Fig.1.

Fig.2.

Fig.3.

M. Adamcikas
& G. massera
INVENTORS

By: Marks & Clerk
ATTYS.

Nov. 10, 1931.   1,831,729

MYKAS ADAMCIKAS, ALSO KNOWN AS MICHAEL ADAMTCHIK
AND GIUSEPPE MASSERA
BLADE OF FANS OR VENTILATORS
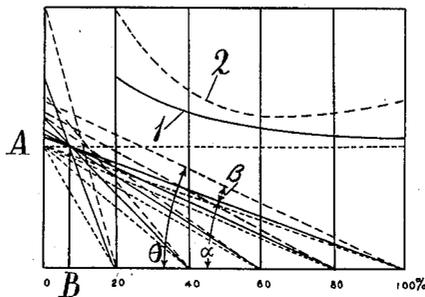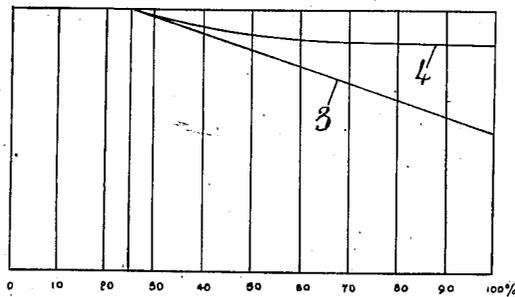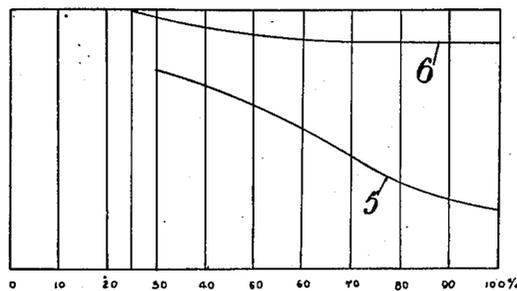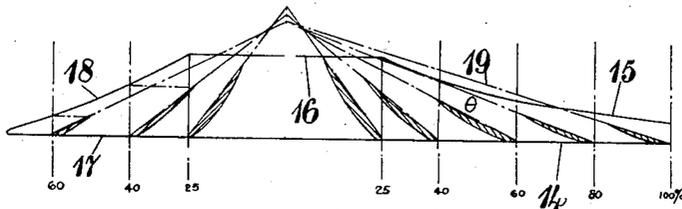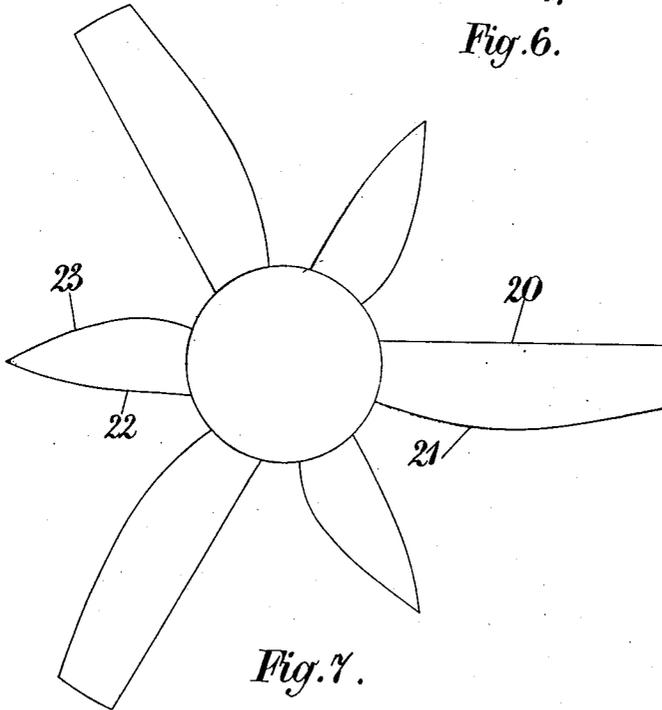Filed March 18, 1929   3 Sheets—Sheet 2

Fig.4.

Fig. 5.

M. Adamcikas
& G. Massera
INVENTORS

By: Marks & Clerk
Attys.

Fig.6.

Fig.7.

M. Adamcikas &
  G. Massera
         INVENTORS

By: Marks & Clark
         Attys.

UNITED STATES PATENT OFFICE

MYKAS ADAMCIKAS (ALSO KNOWN AS MICHAEL ADAMTCHIK) AND GIUSEPPE MAS-
SERA, OF ALDWYCH, LONDON, ENGLAND

BLADE OF FANS OR VENTILATORS

Application filed March 18, 1929, Serial No. 348,094, and in Great Britain March 31, 1928.

This invention relates to fans or ventilators or other screw propellers intended to propel a fluid and the main object of the invention is to improve the efficiency thereof.

5 It is generally known that, in order to obtain the highest possible efficiency in fans or other screw propellers intended to propel a fluid, constancy of specific pressure along their whole working area must be secured.

10 We may define specific pressure of a fan as the ratio between its thrust or pull when rotating and its working area.

Further, theoretical considerations show that constancy of specific pressure also deter-

15 mines constancy of axial velocities of the outflow. The main difficulty in obtaining this constancy of specific pressure is due to the varying peripheral velocities of the blade at different radii, and in order to overcome this

20 difficulty, many combinations of distribution of width and geometrical pitch of the blade along its length have hitherto been proposed.

By "geometrical pitch of the pressure side of the blade surface", which will hereinafter

25 be referred to as "geometrical pitch", we mean the distance between the threads of a screw or the amount of axial displacement effected during one revolution by a surface inclined with respect to the plane of rotation. The

30 geometrical pitch is therefore determined also by the distance of the inclined surface from the centre of rotation, its formula being $2\pi r \tan \theta$, wherein r is the distance of the said surface from the axis of the hub and θ

35 its angle of inclination to the plane of rotation.

According to the present invention, the width of the blades increases towards the hub and the geometrical pitch of the blade

40 surface on the pressure side also gradually increases towards the hub in such a manner that the width and the said geometrical pitch are a maximum as regards the cross sections of the parts of blades lying on the hub itself.

45 It will thus be seen that in order that the geometrical pitch shall increase towards the hub, it is necessary that the tangent of the angle of inclination shall increase more rapidly than the radius decreases.

50 Thus in the region of the smallest periph-

eral velocities of the blade the medium is under the combined influence of width and geometrical pitch and our tests showed that this influence predominates over such factors as the depth of the curvature and the 55 coefficients of lift and drag of the aerofoils used.

In order to ensure constant specific pressure and velocity from the middle of the blade to the hub, it is of particular import- 60 ance to provide increased width and geometrical pitch from the middle of the blade to the hub. As regards the part of the blade from the middle to the tip, the same may be constructed in many different ways. Thus, 65 it may be constructed with constant width, but in this case the geometrical pitch of the blade must considerably decrease in order to counteract the effect caused on the tips by the increase in the axial velocities of the 70 medium.

Our blade with increased width and a geometrical pitch of the blade surfaces which increases from the middle of the blade to the hub has a constructional drawback in the case 75 of slowly rotating fans, or fans which are working under a great difference of pressure, or particularly in the case of fans with a low "hub ratio", inasmuch as the axial length of the hub becomes excessive and 80 therefore impracticable.

Let the width of the blade be β and the angle of blade inclination to the plane of rotation θ; then the axial length of the hub is equal to or a little bigger than $\beta \sin \theta$, if the 85 values of β and θ are taken for the cross section adjoining the hub.

This drawback, however, may easily be overcome by doubling the number of blades, which reduces the axial length of the hub by 90 half. As, however, in this case the blades may become too narrow at their tips we prefer to use fans with blades of different length set alternately, which also possesses the advantage of further reducing the weight of 95 the fan.

In accordance with our general principles of blade construction the sum of the widths of the long and short blades within the circle traced by the tips of the short blades gradu- 100

ally increases from the said circle towards the hub where this sum is at its maximum.

Several constructions of aerial propellers with short and long blades set alternately have already been designed with the purpose of overcoming the resistance of "dead air", but in all these constructions the total width of blade surfaces has its maximum not at the hub as in our case, but at other points of the blade along its length.

According to our invention as applied to fans with long and short blades set alternately, not only does the sum of the widths of the blade surfaces increase as aforesaid, but also the geometrical pitch of the blade gradually increases from approximately the middle of the long blades or from the circle traced by the tips of the short blades towards the hub either for all the blades or for one set of them, the long blades or the short blades.

The total width of the blade surfaces may be distributed between the long and the short blades in many different ways, according to constructional requirements.

Referring to the accompanying drawings, which illustrate the invention by way of example.

Figure 1 is a diagram illustrating the relationship between the constancy of axial velocity of the medium and the differences of relative velocities of the medium and blade, which differences in the case of a big "hub ratio" are nearly constant and in the case of a small "hub ratio" decrease towards the hub.

Figure 2 is a diagram showing width and geometrical pitch variation along the blade of a fan having blades of one and the same length.

Figure 3 is a diagram showing width and geometrical pitch variation along the blade of a fan having long and short blades.

Figure 4 is a side elevation with sections of a blade of a fan with blades of one and the same length.

Figure 5 is a plan view of a fan having a blade such as shown in Figure 4.

Figure 6 is a side elevation of blades of a fan with blades of different lengths.

Figure 7 is a plan view of the fan having blades such as shown in Figure 6.

On the diagrams of Figures 1, 2 and 3, the values on the horizontal axis indicate the distances of the various cross-sections of the blade from the axis of the hub as a percentage of the whole length of the blade.

In Figure 1, O—A is made proportional to the axial velocity of the medium which is constant along the blade. The peripheral velocities of the blade are proportional to the corresponding radii and they are indicated by the values 20, 40, 60, 80 and 100 on the horizontal axis. The directions of the peripheral velocities of the blade are tangent to the circumferences of rotation.

The inclined dotted lines show the directions of the relative velocities of the medium at the various points of the blade and line OA is proportional to the constant geometrical pitch of relative velocities of the medium with respect to the blade.

OB is a constant difference between the peripheral velocities of the blade and medium, which for the sake of simplicity is taken as constant. Thus B—20; B—40; B—60; B—80 and B—100 represent peripheral velocities of the medium and the inclined full lines are the directions of the relative velocities of the medium, the prolongations of which lines to the axis OA give the lines which are proportional to the geometrical pitch of relative velocities of the medium.

If the angles between the directions of the relative velocities of the medium and the plane of rotation are denoted by α, the angles of attack by β and the angles of blade inclination to the plane of rotation by θ, we obtain $\alpha+\beta=\theta$ and thereby the directions of the blade inclination which are indicated by dash lines in Figure 1.

Curve 1 represents the variations of the geometrical pitch of relative velocities of the medium along the blade, and curve 2 shows variations of the geometrical pitch of the blade surface itself.

In this case the curve of the geometrical pitch has its minimum approximately in the middle of the working length of the blade and increases towards the tip and the hub.

In Figure 2 the curves 3 and 4 represent respectively the width and the geometrical pitch distribution along the blade shown in Figure 4 and fan shown in Figure 5. In this particular case the width varies along the blade according to the law of a straight line, when the geometrical pitch is constant on the part of the blade adjoining the tip, and gradually increases from the middle to the hub.

In Figures 3, 5 and 6 are curves representing respectively the width and geometrical pitch distribution along the blade of a fan provided with blades of different lengths, as illustrated in Figures 6 and 7. In this case, curve 5 represents the sums of the widths of the long and short blades. The curve 6 representing the geometrical pitch, which is equal for both blades, viz., for the long and the short ones, is similar to curve 4 shown in Figure 2. However, it is to be understood that the geometrical pitch may also be varied as indicated by curve 2 in Figure 1 or be gradually decreased to the tip.

Referring to Figure 4, lines 7 and 8 represent in side elevation the leading and trailing edges of the blade respectively. The outline 9 of the hub may be of different shape. The cross-sections 10 of the blade are shown in the plane of the drawings. 11 are tangents to the pressure side of the blade, being in-

clined at an angle θ to the plane of rotation.

These tangents intersect the axis at heights indicated by the lines CD, CE, CF, which are proportional to the geometrical pitch of the corresponding cross section of the blade. It can be clearly seen that these heights increase towards the hub and that at the same time also the width of the blade increases. In Figures 5, 12 and 13 are the leading and trailing edges of the blade in plan view.

Referring to Figures 6 and 7, 14 and 15 are respectively the leading and trailing edges of the long blade in elevation and lines 17 and 18 are respectively the leading and trailing edges of the short blade, also in elevation. 20, 21, 22 and 23 are respectively the above-mentioned edges shown in plan view.

The increase in the geometrical pitch towards the hub is illustrated in Figure 6 by the lines 19 which are tangent to the pressure side of the blade and which intersect on the axis, lines proportional to the geometrical pitch.

In this case the long and the short blade have the same geometrical pitch at corresponding radii, but it is to be understood that the distribution of the geometrical pitch depends entirely on the load distribution between the long and short blades which may be effected in many different ways.

What we claim is:—

1. A fan or other screw propeller for propelling a fluid having blades the width and geometrical pitch, viz. $2\pi r \tan \theta$, of the pressure side of which gradually increase towards the hub in such a way that the width and geometrical pitch are at their maximum for the cross section of the blade lying on the hub itself.

2. A fan or other screw propeller for propelling a fluid having blades the width and geometrical pitch, viz. $2\pi r \tan \theta$, of the pressure side of which gradually increase from approximately the middle of the blade to the hub in such a way that the width and geometrical pitch are at their maximum for the cross-section of the blade lying on the hub itself.

3. A fan or other screw propeller for propelling a fluid having blades the width of which gradually increases towards the hub in such a way that it is at its maximum for the cross-section of the blade lying on the hub itself and the geometrical pitch, viz. $2\pi r \tan \theta$, of the pressure side of which gradually increases approximately from the middle of the blade towards the hub and tip, so that the geometrical pitch is a minimum approximately in the middle of the working length of the blade.

4. A fan or other screw propeller for propelling a fluid having short and long blades alternately disposed, the sum of the widths of which within the circle traced by the tips of the short blades continuously increases from the said circle to the hub, being a maximum for the cross-section of the blade lying on the hub itself.

5. A fan or other screw propeller for propelling a fluid as claimed in claim 4 and in which the geometrical pitch, viz. $2\pi r \tan \theta$, of the pressure side of at least one set of blades, increases towards the hub.

6. A fan or other screw propeller for propelling a fluid having blades the width and geometrical pitch, viz. $2\pi r \tan \theta$, of the pressure side of which gradually increase from approximately the middle of the blade to the hub in such a way that the width and geometrical pitch are at their maximum for the cross-section of the blade lying on the hub itself, the geometrical pitch being constant from approximately the middle of the blade to the tip.

In testimony whereof we have signed our names to this specification.

MYKAS ADAMCIKAS.
GIUSEPPE MASSERA.