

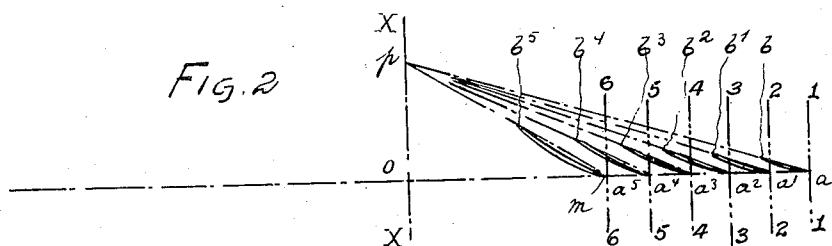
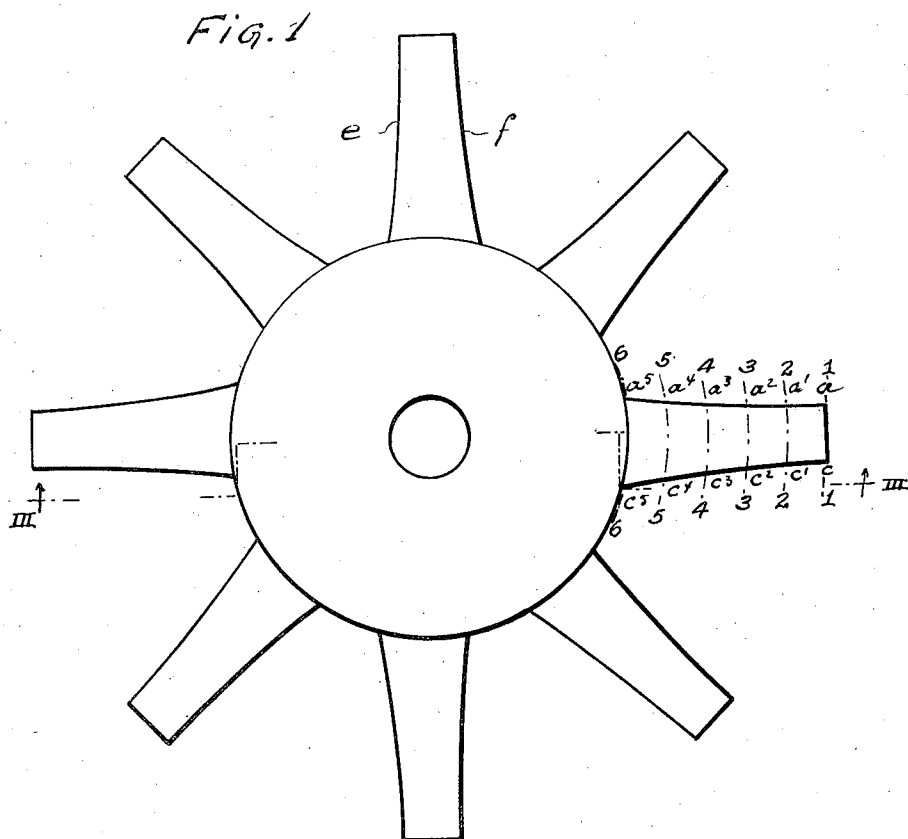
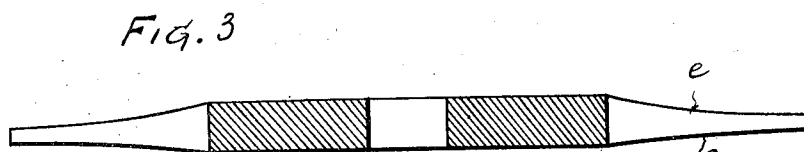
Oct. 26, 1937.

R. DE MEY ET AL
FAN BLADE OR THE LIKE

2,097,389

Filed June 26, 1933

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

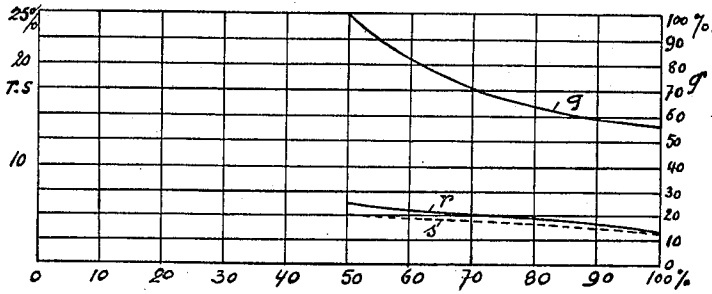


Fig. 10.

Fig. 4

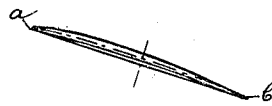


Fig. 5. a'

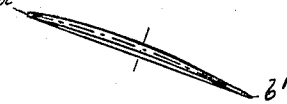


Fig. 6. a''

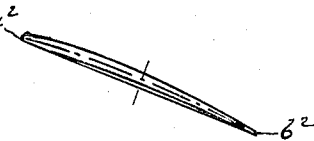


Fig. 7.

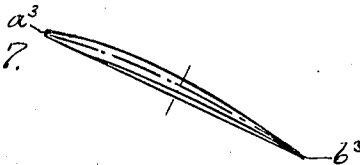


Fig. 8.

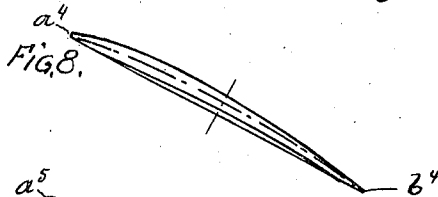
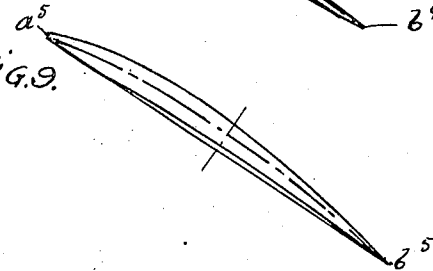


Fig. 9.



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UNITED STATES PATENT OFFICE

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FAN BLADE OR THE LIKE

René De Mey and Paul Havard,
Brussels, BelgiumApplication June 26, 1933, Serial No. 677,746
In Germany July 7, 1932

8 Claims. (Cl. 170—159)

The invention relates to the construction of screw fan blades and its object is to provide a blade arrangement such that, in addition to giving a high efficiency, the construction is simpler and at the same time the blade answers the requirements of practice better than those proposed heretofore.

It is known that the maximum efficiency of a propelling screw implies the production of a constant pressure and constant axial velocity in the whole of the area swept out, and certain known forms of construction are adapted to provide screws of high efficiency, but they are of a complicated form.

In view of the present general tendency, however, to cast these screws in a foundry, it is essential that the blades should be given the simplest form.

Among screws of high efficiency, those regarded heretofore as being the most advantageous comprise a geometrical pitch which is a maximum in the section near the hub, and also comprise a blade width which increases towards the hub. It is precisely this type of screw which, chiefly on account of the variation in the geometrical pitch, offers considerable difficulties in moulding, and necessitates complicated and expensive patterns and foundry methods.

In addition for the same reason, and also because of the increase in the width towards the hub, the latter must necessarily have a considerable axial development. The resulting high weight of the screw naturally involves an appropriate construction of the supporting and other members of the fan and has an unfavourable influence upon the first cost.

If efforts are made to obviate the disadvantage of the said considerable axial development of the hub by the device of doubling the blades, the result is either impossibility of construction in certain cases or still more pronounced foundry difficulties, such as more particularly when the doubling of the blade necessitates a second row of blades.

The invention obviates these difficulties.

In fact, it follows from studies and experimental investigations that it is possible to obtain a constant pressure in the whole of the area swept out by a screw blade of wing or aerodynamic profile if, while maintaining constant the geometrical pitch, the relative curvature and the relative thickness of the sections of the blade are caused to vary suitably at the same time as the width of the blade, such that the said values increase in proportion as the hub is approached

and are a maximum at the intersection of the blade with the hub.

In a wing of aerodynamic profile, each section thereof presents a thickness which varies from end to end and passes through a maximum value at an intermediate point of the length of the section.

When this maximum thickness of a section is related to the width of the section, that is to the length of the chord joining the ends of the section, a ratio is obtained which is termed the relative thickness of the section.

Also if in each of these sections, a median line is traced, i. e., a line located intermediate of and equally distant from the two lines bounding the section on the pressure and suction sides of the wing respectively, the distance from this line to the chord uniting the ends thereof will vary from end to end of the section and passes through a maximum value at an intermediate point of the length of the chord. When this maximum distance or maximum ordinate of the median line of a section is related to the width of the section, that is to the length of the chord joining the ends of said section, a ratio is obtained which is termed the relative curvature of the section.

If for an aerofoil of a given profile, the relative thickness or the relative curvature, or both are varied, modifications of the values of the thrust produced by said aerofoil are obtained.

In helical fans having a maximum geometrical pitch at the intersection of the blade and the hub, it is known that the drop in pressure is compensated by the use of large angles of incidence or attack, which results in the increase in the geometrical pitch towards the hub. However, the maximum angle of incidence which may be used for the aerodynamic profiles of the blades of propelling screws and fans is about 8°, angles of incidence of greater value leading to an increase in the resistance without any increase in the thrust.

If an angle of 4° is taken as the average angle of incidence the thrust increases 20 to 25% when the said angle becomes 8°.

It follows from the investigation and experiments mentioned hereinbefore that all things being equal, starting for example with a relative thickness of 0.075 and a relative curvature of the same value, as currently utilized for average pressures, and doubling for example the relative thickness by giving it the value of 0.15, it is found that the thrust is increased by about 15%. If the value of the relative curvature is doubled, the thrust increases by about 20%.

The combined increase of the relative thickness and of the relative curvature thus renders it possible to attain very easily by this means the result obtained by increasing the angles of incidence.

Accordingly, the invention consists in varying in a blade or wing or aerodynamic profile and of constant geometrical pitch, in the successive sections, from the extremity to the hub, the relative curvature, the relative thickness and the width of the blade in such a manner that the relative curvature, the relative thickness and the width are a maximum at the intersection of the blade with the hub.

The increase of each of these elements—relative curvature, relative thickness and width—may be continuous or may be effected progressively in steps. One or the other of the elements may retain a constant value over a more or less extensive portion of the length of the blade and may afterwards increase more rapidly. Finally, any increase which one or even two elements are to receive according to their normal law of increase may be replaced by a more pronounced increase of the other element or elements.

Of course in constructing screw blades as specified hereinbefore one of the edges, for example the leading edge, may be given a rectilinear form looking at the screw from the front, that is to say, along the axis of rotation. However, screws having blades of this form make a good deal of noise.

It has been found possible to reduce substantially the noise caused by the rotation of the screw if, instead of giving the edge a rectilinear form it is given on the contrary a curved shape, preferably concave.

The same applies to the rear edge and accordingly the invention likewise consists in giving to one or both of the edges of the blade a curved shape, preferably concave, looking at the screw from the front, that is to say, along its axis of rotation.

By virtue of these same considerations, the edge or both edges of the blade, viewed from the side are given a curved form, preferably concave.

The invention also consists, therefore in giving to one or both edges of the blade a curved form, preferably concave, looking at the blade from the side, that is to say, perpendicular to the axis of rotation.

Finally, in order to provide a clear understanding of the manner in which a screw according to the invention may be constructed in practice, a preferred form of construction is shown in the accompanying drawings wherein:

Figure 1 is a front view of a screw.

Figure 2 is a constructional diagram of a blade.

Figure 3 is a side view of the screw according to Fig. 1 in part section taken along the line III—III in the said Fig. 1.

Figures 4 to 9 represent on a larger scale the successive sections of a blade of Fig. 1.

Figure 10 is a diagram showing the variations in width, relative thickness and relative curvature of a screw blade along the length of the latter.

Referring first of all to Figure 2, XX denotes the axis of rotation, om the radius of the hub and op the

$$\frac{\text{pitch}}{2\pi}$$

$ab, a'b'$. . . represent conventionally the successive sections obtained along 1—1, 2—2 . . . 6—6 from tenth to tenth of the lengths of the

blade, the leading edge being rectilinear and the sections being turned over into the plane of the figure.

It will be seen that the chords $ap, a'p, a''p$. . . meet in the point p on the axis XX, showing that the geometrical pitch is constant.

On the other hand, the width, relative thickness and relative curvature increase progressively from the section $a-c$ in the direction of the hub.

Figures 1 and 3 represent in front view and side view, in part section, a screw having blades constructed according to Fig. 2, but the leading edge e has been reduced to a concave, curved profile, viewed both from the front and from the side.

It will be seen that, under such conditions, the rear edge f likewise assumes a concave form.

In Figs. 4 to 9, which show on a larger scale, the successive sections $ab, a'b'$. . . of a blade of the screw according to Fig. 1, turned over about hinge lines passing through the points a and c, a' and c' . . . a^5 and c^5 , Fig. 1, the variations in width relative thickness and relative curvature will be noted more clearly. The said variations are also indicated in Fig. 10 by the curves q, r and s respectively, showing the continuous increase of the values of these functions as the hub is approached.

The application of the invention provides screws of a high efficiency which may be easily constructed by moulding, which have a hub possessing a small axial development and which are consequently of small weight.

In addition, they are relatively silent.

Of course, the screw shown is only one example, which may be modified without departing from the invention, and more particularly, as previously indicated herein, the increase in the width relative thickness and relative curvature, while being progressive may not be continuous but may proceed by successive steps. One or more of these elements may remain constant over a more or less extensive portion of the length and may afterwards vary in a pronounced manner. Finally, a lesser increase or even the absence of increase of one or more of the said elements over a portion of the length of the blade may be compensated by the more pronounced increase of the other element or elements.

We claim:

1. A helical fan or like blade for propelling a fluid with a constant pressure in the whole of the area swept out by said blade, comprising curved sections of aerodynamic profile constructed with a geometric pitch of the working face of constant value in all the sections and with a relative thickness, a relative curvature and a width of which the values are a maximum at the intersection of the blade and the hub and decrease progressively from the hub to the tip.

2. A helical fan or like blade for propelling a fluid with a constant pressure in the whole of the area swept out by said blade, comprising curved sections of aerodynamic profile constructed with a geometric pitch of the working face of constant value in all the sections and with progressively increasing values of relative thickness, relative curvature and width in the successive sections from minimum values at the periphery to maximum values at the hub.

3. A helical fan or like blade for propelling a fluid with a constant pressure in the whole of the area swept out by said blade, comprising arcuate sections of aerodynamic profile constructed with a geometric pitch of the working face of constant

value in all the sections and with continuously increasing values of relative thickness, relative curvature and width in the successive sections from minimum values at the periphery to maximum values at the hub.

5 4. A helical fan or like blade for propelling a fluid with a constant pressure in the whole of the area swept out by said blade, comprising curved sections of aerodynamic profile constructed with a geometric pitch of the working face of constant value in all the sections and with a relative thickness, a relative curvature and a width the values of which increase by successive steps from minimum values at the periphery to maximum values at the hub.

10 5. A helical fan or like blade for propelling a fluid with a constant pressure in the whole of the area swept out by said blade, comprising curved sections of aerodynamic profile constructed with a geometric pitch of the working face of constant value in all the sections and with a relative thickness, a relative curvature and a width increasing from minimum values at the periphery to maximum values at the hub, and the said relative thickness, relative curvature and width being a maximum at the intersection of the blade with the hub, one or more of these elements, in relative thickness, relative curvature and width, remaining constant on a more or less extensive portion of the length of the blade while the increase in the said element or elements is more pronounced in other portions and the absence of increase being compensated by an appropriate more pronounced increase of the remaining element or elements.

35 6. A helical fan or like blade for propelling a fluid with a constant pressure in the whole of the area swept out by said blade, comprising curved

sections of aerodynamic profile constructed with a geometric pitch of the working face of constant value in all the sections and with a relative thickness, a relative curvature and a width increasing from minimum values at the periphery to the hub and the said relative thickness, relative curvature and width being a maximum at the intersection of the blade and the hub, wherein the leading edge of the blade is of a generally concave shape, the blade being viewed from the front.

10 7. A helical fan or like blade for propelling a fluid with a constant pressure in the whole of the area swept out by said blade, comprising curved sections of aerodynamic profile constructed with a geometric pitch of the working face of constant value in all the sections and with a relative thickness, a relative curvature and a width increasing from minimum values at the periphery to the hub and the said relative thickness, relative curvature and width being a maximum at the intersection of the blade and the hub, wherein the leading edge is of a generally concave shape, the blade being viewed from the side.

25 8. A helical fan or like blade for propelling a fluid with a constant pressure in the whole of the area swept out by said blade, comprising arcuate sections of aerodynamic profile constructed with a geometric pitch of the working face of constant value in all the sections and with a relative thickness, a relative curvature and a width increasing from minimum values at the periphery to the hub and the said relative thickness, relative curvature and width being a maximum at the intersection of the blade and the hub, wherein both edges of the blade are concave, the blade being viewed from the front and from the side.

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