

Aug. 27, 1946.

E. P. PALMATIER

2,406,473

FAN DE-ICING OR ANTI-ICING MEANS

Filed Sept. 3, 1943

2 Sheets-Sheet 1

Fig. 2.

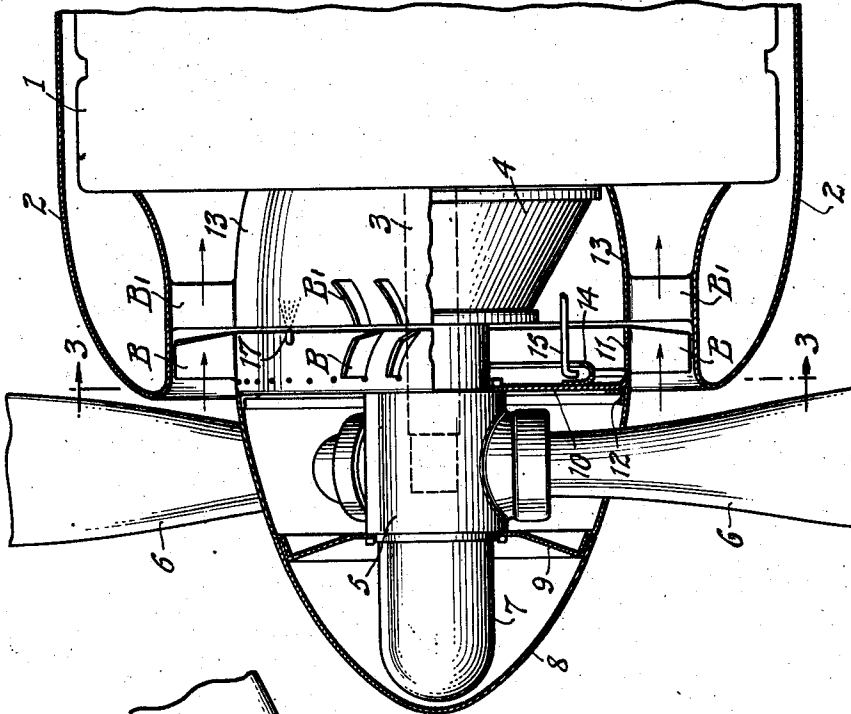
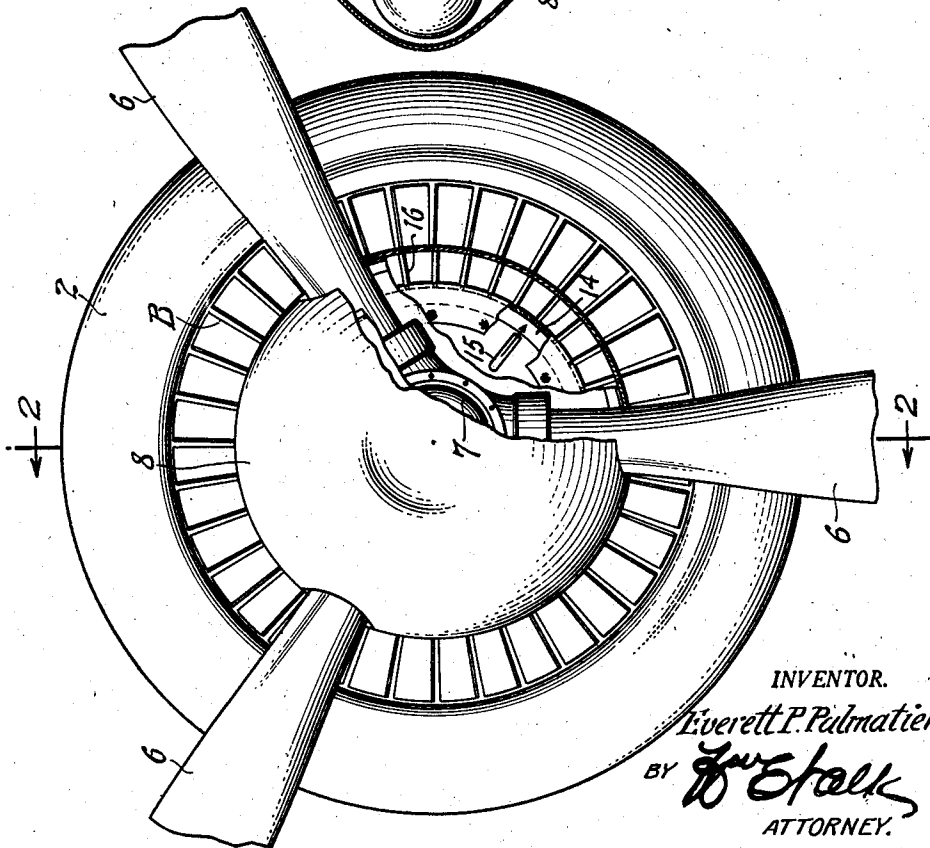


Fig. 1.



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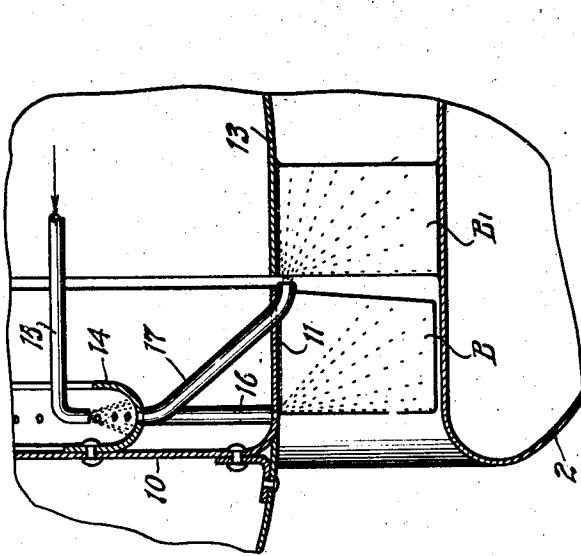


Fig. 4.

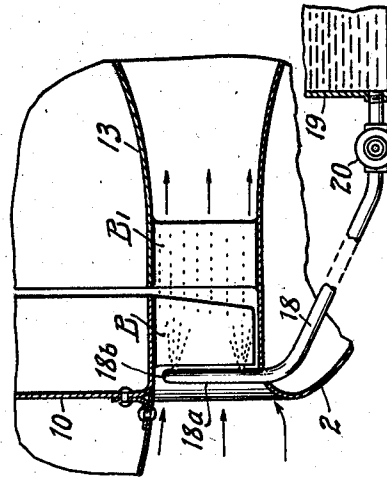
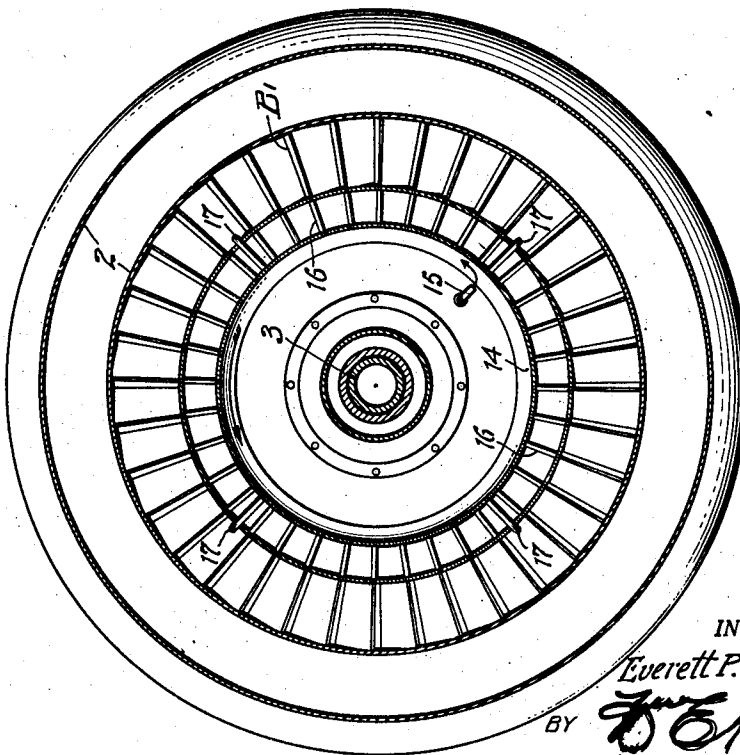


Fig. 5.



Exej. 3.

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FAN DE-ICING OR ANTI-ICING MEANS

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Application September 3, 1943, Serial No. 501,187

1 Claim. (Cl. 244—134)

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My invention relates to de-icing or anti-icing arrangements for applying a liquid medium to an annular series of blades on an aircraft.

In accordance with my invention, a suitable liquid medium is applied to the aforesaid blades, this liquid medium serving either to melt such ice as may have been formed on the blades or to prevent the formation of ice thereon.

Further in accordance with my invention, the aforesaid liquid medium passes through a conduit system under the influence of centrifugal action or independently thereof and engages the exterior surfaces of the blades for the useful purpose stated above.

Various other objects, advantages and features of my invention will become apparent from the following detailed description.

My invention resides in the fan de-icing or anti-icing means, arrangements and combinations of the characters hereinafter described and claimed.

For an understanding of my invention and for an illustration of one of the forms thereof, reference is to be had to the accompanying drawings, in which:

Figure 1 is a front elevational view, partly broken away, showing one form of my invention;

Fig. 2 is a vertical sectional view, partly in elevation, taken on the line 2—2 of Fig. 1 looking in the direction of the arrows;

Fig. 3 is a transverse, vertical sectional view, partly in elevation, taken on the line 3—3 of Fig. 2 looking in the direction of the arrows;

Fig. 4 is an enlarged elevational view, partly in section, showing a feature of the invention; and

Fig. 5 is an enlarged elevational view, partly in section, showing a modification of the invention.

Referring to Fig. 1, 1 designates the aircraft engine with which, in suitable manner, the usual circular cowling 2 is associated. The engine 1 operates the propeller shaft 3 which extends forwardly beyond the engine nose 4 and there carries the propeller hub 5 having the propeller blades 6 projecting therefrom. Associated with the hub 5 is a housing 7 for the motor and associated apparatus operative, as known in the art, for changing the pitch of the propeller blades 6. A spinner 8 encloses the hub 5 and housing 7, the blades 6 extending through the respective openings provided therefor in the spinner 8 which, in a conventional manner, is secured to the hub 5 as indicated at 9 whereby said hub 5 and the spinner 8 are rotatable together as a unit.

The spinner 8 extends just to the rear of the blades 6 and the otherwise open, circular end thereof is closed by a disk 10 which comprises a rearwardly extending circular flange 11, said disk 10 being provided with a central opening through which the aforesaid shaft 3 extends in close-fitting relation. The disk 10 is secured to the spinner 8 in any suitable manner so as to be rotatable therewith as a unit. As herein shown, a circular

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connecting member 12 is utilized for this purpose, the respective angular sides thereof engaging the spinner 8 and disk 10 and the surfaces which thus engage being riveted, welded or otherwise secured together in any suitable manner.

Projecting from and carried by the disk flange 11 are the rotatable fan blades B which form the fan rotor, the blades B being angularly related in suitable manner to the path of movement thereof through the air so that, when rotated, they direct a stream of air rearwardly toward the engine 1. Disposed rearwardly of the rotor blades B is the set of fixed fan blades B1 which form a circular stator, the blades B1 being angularly related in suitable manner to the rotor blades B. In the example shown, the stator blades B1 are secured to the cowling 2 and to a housing 13 fastened in suitable manner to the engine 1 or the nose 4 thereof.

When the aircraft engine 1 is in operation, the shaft 3, the hub 5, the propeller blades 6 and the spinner 8 rotate as a unit. The disk 10 and its flange 11 rotate with the spinner 8 and, therefore, the rotor blades B direct a stream of air rearwardly toward the engine 1. Before such stream of air reaches said engine 1, it is suitably deflected by the stator blades B1.

In accordance with the invention, the arrangement described above has associated therewith suitable means for supplying de-icing liquid to one or both of the fans described above. To this end, as shown in Figs. 1-4 inclusive, a ring 14, known as a "slinger" ring, is riveted, welded or otherwise suitably secured to the rear face of the disk 10, the ring 14 being shaped to form a circular chamber open throughout its length, at the inner side thereof. A conduit 15 which is anchored in position in any suitable manner, for example, by attachment to the engine nose 4 is supplied with the de-icing liquid, the latter being discharged from said conduit 15 into the ring 14 at any suitable rate.

A plurality of pipes 16 supported in suitable manner, for example, by seating the respective opposite ends thereof in passages formed in the ring 14 and in the disk flange 11 are utilized for passing de-icing liquid from the ring 14 and discharging it at the leading edges of the respective rotor blades B at or adjacent the roots thereof. In the example shown and preferably, one pipe 16 is provided for each rotor blade B.

A plurality of pipes 17 supported, for example, in the same manner as described with respect to the pipes 16 are utilized for passing de-icing liquid from the ring 14 and discharging it so that it engages the leading edges of the stator blades B1 at or adjacent the roots thereof. In the form of the invention shown, four of the pipes 17 are provided and these are symmetrically related to each other around the periphery of the stator. How-

ever, it will be understood that more or less of the pipes 17 may be provided as desired.

During operation of the aircraft engine as described, the ring 14 together with the pipes 16 and 17 rotate as a unit with the disk 10 and its flange 11.

When it becomes desirable to operate the de-icing system, a suitable de-icing liquid such, for example, as alcohol, glycerine or the like is supplied to the pipe 15 under suitable pressure. From the pipe 15, the de-icing liquid passes into the ring 14 and, by centrifugal action, is distributed throughout the circumferential length thereof. Accordingly, the ring 14 serves as a chamber providing a source of supply of the de-icing liquid for the pipes 16 and 17 through which the de-icing liquid passes to the roots of the rotor and stator blades B and B1, said de-icing liquid passing through the pipes 15 and 16 and being distributed along the surfaces of the respective rotor blades B from the leading edges thereof by centrifugal action as will be understood.

As hereinbefore stated, it is desirable that one of the pipes 16 be provided for each rotor blade B. However, as regards the stator blades B1 and, as stated, a substantially smaller number of the pipes 17 are provided than there are blades B1. As will be understood from the foregoing description, the pipes 17 sweep past the roots of the stator blades B1 and, since each of the pipes 17 is traversed by the de-icing liquid, it results that each stator blade B1 receives its share of the total supply of de-icing liquid which is distributed by the pipes 17. The air stream produced by the rotor blades B aids in the distribution of the de-icing liquid along the surfaces of the stator blades B1. Further, said stator blades B1 may receive some de-icing liquid directly from the rotor blades B.

With the form of my invention hereinbefore described, the ring 14 together with the pipes 16 and 17 rotate as a unit in order to effect the de-icing operation. Each pipe 16 is immovable with respect to the rotor blade B with which it is associated. However, the pipes 17 rotate with respect to the stator blades B1 and the de-icing liquid is distributed therefrom onto the latter.

With the form of my invention referred to above, pipes 16 have been described for conveying the de-icing liquid from the ring 14 to the blades B. It shall be understood that the invention is not to be limited to said pipes 16. Obviously, the diameter of the ring 14 may be such that it is located closely adjacent the roots of the blades B and, if so, the liquid preferably passes to the respective blades B through orifices or nozzles formed in said ring 14.

Referring to Fig. 5, I have shown a modification of the invention wherein a pipe 18 is fixed to the cowling 2 or equivalent structure for fixing said pipe 18 with respect to the rotor blades B. The pipe 18 terminates in an angular section 18a provided preferably with a plurality of nozzles 18b which face toward the leading edges of the respective rotor blades B as they arrive in succession opposite the pipe section 18a. As will be understood, de-icing liquid may be stored in a tank 19 and, under the control of a pump 20, the de-icing liquid may be supplied through the pipe 18 under suitable pressure and ejected continuously from the nozzles 18b. As the rotor rotates, each of the blades B thereof receives a portion of the total supply of the de-icing liquid which is thus ejected from the nozzles 18b. Forward movement of the fan blades B through the air causes distribution of the de-icing liquid 75

across the fan blades B from the leading edges to the trailing edges thereof and some of this de-icing liquid may pass onto the stator blades B1. Further, some of the de-icing liquid is entrained in the air stream produced by the rotor and carried thereby into engagement with the surfaces of the stator blades B1.

In view of the foregoing description, it will become apparent that, as regards either or both the rotor or stator of a fan cooling arrangement for an aircraft engine, I provide arrangements for supplying liquid to the blades in proper proportions to effect the desired de-icing action.

With the forms of my invention herein disclosed, the de-icing liquid is applied effectively to both sides of each fan blade, whether rotor or stator, throughout substantially the entire area thereof. Particularly as regards the form of my invention illustrated in Fig. 5, the liquid de-icing material is applied effectively to each rotor blade at the tip end area thereof. The arrangement last noted is particularly advantageous because it has been ascertained that the leading edge area together with the area at the tip end of each rotor fan blade are critical from the icing viewpoint.

In the appended claim, the expression "de-icing" shall be understood as describing true de-icing wherein that ice is melted which, previously, had been formed on the fan blades and said expression shall also be considered as describing an operation wherein the fan blades are subjected to the action of an agent which positively prevents the formation of ice thereon.

While the invention has been described with respect to certain particular preferred examples which give satisfactory results, it will be understood by those skilled in the art after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention and it is intended therefore in the appended claim to cover all such changes and modifications.

What is claimed as new and desired to be secured by Letters Patent is:

In an aircraft, in combination, a streamlined spinner, an annular cowling concentrically surrounding said spinner and defining therewith an annular air entrance channel, a rotary fan comprising a hub whose surface is contiguous with the spinner surface, having a large plurality of fan blades extending therefrom and sweeping said annular channel, a stator fan comprising a large plurality of stationary fan blades disposed in a plane parallel to the rotary blades and extending across said annular entrance in series relation with the rotating blades, an annular collector within said rotary fan hub rotatable therewith, means to feed a de-icing fluid thereto, ducts leading from said collector outwardly to points adjacent the roots of the leading edges of the several rotary fan blades for conducting fluid from said collector for spraying, under the influence of centrifugal force, a spray of fluid along the leading edges of said rotary fan blades, and ducts fewer in number than the number of blades leading from said collector to points on said hub close to the leading edges of said stator fan blades for spraying, under the influence of centrifugal force, a uniform spray of fluid in advance of all the leading edges of said stator blades as the rotary fan hub rotates relative thereto, whereby the sheet of spray thus formed impinges, at least in part, upon the all of the stator fan blades for removal of ice therefrom.

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