April 12, 1932. R. B. FERREBY 1,853,607

AIRPLANE PROPELLER

Filed May 9, 1928 3 Sheets-Sheet 1

Fig. 1.

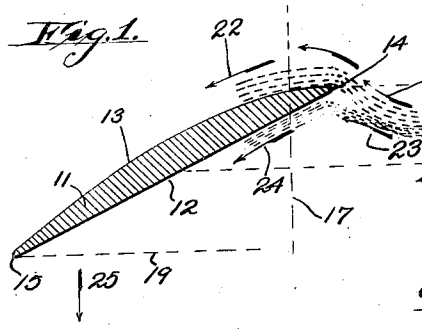


Fig. 5.

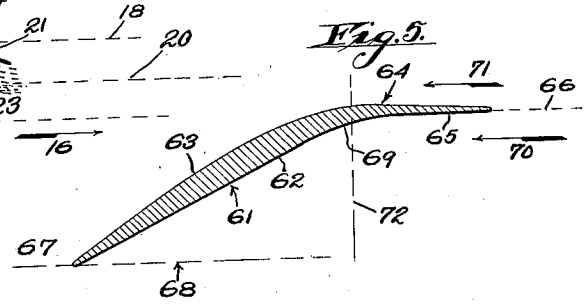


Fig. 2.

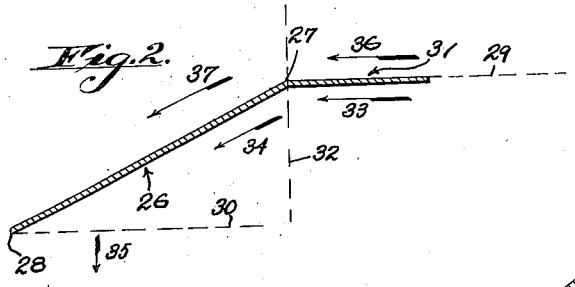


Fig. 6.

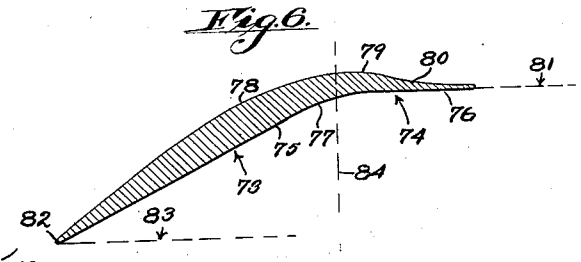


Fig. 3.

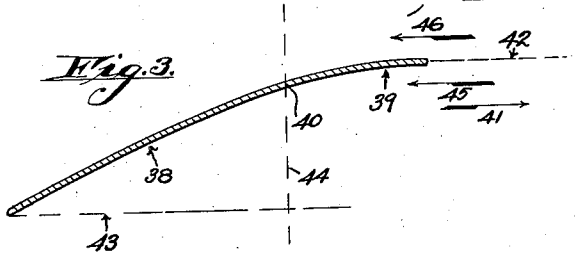


Fig. 7.

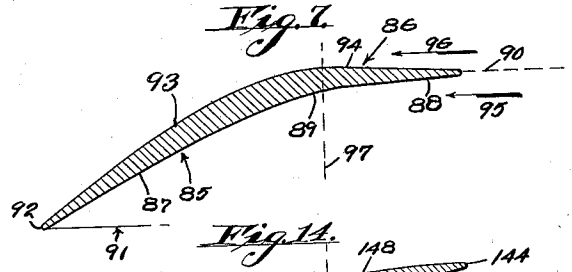


Fig. 4.

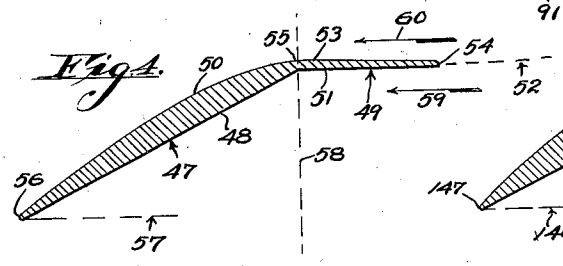
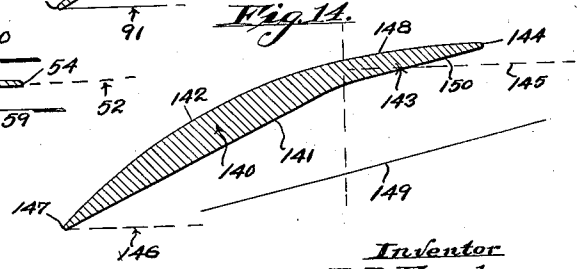


Fig. 14.

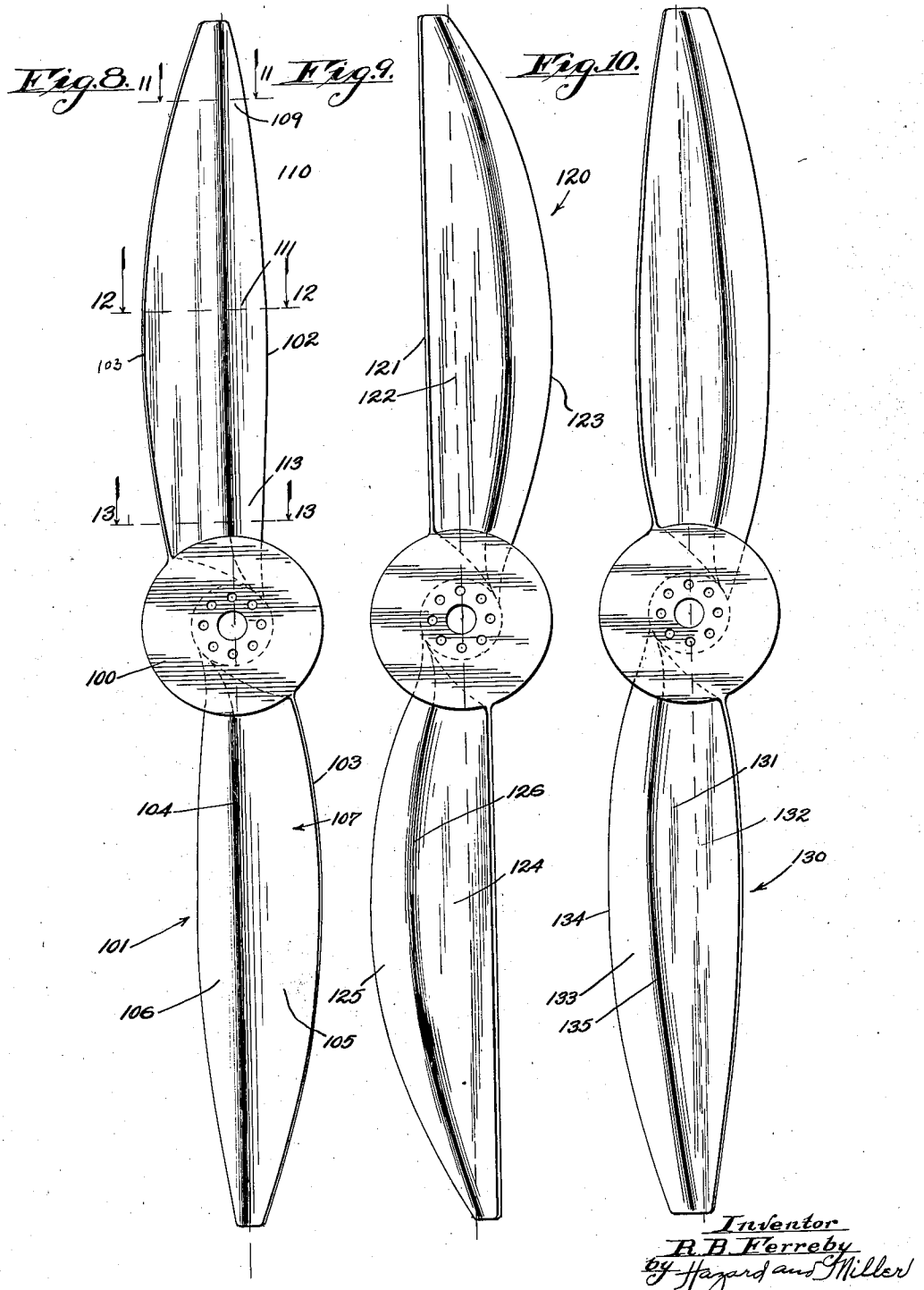


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AIRPLANE PROPELLER

Filed May 9, 1928 3 Sheets-Sheet 3

Fig. 11.

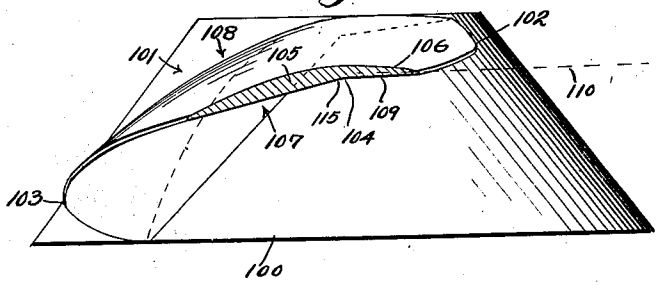


Fig. 12.

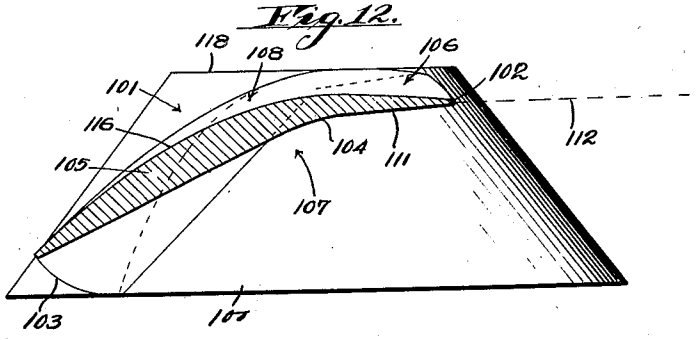
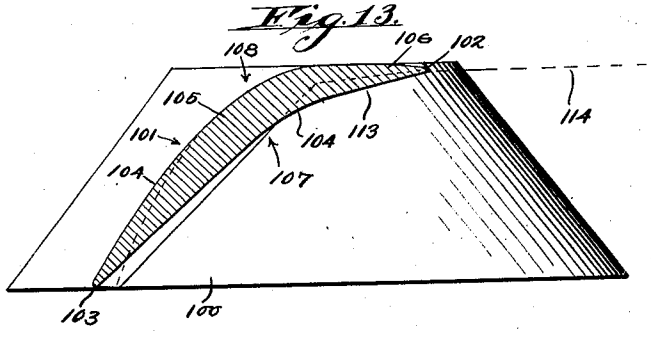


Fig. 13.



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UNITED STATES PATENT OFFICE

ROLLA BARKER FERREBY, OF LOS ANGELES, CALIFORNIA

AIRPLANE PROPELLER

Application filed May 9, 1928. Serial No. 276,410.

My invention pertains to an airplane propeller and particularly to the aerofoil structure thereof. The improvements of my invention may also be adapted to aerofoil structures of airplane wings.

In the ordinary type of rotating propeller I have ascertained that a portion of the air which is in the direct path of the leading edge of the aerofoil of the blade is deflected outwardly or forwardly considered in the direction of travel of the airplane, and passes over the forward side of the blade. In some cases a large proportion of the total volume of air which is in the direct path of the pressure surface of the blade is thus deflected over the leading edge of the blade causing more or less turbulence and depriving the propeller of the full volume or quantity of air to operate on what would normally be in the direct path of the blade.

I have discovered that by constructing a fin extending forwardly of the leading edge of a blade that I obtain an aerofoil which prevents, to a great extent, the loss of air from the pressure side of the blade to the non-pressure side, and hence with my improved construction the blade operates on a full volume of air swept in the revolution of the propeller.

An object, therefore, of my invention is the construction of an airplane propeller which may have a fin, or be constructed in effect to have a fin-like structure extending forwardly of the main body structure of the blade to catch the air which would otherwise be lost from the pressure to the non-pressure side of the blade.

A further object of my invention is the construction of a propeller in which the fin or the fin-like leading portion of the blade is positioned relative to the main portion of the blade and the axis of rotation to gather and deflect substantially all the air in the sweep of the blade on the pressure side thereof, preventing a back flow of part of this air to the non-pressure side.

In constructing a simple form of my propeller I may utilize a flat or substantially flat blade as might be formed from a sheet metal plate, positioned at the desired angle to a rotatable hub giving any suitable pitch; and from the leading edge I extend a fin forwardly which is substantially in the plane of the rotation of the leading edge of the blade. Thus I form an aerofoil which may be considered as having one portion at a pitch or angle to the axis of rotation and the fin part in a plane at right angles or substantially at right angles to the axis of rotation.

As various modifications of this simple form I may give the aerofoil a curve so that there is no sharp angle between what may be termed the blade and the fin portion. In further modifications I may stream line the non-pressure side of the blade and of the fin described, and with such stream lining I may also incorporate a curve or curves on the pressure side between the portions which may be considered as the blade proper and the fin.

In these various constructions of aerofoils suitable for propellers it is to be understood that there may be different pitches and different distances from the hub, giving in effect a warped aerofoil type of blade.

My invention in its various aspects may be more readily understood from the following description and drawings, in which:

Fig. 1 is a transverse section through an aerofoil forming a blade of a typically standard propeller,

Fig. 2 is a cross section of an aerofoil showing my blade construction in its simplest form with the leading fin,

Fig. 3 is a modification of Fig. 2 in which the angle of the blade proper and the fin are joined by a curve,

Fig. 4 is a cross section, a modification of Fig. 2, in which the non-pressure side of the blade and the fin has stream lining,

Fig. 5 is a cross section, a modification of Fig. 4, in which the pressure side is given a curve between the blade proper and the fin,

Fig. 6 is a section, being a further modification of Fig. 5, using a thicker section with a reverse curve on the non-pressure side of the fin in the stream lining,

Fig. 7 is a cross section of a relatively thick wing section stream lined on the non-pressure surface and having a curve on the pressure

surface connecting the blade proper and the fin, the pressure surface of the fin being inclined forwardly, being relative to the direction of travel,

Fig. 8 is an elevation of one form of propeller viewed from the pressure side, that is, the rear side of the blade,

Fig. 9 is an elevation similar to Fig. 8 of another shape of propeller,

Fig. 10 is an elevation similar to Fig. 8 of still another shape of propeller,

Fig. 11 is a cross section of the blade of Fig. 8 on the line 11—11 in the direction of the arrows,

Fig. 12 is a cross section of Fig. 8 on the line 12—12 in the direction of the arrows,

Fig. 13 is a cross section of Fig. 8 on the line 13—13 in the direction of the arrows,

Fig. 14 is a section of a blade.

In Fig. 1 a typical aerofoil of a propeller blade is indicated by the numeral 11 in which the side 12 is designated as the pressure side and the side 13 as the non-pressure side. 14 is the leading edge and 15 the trailing edge. The direction of rotation is indicated by the arrow 16. It is more or less immaterial as to the position of the axis of rotation in regard to the section of the blade, but the axis of rotation may be considered as on the line 17.

Therefore, in rotation the particular point of the leading edge 14 may be considered as rotating in a plane designated by the numeral 18 and the trailing edge in a plane designated by the numeral 19. It is found that the body of air contained between the planes 17 and 18 is in effect separated or split substantially on the line 20, a portion of the air following the arrow 21 over the leading edge and 22 over the non-pressure side 13. Another portion of the air follows the arrow 23 having in effect a relative motion toward the leading edge of the blade and following the direction of the arrow 24 along the pressure side of the blade. The general blast of air from the propeller may be considered as in a rearward direction as indicated by the arrow 25. In this flow of air there is more or less turbulence forward of the leading edge and slightly in a rearward direction from the plane 18. Moreover, in this type of propeller the blade does not cause a movement of the whole body of air between the planes 18 and 19.

In the simple form of my aerofoil for a propeller blade as indicated in Fig. 2, the main portion of the blade may be considered as designated by the numeral 26, this being shown at substantially the same inclination as the pressure surface 12. For simplicity's sake this is illustrated as a flat blade. The leading edge may be designated by the numeral 27 and the trailing edge by the numeral 28. The leading edge rotates in a plane 29 and the trailing edge in a plane 30.

On the blade structure as indicated, I attach or extend a fin 31 in a forward direction from the leading edge, this fin being substantially in the plane of rotation of the leading edge. In this illustration the axis of rotation is indicated by the line 32.

In this form of blade the whole body of air between the planes 29 and 30 substantially passes on the rearward side of the fin 31 as indicated by the arrow 33, this air being deflected by the main portion 26 of the blade in the direction of the arrows 34, the general movement of the air being rearwardly in a direction indicated by 35. The air forward of the plane 29 passes on the forward side of the fin 31 as indicated at 36 and flows over the non-pressure side of the body of the blade as indicated at 37. In this construction, however, the sharp angle of the blade and the fin at the part indicated by 27 will be more or less turbulent.

In order to overcome the turbulence above mentioned in connection with Fig. 2 I may utilize a blade structure illustrated in Fig. 3 in which the main portion of the blade may be considered as that indicated by 38 with a fin portion 39. These parts are substantially straight, being joined by the curve 40. The direction of rotation follows the arrow 41, the air swept by the blade being between the planes 42 and 43. The axis of rotation is indicated by the numeral 44. In this case the flow of air is practically divided by the forward edge of the fin 39, part of the air following the direction of the arrow 45 and being subject to the pressure side of the blade, the air on the forward side following the arrow 46 on the non-pressure side of the blade.

In Fig. 4 I illustrate a modification of the blade shown in Fig. 2 in which 47 designates the main aerofoil structure of the blade in which the pressure side 48 may be considered as equivalent to the pressure side 12 of Fig. 1, there being a fin 49 extending from the forward edge of the main portion of the blade.

The aerofoil is more or less stream lined on the non-pressure side 50, this being equivalent to the shape of the non-pressure side 13 of Fig. 1. The rear surface of the fin 51 is indicated as being in a plane following that of the rotation of the fin as indicated at 52. The forward surface 53 of the fin is tapered from the front edge 54 to a junction point 55 with the main body of the blade. In this case 56 is the trailing portion of the blade and this rotates in the plane 57, the axis of rotation being indicated at 58.

In this case the air on the pressure side of the blade may be considered as following the arrow 59 and that on the forward or non-pressure side as following the arrow 60, the air being substantially divided in the two flows on the line of the plane 52. It will, therefore, be seen that in this construction substantially all of the air between the leading edge of the aerofoil and the trailing edge

is acted upon by the pressure side of the blade.

In Fig. 5 the main body of the blade is designated by the numeral 61 in which 62 is the pressure side and 63 the non-pressure side. A fin 64 extends forwardly and has its rearward surface 65 substantially in the plane of rotation as indicated at 66. The trailing edge 67 rotates in the plane 68. In this construction the surfaces 62 and 65 are substantially flat being joined by a curve 69. The forward side 64 of the fin and the non-pressure side of the main body of the blade are also curved as shown in Fig. 4 to give a stream line flow to the air. In this construction substantially all the air on the rearward side of the fin flowing in the relative direction of the arrow 70 is acted upon by the pressure side of the blade and the air on the forward side of the fin follows the relative direction of the arrow 71 and passes over the non-pressure side of the blade. The axis of rotation is indicated by the numeral 72.

In Fig. 6 the main section of the blade is indicated by the numeral 73, the fin by the numeral 74 and the pressure surface of the main body of the blade by the numeral 75, the rear side 76 of the fin being flat and joined by a curve 77. In this illustration the blade is shown as having a thicker section than in Figs. 4 and 5, the non-pressure side 78 of the main body of the blade being joined into the curve of the fin by a convex curve 79, the forward part of this fin having a concave or reverse curve 80. The fin describes the plane 81 in rotation and the trailing edge 82 describes the plane 83, the axis of rotation being indicated at 84.

In Fig. 7 the main body of the blade is indicated at 85 and the fin at 86. The main portion of the pressure surface 87 is flat as is the main portion of the rearward surface of the fin 88, this being joined by a curve 89. In this case the dotted line 90 indicates the plane described by the forward edge of the fin in rotation, and the plane 91 that of the trailing edge 92. The non-pressure side 93 of the main portion of the blade has a concave curve joining with the forward side of the fin 94. It will be noted in this case that the rearward surface 88 of the fin is inclined in a slight forward direction, but nevertheless the main portion of the fin rotates in a plane and causes substantially all the air rearwardly of this plane to travel in the relative direction of the arrow 95 and that on the forward side in the direction of the arrow 96, the axis of rotation being designated by the dotted line 97.

Figs. 8, 11, 12 and 13 show respectively rear side elevations of a propeller and sections therethrough. In this instance a hub is designated by the numeral 100 having a pair of opposite and similar blades 101 in which the leading edge is designated by 102 and the trailing edge by 103. The approximate line indicating the junction of the fin with the main portion of the blade is indicated by the numeral 104, and this is shown substantially as passing through the axis of rotation of the hub.

Therefore, in this construction the rear portion or main body of the blade is indicated by the numeral 105 and the fin by the numeral 106. (Note Fig. 8.)

Referring to Figs. 11, 12 and 13, the pressure side of the blade is designated by the numeral 107 and the non-pressure side by the numeral 108. In this construction the under side of the fin adjacent the tip is slightly inclined upwardly indicated at 109 as regards the plane of rotation 110 of the leading edge at the section of this figure. In Fig. 12 the rear surface of the blade is given a greater inclination as indicated by the numeral 111 having regard to the plane of rotation 112 of the leading edge of this section. In Fig. 13, which is near the hub, there is a greater inclination of the rear surface 113 of the fin in regard to the plane of rotation 114 of the leading edge. In all these sections the main body of the blade and the fin are joined by a curve as indicated by the numeral 115 on the pressure side of the blade. The non-pressure side of both the blade and the fin are stream lined as indicated at 116.

In Fig. 9 the blades 120 are illustrated as having a trailing edge 121 substantially parallel to a line 122 through the axis of rotation, the leading edge 123 being bowed out considerably to give sufficient blade area at the different sections. In this case the approximate line of junction of the main blade portion 124 and the fin portion 125 is on approximately the curved line 126, it being understood however that these sections will be merged one in the other with a curve.

In Fig. 10 the blades 130 have the main portion 131 of the blade substantially equally divided by the line 132 diametrically through the axis of rotation. The fin portion 133 has a leading edge 134 and the fin and the main body of the blade merge on substantially the line 135, this, however, being not a distinct junction on account of curving or stream lining the meeting surfaces.

In Fig. 14 I show a section of a blade constructed to take account of the combined rotary movement of the blade and the bodily advancement of the blade through the air on an airplane and the slip of the air. In this construction the main body of the aerofoil is designated by the numeral 140 which has a pressure side 141 with a non-pressure side 142. The fin portion 143 has a leading edge 144 which may be considered as extending forwardly of the plane 145 of the rotation of the junction line of the fin and the main body of the aerofoil when the propeller is not advancing through the air; and when in this

condition the plane 146 is described by the trailing edge 147.

As the propeller is rotating and the airplane in travel, the propeller has a forward lead into the air and therefore the fin is given a forward inclination so that there will be no back pressure on the forward side 148 of the fin. In this illustration the line 149 indicates approximately the pitch of advance of the blade through the air due to the screw acting motion, taking into consideration the slip of the air. The rear side 150 of the fin is therefore made substantially parallel to the line 149.

Fig. 14 shows in a somewhat exaggerated manner, the pressure surface 141 of the main portion of the aerofoil and the rear side 150 of the fin. The surface 150 of the fin is approximately parallel to or in a plane of the line 149 indicating the pitch advance of the blade through the air due to the screw action motion. I have found it of advantage to make the angle formed by the surface 150 of the fin and the line 145 indicating the plane of rotation of a point on the fin, substantially half the angle formed by the surface 141 and the line 146 indicating a plane of rotation of the surface 141.

Fig. 13 together with part of Fig. 12 depict certain common forms in the blade section in which it will be noted that the pressure surface 113 of the fin of Fig. 12 is such as to be substantially in the line of the screw advance when the propeller is rotating and advancing through the air; this being somewhat the same as the surface 150 of Fig. 14. As Fig. 13 depicts a section of the propeller blade adjacent the hub, this shows a blade section thicker and stronger than the sections more remote from the hub but the change of shape of the blade from the hub to the outer portion adjacent the tip may involve a section somewhat similar to Fig. 14 in which the pressure side of the fin continues somewhat in the same direction of the screw advance of the blade when rotating and somewhat similar to the fin surface 150 of Fig. 14.

It will be noted also that the pressure surface 111 of the fin of Fig. 12 also has a slight inclination in reference to the direction of rotation of the blade, this inclination being somewhat in the plane of the screw advance of the blade through the air while rotating.

It will, therefore, be seen by the above illustrations and descriptions that the blades constructed in accordance with my invention having a distinct leading fin may be made of various shapes and profiles of the blades.

It is to be understood that all the propeller blades made in accordance with my invention may have the fin positioned relative to the main body of the aerofoil of the blade so that account is taken of the forward motion of the propeller through the air in a traveling airplane as well as the rotary motion of a propeller. The fin is designed to prevent back flow of air from the pressure to the non-pressure side of the aerofoil. The fin is positioned at such an angle in reference to the main body of the aerofoil so that the air in line with the leading edge of the fin is caught by the fin and forced against the pressure side of the blade. It is to be understood in my construction that I may use this type of fin in connection with the blade with propellers having a constant pitch from hub to tip or those having a changing angle of incidence or a blade having a warped shape. It is also to be understood that a blade constructed with a fin functioning as set forth herein may be utilized with a blade of the changeable pitch type of propeller.

Various changes may be made in the principles of my invention without departing from the spirit thereof, as set forth in the description, drawings and claims.

I claim:

1. A rotatable propeller having a blade with an aerofoil positioned at an angle to the direction of rotation with a pressure side in the direction of rotation and a non-pressure side opposite thereto, a fin extending forward from the forward part of the aerofoil in the direction of rotation, the main body of the fin rotating in a plane substantially at right angles to the axis of rotation of the aerofoil, the aerofoil being stream lined on the non-pressure side.

2. A rotatable propeller as claimed in claim 1, the front side of the fin considered in the direction of the flow of air having a curved stream lining merging with the stream lining of the aerofoil.

3. A rotatable propeller having a main portion with a pressure surface at an angle to the direction of rotation and a non-pressure surface opposite thereto, a fin connected to the leading edge of such pressure surface, the body of the fin extending in a plane substantially at right angles to the direction of rotation, the non-pressure side of the blade having stream lining merging with the front of the fin considered in relation to the flow of air and the pressure surface of the blade being connected to the rear side of the fin considered in the direction of the flow of air by a curved surface, the rear side of the fin having a portion with a flat surface directed forwardly having regard to the flow of air caused by the pressure surface of the blade, the non-pressure surface of the propeller and a portion of the fin being stream lined.

4. A rotatable propeller having a hub and blades, the blades having an aerofoil structure with a pressure surface in the direction of rotation and a non-pressure surface opposite thereto, the angle of said surfaces warping from the hub to the tip of the blade, the angle decreasing toward the tip, a fin-like

structure extending forwardly in the direction of rotation from the forward part of the aerofoil, the main body of the fin rotating in a plane substantially at right angles to the axis of rotation, the fin preventing flow of air from the pressure to the non-pressure side of the aerofoil, the pressure and non-pressure sides of the aerofoil being stream lined and having curves merging into the front and back surfaces of the fin considered in the direction of the flow of air caused by the pressure surface of the aerofoil.

5. A rotatable propeller having a main aerofoil structure with a pressure surface at an angle to the direction of rotation and a non-pressure surface opposite thereto, a fin connected to the leading portion of the aerofoil and extending forwardly, the said fin being substantially in the line of the screw motion of the propeller through the air, having in consideration the motion of rotation and translation through the air and the air slippage the non-pressure surface of the aerofoil being stream lined and such stream lining merging into the fin.

6. A rotatable propeller having a main aerofoil structure with a pressure surface at an angle to the direction of rotation and a non-pressure surface opposite thereto, a fin connected to the leading portion of the aerofoil and extending forwardly in the direction of rotation, the said fin having a rearward surface on the side in the direction of the flow of air caused by the propeller, said surface being substantially in the line of the screw motion of the propeller through the air, having in consideration the motion of rotation and translation through the air and the air slippage the non-pressure side of the aerofoil structure and the front of the fin being streamlined the pressure surface of the main aerofoil structure having a greater angle to the plane of rotation than the rearward surface of the fin.

7. A rotatable propeller having a main aerofoil structure with a pressure surface at an angle to the direction of rotation and a non-pressure surface opposite thereto, a fin connected to the leading portion of the aerofoil and extending forwardly in the direction of rotation, said fin having a rearward surface on the side in the direction of the flow of air caused by the propeller, the said rearward surface of the fin being approximately in a line representing the pitch or screw advance of the propeller in the air and the pressure surface of the aerofoil being at an angle to such line of advance the non-pressure surface of the aerofoil being stream lined and such stream lining merging into the fin.

8. A rotatable propeller having a main aerofoil structure with a pressure surface at an angle to the direction of rotation and a non-pressure surface opposite thereto, a fin connected to the leading portion of the aerofoil extending forwardly in the direction of rotation, said fin having a rearward surface on the side in the direction of the flow of air caused by the propeller, the angle formed by the rearward surface of the fin in relation to the plane of rotation being substantially one half of the angle formed with the plane of rotation of the aerofoil and a curved stream lining on the non-pressure side of the aerofoil merging with a stream lining on the forward side of the fin.

9. A rotatable propeller having a main aerofoil structure with a pressure surface at an angle to the direction of rotation and a non-pressure surface opposite thereto, a fin connected to part of the leading edge of the aerofoil and extending forwardly, said fin having a pressure surface in substantially the line of the screw motion of the propeller through the air, having in consideration the motion of rotation and translation through the air and air slippage, the non-pressure surface of the aerofoil and the fin being stream lined and convex and the pressure surface merging by a curve.

10. A rotatable propeller having a main aerofoil blade structure with a pressure surface at an angle to the direction of rotation and a non-pressure surface opposite thereto, a fin extending from adjacent the hub portion to adjacent the tip portion of the blade and being connected to the leading portion of the aerofoil and extending forwardly, said fin having a portion thereof substantially in the line of the screw motion of the propeller through the air, having in consideration the motion of rotation and translation through the air, and air slippage, and another portion substantially in the plane of rotation of the leading edge of the propeller, the non-pressure surfaces of the fin and the aerofoil being stream lined and convex.

In testimony whereof I have signed my name to this specification.

ROLLA BARKER FERREBY.