to the peripheral path of travel of such part, and said strip being free between the places of mounting to assume centrifugal catenary form and providing air propelling surface on rotation of said member.

3. A fan comprising a rotatable member and a blade comprising an elongated strip of pliable material mounted at longitudinally remote places of said strip on said member in slack condition between spaced places of said member, the side edges of said strip being each several times as long as the direct dis-

tance between the places of mounting, part of said strip being constrained by said member to have substantially fixed position angularly to the peripheral path of travel of such part, and said strip being free between the places of mounting to assume centrifugal catenary form and providing air propelling surface on rotation of said member.

4. A fan comprising a rotatable member and a blade comprising an elongated strip of pliable material mounted at longitudinally remote places of said strip on said member in slack condition between spaced places of said member, the side edges of said strip being each substantially longer than the direct distance between the places of mounting, part of said strip being constrained by said member to have substantially fixed position angularly to the peripheral path of travel of such part, and said strip being free between the places of mounting to assume centrifugal catenary form and providing, on rotation of said member, a plurality of air propelling surfaces joined remote from the axis of rotation at a substantially tangential portion of the blade.

5. A fan comprising a rotatable member and a blade comprising a relatively narrow strip of limp or non-elastic and flexible material secured to said member in slack condition between spaced places thereon and part of said strip being constrained by said member to have substantially fixed position angularly to the peripheral path of travel of such part.

6. A fan comprising a rotatable member and a blade comprising a strip of pliable material mounted on said member in slack condition between spaced places thereof, said strip being thrown outwardly like a jump rope from said member on rotation of said member and part of said strip being constrained by said member to have substantially fixed position angularly to the peripheral path of travel of such part.

7. A fan comprising a rotatable member and a loop blade of ribbon-like pliable material, the end portions of the loop being secured to said member at spaced places thereon with the material in slack condition and at least one of said end portions joining the rotatable member obliquely to the axis of rotation of said member.

8. A fan comprising a rotatable member and a loop blade comprising a strip of fabric, the end portions of said strip being secured to said member at spaced places thereon with the strip in slack condition and one of said end portions being oblique with respect to the axis of rotation of said member.

9. A fan comprising a rotatable member and a blade comprising a ribbon-like strip of pliable material secured to said member at axially spaced places thereon and obliquely to the axis of rotation of said member, said

strip being extensible outwardly from said member between said spaced places.

10. A fan comprising a hub, means for rotating said hub, and a blade comprising an elongated strip of pliable material having places thereof relatively far apart in stretched condition secured in slack condition between substantially closer spaced places of said hub, the strip being obliquely disposed with respect to the axis of the hub adjacent to one of the places of attachment thereto, said blade being free to assume substantially the form of a centrifugal catenary curve on rotation of the hub.

11. A fan comprising a hub, means for rotating said hub, and a blade, said blade comprising an elongated strip of relatively soft flexible material having places thereof relatively far apart in stretched condition secured in slack condition between substantially closer spaced places of said hub, the strip being obliquely disposed with respect to the axis of the hub adjacent to one of the places of attachment thereto, said blade being free to assume substantially the form of a centrifugal catenary curve on rotation of the hub.

12. A fan comprising a hub, means for rotating said hub, and a blade, said blade comprising an elongated strip of relatively soft flexible material having places thereof relatively far apart in stretched condition secured to said hub in slack condition between substantially closer axially spaced places of said hub and free to be thrown outwardly and to derive its operating contour due to centrifugal force upon rotation of said hub and constrained by said hub to provide a plurality of axially spaced air-screw surfaces, said strip being limp when at rest.

13. A fan comprising a hub, means for rotating said hub, and a blade, said blade comprising an elongated strip of relatively soft flexible material secured to said hub at axially and peripherally spaced places and adapted to derive its operating contour due to centrifugal force upon rotation of said hub and providing air-screw surface, said strip being limp when at rest.

14. A fan comprising a hub, means for rotating said hub, and a blade, said blade comprising a strip of relatively soft flexible material having places thereof relatively far apart in stretched condition secured at a plurality of more closely spaced places on said hub and adapted to derive an operating contour due to centrifugal force of substantially centrifugal catenary form upon rotation of said hub, said strip being angularly disposed with respect to the axis of the hub and its peripheral path of travel at one of the places of attachment thereto and being limp when at rest.

15. A fan comprising a hub, means for rotating said hub, and a blade, said blade

comprising a strip of relatively soft flexible material having places thereof relatively far apart in stretched condition secured at a plurality of more closely spaced axially disposed places on said hub and adapted to derive an operating contour due to centrifugal force of substantially centrifugal catenary form upon rotation of said hub, said strip being joined to the hub oblique to the axis of the hub and oblique to its peripheral path of travel and being limp when at rest.

16. A fan comprising a rotatable member and a loop blade for displacement of air axially of said member upon rotation thereof, said blade comprising a ribbon-like strip of fabric and the ends of the blade being secured at axially spaced places on said member and arranged obliquely with respect to the axis of rotation of said member.

17. A fan comprising a rotatable member and a loop blade for displacement of air axially of said member upon rotation thereof, said blade comprising a ribbon-like strip of relatively soft pliable material, the ends of said blade being secured to said member at axially spaced places and joining said member along curved lines generally oblique to the axis of rotation of said member.

18. A fan comprising a rotatable hub having a peripheral surface formed with a pair of spaced slots at least one of which extends angularly with respect to the axis of rotation of the hub and a ribbon-like strip of relatively soft pliable material providing a loop blade having ends secured in said slots.

19. A fan comprising a rotatable hub, said hub being formed with a pair of axially spaced slots on the periphery thereof extending obliquely to the axis of rotation of the hub and a ribbon-like strip comprising pliable fabric providing a loop blade having ends secured in said slots.

20. A fan comprising a hollow rotatable hub, said hub being formed with a pair of spaced slots extending through the peripheral wall of the hub, at least one of said slots being disposed at an angle with respect to the axis of rotation of the hub, and a ribbon-like strip of pliable material providing a loop blade having ends passing through said slots to the interior of said hub, said ends being enlarged within the hub to prevent them from being withdrawn through said slots due to centrifugal force acting on said strip.

In testimony whereof I hereunto affix my signature.

FREDRIK LJUNGSTROM.