Jan. 22, 1946. R. S. JOHNSON 2,393,472

PROPELLER AND ANTI-ICER THEREFOR

Filed Nov. 13, 1939

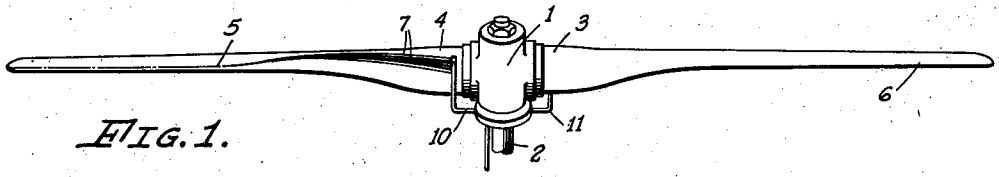


FIG. 1.

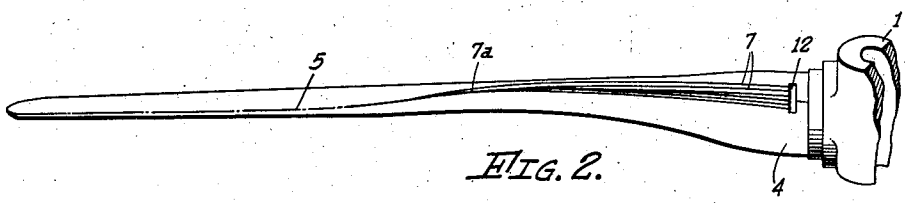


FIG. 2.

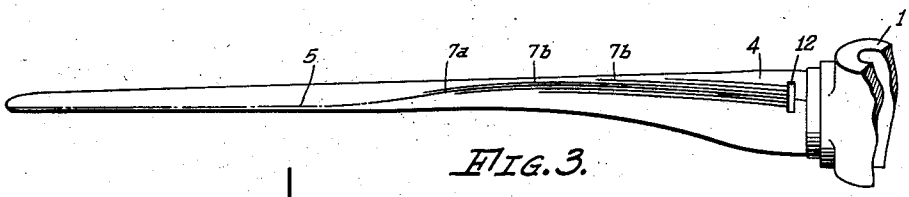


FIG. 3.

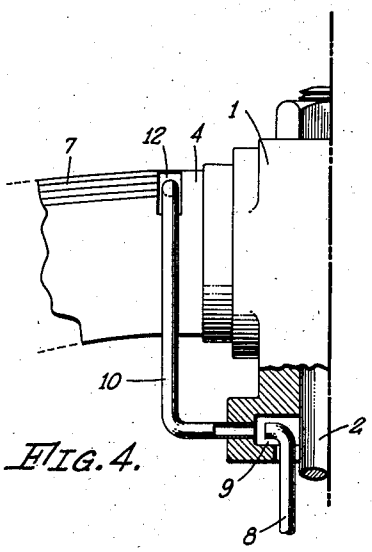


FIG. 4.

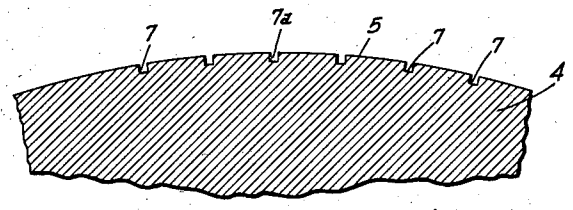


FIG. 6.

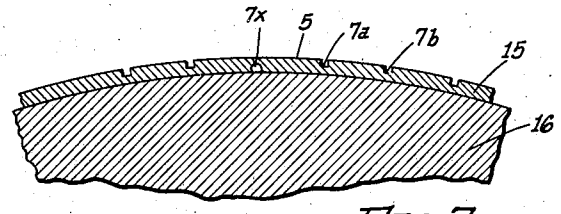


FIG. 7.

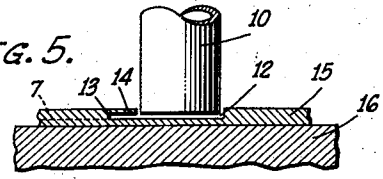


FIG. 5.

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PROPELLER AND ANTI-ICER THEREFOR

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Application November 13, 1939, Serial No. 304,065

14 Claims. (Cl. 244—134)

My invention relates to propellers and has particular reference to airplane propeller constructions and means for preventing the accumulation of ice and ice particles thereon.

In the operation of airplanes one of the more serious dangers encountered is that of flying in icing conditions due to the accumulation of ice upon the plane. Heretofore it has been considered that the ill effects were produced by the accumulation of ice upon the wings of the plane and thus injuring or destroying the efficency of the air foil of the wings. However, more recent investigations tend to show that it is the loss of efficiency in the propeller air foil which causes the greatest damage by reason of the fact that a relatively small accumulation of ice upon the propeller blade, and particularly upon the leading edge thereof, effectively reduces the efficiency of the airplane in greater proportion than a corresponding accumulation of ice upon the wings.

As will be understood by those skilled in this art, the contour of the propeller blade is carefully calculated and carefully constructed so as to produce the most efficient air foil. Hence even minute accumulations of ice upon the propeller blade materially detract from the efficiency of the blade, even the grinding out of dents or scratches suffered by the blade during normal service injuring the efficiency of the carefully designed air foil.

It is therefore an object of my invention to provide a propeller construction in which the air foil surface can be maintained satisfactorily true to its original design.

Another object of my invention is to provide a propeller construction in which the accumulation of ice is effectively prevented.

Another object of my invention is to provide a method by which anti-icing fluid may be distributed over a relatively large portion of the area of the propeller to prevent the accumulations of ice thereon.

Another object of my invention is to provide a method by which such anti-icing liquid can be conveyed along the leading edge of the propeller and be distributed over the leading edge thereof in such manner as to effectively prevent the accumulation of ice upon the same at relatively great distances from the propeller hub.

Another object of my invention is to provide a means for conveying anti-icing liquid to the propeller blades and along the propeller blades to a position not less than substantially midway of the length of the blade and to substantially evenly distribute such liquid over the leading edge surface of the propeller blade between such mid point and the hub.

Another object of my invention is to provide a propeller construction wherein conduits are provided along the leading edge of the propeller blade for conveying anti-icing liquid therealong and to provide a system of distribution of said liquid along the propeller.

Another object of my invention is to provide one or more grooves disposed along the leading edge of the propeller blade, such grooves being formed either in the body material of the propeller blade or in suitable material applied to and mechanically bonded to the body of the propeller blade.

Another object of my invention is to provide an airplane propeller construction in which the propeller blade is formed of a body portion of suitable material and is provided with a surface layer of material machined or ground to the desired air foil contour, and in which the surface layer of material is so mechanically bonded to the body of the propeller blade that dents, scratches or cracks in the surface layer are prevented from extending into the body material of the blade.

Another object of my invention is to provide a construction of propeller blade as set forth in the preceding paragraph wherein the surface layer material may be built up after being dented, scratched or cracked and be re-machined or reground to restore the original contour to the propeller blade after injury.

Other objects and advantages of my invention will be apparent from a study of the following specifications, read in connection with the accompanying drawing, wherein

Fig. 1 is a perspective view of a propeller hub and blades constructed in accordance with my invention;

Fig. 2 is an enlarged detail perspective view of one of the blades of the propeller shown in Fig. 1;

Fig. 3 is a detail perspective view of a similar blade but illustrating a modified arrangement of anti-icing-liquid conduits thereon;

Fig. 4 is a fragmentary view of the propeller shown in Fig. 1 and illustrating the manner in which anti-icing liquid may be conveyed to the propeller;

Fig. 5 is a detail sectional view taken along line V—V of Fig. 4 and illustrating one manner in which the anti-icing liquid may be accumulated upon the propeller blade;

Fig. 6 is a fragmentary cross sectional view through a portion of the propeller blade shown

in Fig. 1 and illustrating the grooves or conduits formed therein; and

Fig. 7 is a detail fragmentary view similar to Fig. 6 and illustrating a modified manner in which the grooves or conduits may be applied to the propeller blade.

Referring to the drawing, I have illustrated in Fig. 1 a conventional two-bladed propeller having a hub 1 to which the power shaft 2 of an engine may be coupled and having a pair of oppositely disposed blades 3 and 4 secured thereto.

As is understood by those skilled in this art, each of the propeller blades 3—4 is carefully shaped to provide the most effective and efficient air foil as it is whirled through the air, having a reasonably broad leading edge 5 and a feathered trailing edge 6.

In prior attempts to prevent the accumulation of ice upon the propeller blades with the resultant decrease in the efficiency of the carefully shaped air foil structure thereof, it has been proposed to deposit anti-icing liquid such as alcohol upon the whirling propeller blades. However, the point of application of such anti-icing liquid has been at the cylindrical portion of the propeller blade immediately adjacent the hub, with the result that the air forces and centrifugal force set up by the whirling propeller have immediately thrown such liquid off of the propeller before there has been any opportunity to obtain a reasonable distribution of such liquid along the length of the propeller. The formation or accumulation of ice upon the propeller immediately adjacent the hub does not injure or destroy the effective shape of the air foil structure of the propeller to any appreciable extent, but even the minute ice formation which occurs upon the leading edge of the propeller so alters the attack surface of the propeller as to cause turbulence of the air and effectively destroying the efficiency of the propeller.

I provide means upon each blade of the propeller for receiving such anti-icing-liquid and for conveying the same along the propeller toward the tip thereof so that the anti-icing-liquid not only covers the propeller area immediately adjacent the hub but may be substantially uniformly distributed throughout the greater portion of the length of the propeller blade.

This means may comprise any form of conduits which may receive the anti-icing-liquid and conduct the same to a plurality of points spaced along the length of the propeller blade; for example, as illustrated particularly herein, such conduits may comprise a plurality of relatively narrow and relatively shallow grooves 7 extending longitudinally along the leading edge of the propeller from a point immediately adjacent the hub to one or more points spaced toward the tip end thereof; or the conduits may be formed as small bores (see 7x in Fig. 7) near the hub but which open into grooves as they extend toward the tip of the blade.

The grooves or channels 7, as illustrated in Figs. 1, 2 and 6, may be formed directly in the material of the blade proper as by cutting or scoring the surface of the body material of the blade and, as shown in Figs. 1 and 2, one of such grooves 7a may extend to a point approximately midway or beyond the length of the propeller while the remaining grooves may act as conducting channels which meet and intersect the grooves 7a. Thus any liquid which is deposited upon the leading edge of the propeller blade adjacent the hub will find its way into one or more of these grooves and will be held therein by the air pressure exerted upon the leading edge of the propeller. The centrifugal force set up by the rapidly rotating propeller will tend to move such liquid along the length of the grooves toward the tip of the propeller, portions of such liquid spilling over from the various grooves as the grooves converge toward and intersect each other so that a substantially even distribution of the anti-icing-liquid will occur throughout the length of that portion of the propeller which is provided with the grooves and such liquid as will be spilled out, or that finds way under the ice deposit, will effectively prevent the accumulation of ice upon the leading edge.

While one or more of the grooves may extend throughout the full length of the propeller blade, I do not believe that it is necessary or desirable to extend the same more than somewhere between the mid point and three-quarters of the length of the blade from the hub since the centrifugal forces set up by the rapidly rotating blade will effectively throw off any ice which tends to accumulate on the outermost portion of the length of the propeller blade.

The anti-icing-liquid may be supplied to or sprayed upon the grooved surface of the propeller by a distribution system which may include a suitable supply pipe 8 from a source of liquid or a pump therefor, which supply pipe empties readily into an internal annular channel 9 formed upon the hub 1, from which channel the liquid will be thrown by centrifugal force through a pair of conveying pipes 10 and 11, one for each blade of the propeller, the conveying pipes having their outer ends turned inwardly toward the leading edge of the associated blades so as to cause the liquid passing therethrough to be ejected in a direction normal to the adjacent surface of the propeller blade. While the liquid deposited upon the propeller blades may be effectively received in the mere ends of the grooves 7, I prefer to form a sump 12 on the surface of the blades immediately adjacent the hub and allow the inner ends of the grooves to extend into such sump. Such sump may be merely a depression in the propeller surface though, as illustrated particularly in Fig. 5, I prefer that the outer edge 13 of such sump shall extend somewhat under an overhanging ledge 14 which will further assist in holding liquid in the sump ready for passage outwardly through the grooves 7.

In Fig. 3 I have illustrated a modified arrangement of the conveying grooves 7, in which the grooves 7a extend in the same manner as described with reference to Figs. 1 and 2 but the remaining grooves designated as 7b are not only considerably shorter in length than the groove 7a but terminate at different distances away from the hub without intersecting the grooves 7a. Thus each of these grooves will serve to convey a portion of the anti-icing liquid over a desired length of the blade and insure by their arrangement a uniform distribution of the liquid over the surface area of the propeller.

As hereinbefore stated, the grooves 7 and the sump 12 may be formed directly into the surface of the material of the propeller blades themselves, particularly when the material of the propeller blades is wood. When the propeller blades are formed of metal or other material, the strength of which might be weakened by scratches, scoring or grooves formed in the surface of such material, the conveying grooves and sump may be formed in a surface material which is applied to and mechanically bonded to the material of the blade

proper. Such material may be a thin strip of metal, rubber, or any of the plastic materials such as "Bakelite" and the like, glued, cemented or otherwise mechanically bonded to the propeller surface. By the term "mechanically bonded" as used herein, it will be understood that I mean any bond between the materials resulting from adherence or the physical inter-locking of the materials as distinguished from a fusion or molecular intermingling of the materials so as to produce a junction of the materials to which cracks or imperfections in the surface material may extend but will be prevented from penetrating past the junction and into the material of the blade proper.

However, a most effective manner of providing material into which the grooves and sump may be formed is that of metal spraying a suitable surface material upon the leading edge of the propeller blade to a depth sufficient to accommodate the cutting or forming of the grooves and sump therein, such structure being illustrated particularly in Figs. 5 and 7 wherein a suitable thickness of surface material 15 has been applied to the body material 16. Such metal spray process provides a mechanical bond between the surface material and the body material sufficient to maintain the surface material in place upon the propeller blade during service.

Another distinct advantage which may be accomplished by the employment of surface material added to the body material of the blade lies in the fact that any cracks which may occur in the surface material which have enlarged under stress will extend only to the mechanical bond between the surface material and body material and there stop. Thus the surface material may be applied not only to the leading edge of the propeller blade for a distance sufficient to accommodate the groove 7 but may also be employed over the entire surface of the propeller blade. Thus any dents, scratches or cracks which may occur in the surface of the blade due to injury to the propeller while in service may be readily ground out and the propeller restored to its initial carefully calculated and formed air foil contour by rebuilding the surface material to a desired depth and refinishing this surface to the exact desired contour.

It will therefore be observed that I have provided a propeller construction which is particularly adapted for the maintenance of its carefully designed efficient air foil characteristics regardless of minor injuries which may occur during the active life of the blade and regardless of icing conditions through which the plane so equipped may be required to fly.

While I have shown and described the preferred embodiment of my invention, I do not desire to be limited to any of the details of construction shown or described herein, except as defined in the appended claims.

I claim:

1. In an airplane propeller construction, a propeller blade comprising a propeller body having the general shape and contour of the desired propeller air foil, a layer of metallic surface material extending over the surface of said blade from the hub end thereof, said surface material being mechanically bonded to said blade throughout the area of the blade covered thereby, and one or more conduits formed within said layer of material to convey anti-icing-liquid along said blade.

2. In an airplane propeller construction, a propeller blade comprising a propeller body having the general shape and contour of the desired propeller air foil, a layer of metallic surface material extending over the surface of said blade from the hub end thereof, said surface material being mechanically bonded to said blade throughout the area of the blade covered thereby, and one or more grooves formed in the surface of said layer material and extending longitudinally along said blade to convey anti-icing-liquid along said blade.

3. In an airplane propeller construction, a propeller blade comprising a propeller body having the general shape and contour of the desired propeller air foil, one or more conduits formed in the leading edge of said propeller body to convey anti-icing-liquid along said blade, and a liquid receiving receptacle formed in the hub end of said propeller body and communicating with the hub end of said conduits.

4. In an airplane propeller construction, a propeller blade, a layer of metallic surface material upon at least the leading edge of said propeller, and a plurality of grooves formed in said layer material and extending different distances longitudinally along said blade from the hub end thereof, for distributing anti-icing-liquid along said blade.

5. In an airplane propeller construction, a propeller blade comprising a propeller body having the general shape and contour of the desired propeller air foil, a layer of surface material upon at least the leading edge of said propeller, and a plurality of grooves formed in said layer material and extending different distances longitudinally along said blade from the hub end thereof, the outer end portions of at least some of said grooves converging toward and joining each other.

6. In a propeller construction, a blade having a desired air foil contour, and a plurality of anti-icing-liquid conduits formed in and extending longitudinally of said blade per se and terminating at different distances along the leading edge of said blade for distributing anti-icing liquid along said blade.

7. In a propeller construction, a blade having a desired air foil contour, and a plurality of anti-icing-liquid conduits formed in and extending longitudinally of said blade and terminating at different distances along the leading edge of said blade by joining with a longer one of said conduits.

8. In a propeller construction, a blade having a desired air foil contour, and a plurality of anti-icing-liquid conduits formed in and extending longitudinally of said blade per se along the leading edge of said blade for distributing anti-icing liquid along said blade.

9. In a propeller construction, a propeller blade comprising a blade body having a desired air foil contour, a layer of surface material associated with said blade body and having formed therein a plurality of anti-icing-liquid conduits extending longitudinally of said blade, said conduits having their radially outer end portions converging and joining one another.

10. In a propeller construction, a blade having a desired air foil contour, and being formed with a plurality of anti-icing-liquid grooves extending longitudinally of said blade and terminating at different distances along the leading edge of said blade spaced from the hub end thereof for uniformly distributing anti-icing-liquids along said blade, the outer end portions of at least

some of said grooves converging toward and joining each other.

11. In a propeller construction, a blade having a desired air foil contour, and a plurality of anti-icing-liquid grooves formed in the surface of the leading edge of said blade per se and extending longitudinally of said blade from the hub end thereof for distributing anti-icing-liquid along said blade.

12. In a propeller construction, a blade comprising a blade body having a desired air foil contour, the outer surface of said blade body per se being provided with an anti-icing-liquid groove extending longitudinally of said blade body from the hub end thereof for distributing anti-icing-liquid along said blade.

13. In a propeller construction, a blade having a desired air foil contour, and a plurality of anti-icing-liquid grooves formed in the surface of said blade and extending longitudinally in the outer surface of said blade for distributing anti-icing-liquid along said blade.

14. In a propeller construction, a propeller having a hub, a deicer shoe secured to the leading edge of said propeller, a deicer liquid supply recess formed in the hub end of said shoe, converging grooves formed in the weather-exposed side of said shoe, said grooves being inter-connected and communicating with said recess, whereby deicer liquid received in said recess will enter said grooves, when said propeller is rotated in service, and flow therein, thus providing areas on said propeller on which ice will not form.

RALPH S. JOHNSON.