April 16, 1963 K. DAGRELL 3,085,631

PROPELLER FAN BLADES

Filed May 29, 1959 2 Sheets-Sheet 1

FIG. 3.

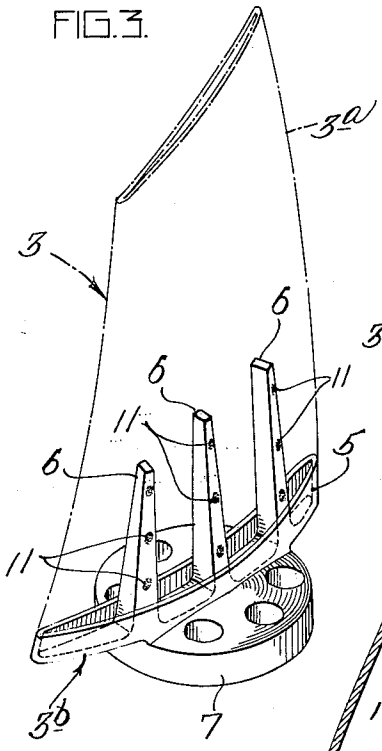
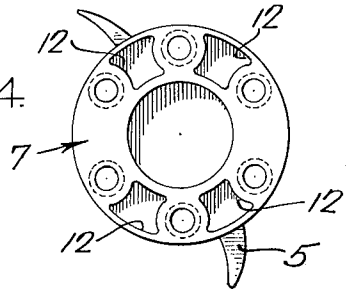


FIG. 1.

FIG. 4.



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FIG. 2.

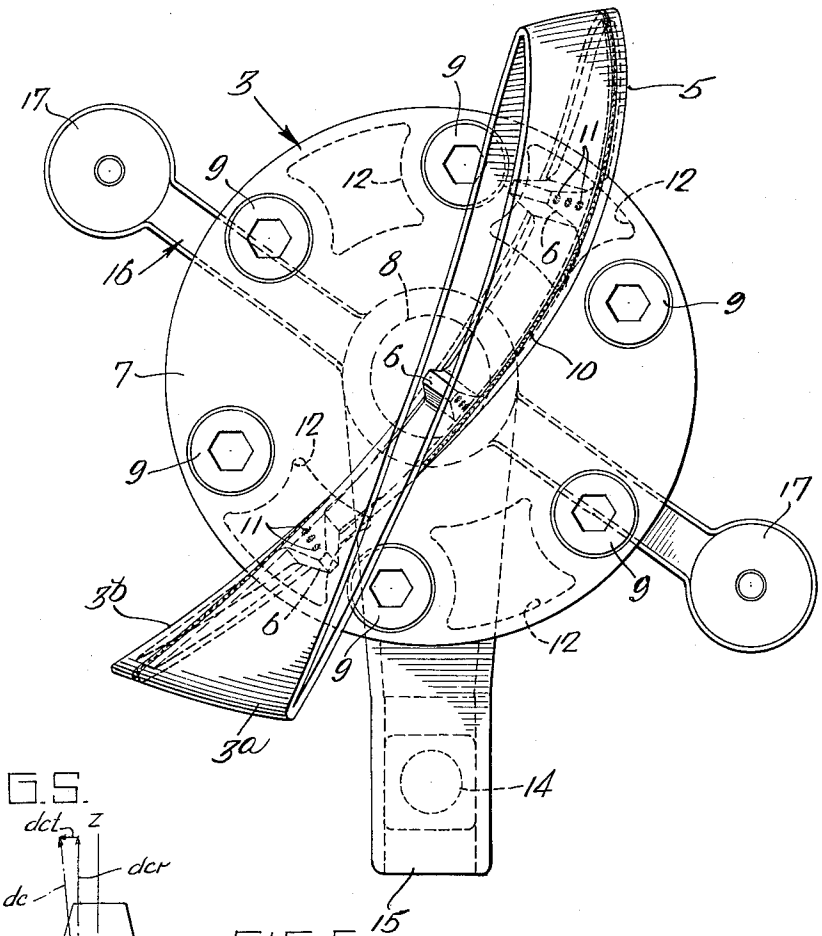


FIG. 5.

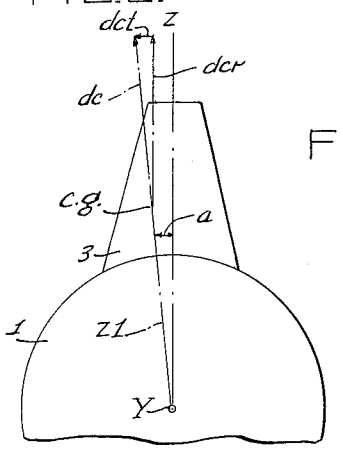
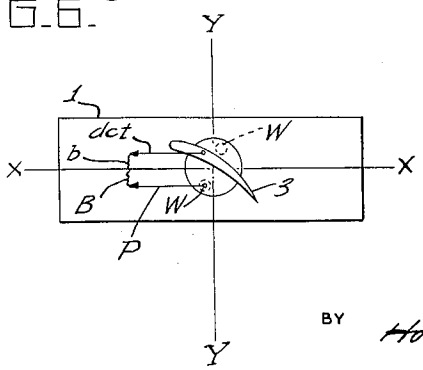


FIG. 6.



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PROPELLER FAN BLADES

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Claims priority, application Sweden May 29, 1958
1 Claim. (Cl. 170—159)

The present invention relates to a new and improved construction of fan blades for larger propeller fans with adjustable-pitch blades with a large root-width, rotatably pivoted in a hub. In fans of the above mentioned type it has been difficult to accomplish the connection between the blade-wings and the axle-journals pivoted in the hub with sufficient mechanical strength, considering the strains, both the axial stress arising due to the centrifugal force from fan rotation and the torque stress arising from the obliquity of the blades relative to the plane of rotation.

The invention, the object of which is to eliminate the difficulties mentioned, is characterized in that the blades are made of two parts welded to each other, one of said parts consisting of a hollow blade-wing made of plate and the other part consisting of a cast root-piece made with a profile corresponding to that of the blade-wing and provided with one or several support arms projecting into the blade-wing. The root-piece is cast in one piece with a circular base-plate slidable into a cavity in the hub and arranged to be joined with an axle-journal for the blade which is rotatably pivoted in the fan hub. The blade-wing is suitably joined with the root-piece both by a continuous weld made along the joint line and by a number of spot connections either welded or riveted between the blade-wing and the support arms of the root-piece. In order to compensate for the torsional moment around the turning axle of the blade, arising during the rotation of the fan and caused by the obliquity of the blade in relation to the plane of rotation, the circular base-plate is in accordance with a preferred embodiment made with a distribution of the mass suited for this purpose.

The invention will now be described more fully with reference to the accompanying drawing, wherein

FIG. 1 shows a cross section through a propeller fan provided with a device for the adjustment of fan blades constructed in accordance with the invention.

FIG. 2 shows a fan blade seen radially towards the center of the fan.

FIG. 3 is a view in perspective of the root piece with the blade shown in broken lines.

FIG. 4 is an inverted plan view of the root piece.

FIG. 5 is a diagrammatic view looking in a direction along the axis of the fan rotor.

FIG. 6 is a diagrammatic view looking down on the top of FIG. 5.

In the drawings, a propeller fan **1** is mounted for rotation with an axle **2** and is provided with a number of adjustable-pitch fan-blades **3** rotatably pivoted in a hub **4**. The fan-blades are in accordance with the invention made of two parts welded to each other, one of which **3***a* consisting of a hollow blade-wing made of plate with a designed profile and the other part **3***b* consisting of a cast root-plate **5** made with a profile corresponding to that of the blade-wing. The root piece **5** has a number of radial support arms **6** projecting outwardly into the blade-wing **3***a*, and a circular base-plate **7** projecting inwardly into a cavity **4***a* in the hub **4**. A rotatably pivoted axle-journal **8** in the fan hub is connected to the base-plate **7** by a number of counterbored bolts **9**. A continuous welding string **10** joins the root-piece **5** to the blade-wing **3***a*, and a number of spot connections **11**, either welded or riveted, connect the blade-wing **3***a* and the support arms **6** of the root-piece.

The adjustment of the fan-blades **3** is carried out by

means of an axially displaceable driving plate **13** arranged in the fan hub **4**, which along its periphery is provided with a corresponding number of studs **14** for cooperating with the fan blades. Said studs engage crank arms **15** arranged on the axle-journals **8** of the fan blade. For the compensation of the torsional moment arising during the rotation of the fan and caused by the obliquity of the blade **3** in relation to the plane of rotation, a double armed levelling arrangement **16** of a well-known construction and provided with exchangeable weights **17** is mounted on the inner radial end of each axle-journal **8**. Furthermore, for the same purpose according to the invention, the circular base-plate **7** of the root-piece **5** is made with a suitable distribution of the mass. In the illustrated embodiment this is accomplished, as can be seen from FIGS. 2 and 4, by having the base-plate **7** provided with a number of recesses **12**, properly located relative to the mass distribution of the blades **3**.

In FIGS. 5 and 6, **1** designates the hub of a propeller fan rotatable about is axis Y and provided with a number of blades **3** each adjustably rotatable about its longitudinal axis Z. When the fan is rotated the centrifugal force not only acts in a radial direction on the blade but also produces a torque about the rotation axis Z of the blade, which torque tends to turn the blade to a position in which its center plane coincides with its rotation plane which is parallel to the X-axis, that is an axis in a plane through the blade axis Z and perpendicular to the axis Y of the main rotor.

This torque it due to the fact that the main inertia axis Z1, that is the axis through the center of gravity c.g., forms an angle "*a*" to the longitudinal axis of the blade, and the inertia load "*dc*" creates a force equal to the component "*dct.*" As the mass center c.g. is positioned a distance "*b*" from the plane of rotation (X-axis) the force "*dct*" produces a moment of rotation "T" equal to "*dct*"×"*b*". This moment or torque acts upon the device, which has to effect the adjustment of the blade and a great consumption of force is required to turn the blades.

The invention renders possible even in rapidly operating propeller fans an adjustment of the blades during rotation of the fan without requiring much force for this purpose. According to the invention this is obtained by providing the fan blades with equalizing members or weights in that the circular base plate portion is formed with parts of different mass at suitable locations to compensate for the torsional moment. In FIG. 4 the masses will be concentrated in the portions on each side of the base plate which are left after forming the recesses **12**. In the drawing such an equalizing weight is designated W which produces a force P and a counteracting torsional moment K equal to $P \times B$ where "B" stands for the distance for W and "P" from the X-axis. If

$$dct \times b - P \times B = 0$$

the torque is fully counteracted; but it is, of course, not necessary to exactly equalize said force. The arrangement according to the invention—i.e. the equalizing members being integral parts of the circular base plate—renders unnecessary the employment of any other members than those normally applied to the blade.

What I claim is:

A rotatable variable pitch propeller fan blade which in use is mounted on a rotatable hub for turning movement about a radial axis and wherein the centrifugal force of hub rotation and the torque on the blade due to its large size and obliquity to the radial plane of rotation impose great strains at the base of the blade, comprising in combination, a rotatable hub having a plurality of circumferentially spaced cylindrical cavities disposed around its periphery, a cast stub blade root part including an integral circular base plate portion fitting within

a cavity of the hub, said cast stub blade root part having an airfoil blade base portion including a peripheral flange-like portion extending upward for a short distance from the circular base plate portion to form a part of the blade airfoil surface, said circular base plate portion having at least one upwardly extending stub projection portion offset inwardly at the lower end from said airfoil base portion, and a hollow airfoil blade part made of plate metal fitting on said stub projection down to the end of the airfoil blade base portion of the root part at the offset and forming a smooth outer surface continuation with the outer surface of the airfoil blade base portion of the root part, the adjacent edges of the blade part and the base plate portion of the root part being welded together in a continuous peripheral line joint, and said airfoil blade part above the peripheral weld joint being welded to said projection portion of said root part, said airfoil blade base portion of said cast stub blade root part having a major chord greater than the diameter of said circular base plate portion and a minor chord smaller than the diameter of said circular base plate portion, said circular base plate portion being formed with parts of different mass at suitable locations to compensate for torsional moment around the radial axis caused by the obliquity of the blade in relation to the plane of rotation of the radial axes, the circular base plate portion having weight concentration toward its periphery at the ends of a diameter disposed approximately along the direction of the length of the minor chord of said airfoil blade portion.

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