

Sept. 17, 1940.

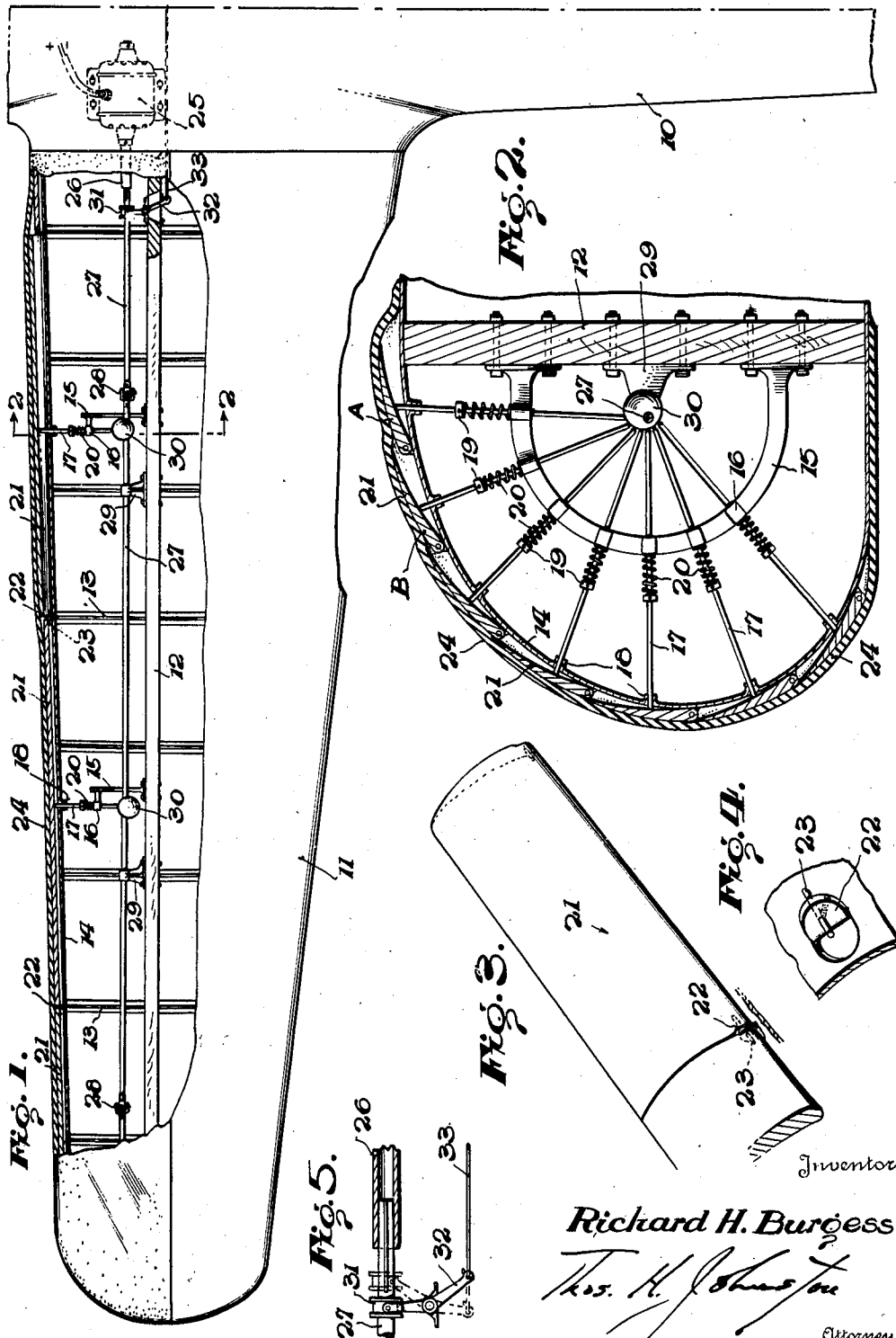
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2,214,919

DE-ICING MECHANISM

Filed May 5, 1939

2 Sheets-Sheet 1



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Fig. 6.

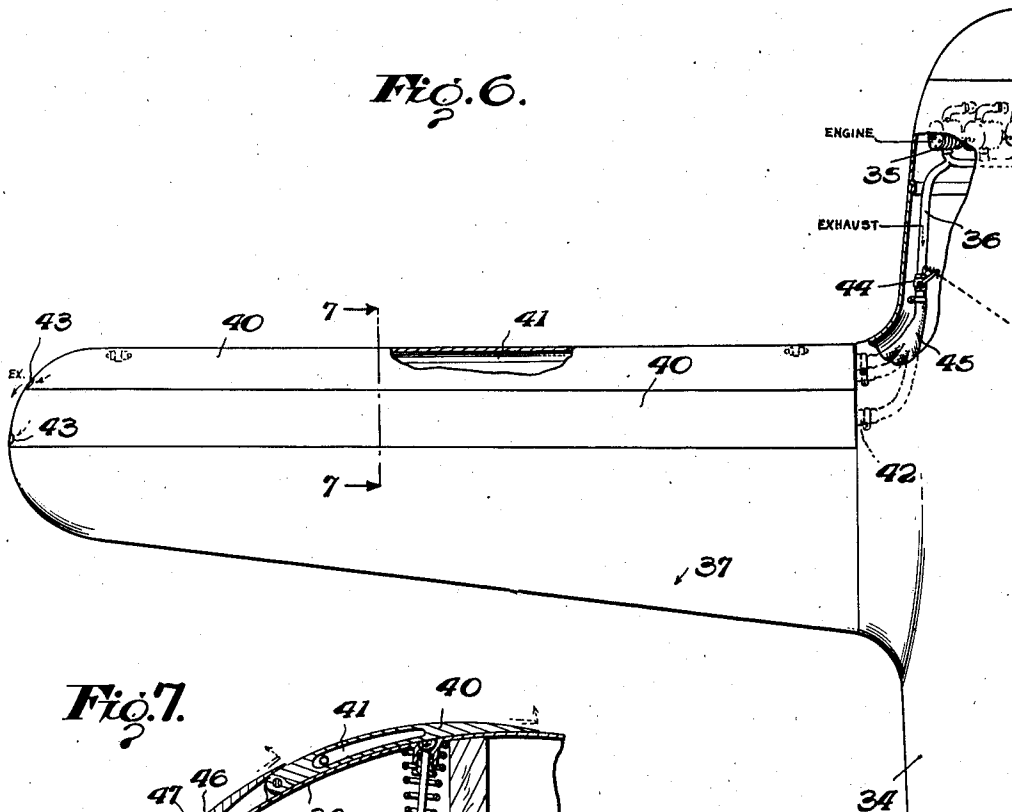


Fig. 7.

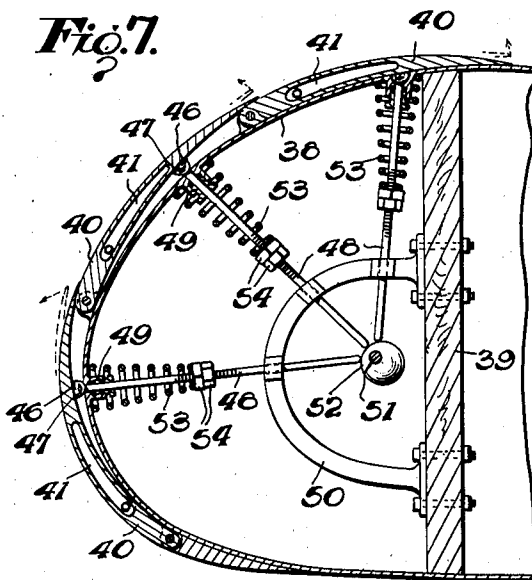


Fig. 8.

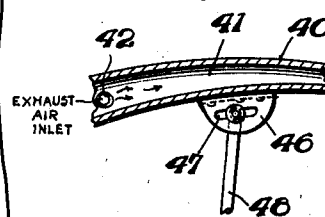
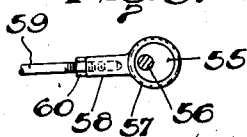


Fig. 9.



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UNITED STATES PATENT OFFICE

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DE-ICING MECHANISM

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8 Claims. (Cl. 244—134)

This invention relates to an improved mechanism for freeing the leading edges of aeroplane wings or other airfoils of ice.

It has been discovered that the bond between an ice incrustation and the leading edge of a wing tends to preserve intact, even though measures are taken to crack or break the ice sheet in a maze of ramifying directions. An object of the present invention, therefore, is to provide means, not only for cracking or breaking the bond between the ice sheet and the leading edge of the wing or otherwise weakening or disrupting said bond, but also, coincidentally, setting up a shaking or vibrating action such as will dislodge the sheet from said edge.

A further object of the invention is to provide, in one variation of the invention, an overshoe for the leading edge of the wing, means for locally bending or flexing said overshoe to crack ice therefrom, wherein said local flexing will progress in bands longitudinally of the overshoe, wherein the bands of flexing movement will succeed each other, each after the next proceeding transversely about the leading edge of the overshoe for cracking and breaking up any ice incrustation thereon, and wherein the overshoe will, at said bands, be coincidentally vibrated, hammered and shaken to dislodge the ice therefrom.

Still another object of the invention is to provide, as another variation, a plurality of mating hinged shutters which form the exposed leading surface of the wing, wherein said shutters may be heated to weaken the bond between any ice incrustation thereon and the shutters, and wherein the shutters may be coincidentally vibrated, hammered and shaken to dislodge the ice therefrom.

And the invention seeks, as a still further object, to provide a mechanism which will be dependable and sure and which may be readily embodied in aeroplanes as now manufactured.

Other and incidental objects of the invention will appear during the course of the following description and in the drawings.

Figure 1 is a plan view, partly broken away and shown in section and showing a wing of an aeroplane equipped with my improved mechanism.

Figure 2 is a transverse vertical section on the line 2—2 of Figure 1.

Figure 3 is a fragmentary perspective view showing the hinge mounting for the shutters employed.

Figure 4 is a detail perspective view showing one of the hinge ears.

Figure 5 is a detail elevation, partly in section,

and showing the cam control of the mechanism.

Figure 6 is a plan view showing a variation of the invention.

Figure 7 is a transverse vertical section on the line 7—7 of Figure 6.

Figure 8 is a detail section showing, on an enlarged scale, how the push rods of Figure 6 are connected to the shutters.

Figure 9 is a fragmentary detail section showing a further slight variation.

Referring now more particularly to Figures 1 to 5 of the drawings, I have shown a portion of a conventional fuselage of an aeroplane at 10 and one of the wings at 11. A spar is shown at 12, the usual ribs at 13 and the metal leading edge of the wing at 14.

In accordance with the present invention, U-shaped brackets 15 are appropriately mounted at suitably spaced points along the spar 12 and projecting from each bracket is a plurality of radially spaced arms 16. Journaled through suitable bearings at the free ends of the arms of each bracket is a set of radial push rods 17 slidably received through suitable nipples or sleeves 18 at the inner side of the leading edge 14 of the wing. Fixed to the rods 17 are collars 19 to which are attached contractile springs 20, the inner ends of which are likewise attached to the bearings at the free ends of the arms 16. Thus, the springs 20 will serve to retract the rods 17 and normally hold said rods in retracted position.

Mounted at the outer side of the leading edge 14 of the wing is a plurality of overlapping mating shutters 21 which are tapered in thickness and curved to conform to the curvature of said edge. As seen in Figure 4, ears 22 may be struck up from the leading edge 14 of the wing to receive pins 23 which pivotally mount the shutters and, as will be observed, the push rods 17 contact the inner sides of the shutters near the pivoted edges thereof.

The shutters 21 match endwise in rows lengthwise of the wing. For instance, at the top of the leading edge 14 is provided a row of endwise matching shutters indicated at A in Figure 2. The next longitudinal row is indicated at B and so on around the leading edge transversely thereof. The number of shutters in each row must remain, of course, a matter of choice, but for each shutter in each row it will be necessary to provide a push rod 17. In Figure 1, I have shown three shutters in each row.

Overlying the shutters 21 is an overshoe 24 of rubber or other appropriate elastic fabrication appropriately secured at its margins to the top and bottom of the leading edge 14 of the wing.

This overshoe will, of course, fit tight and will thus serve to resiliently resist outward swinging movement of the shutters 21 as well as normally retain the shutters in collapsed folded relation each abutting the next to normally provide a substantially smooth surface at the exterior of the overshoe.

Suitably mounted in the fuselage 10 is an appropriate motor 25, seen in dotted lines in Figure 1. The construction of the motor itself is of no concern, except that it may be manually controlled, suitably, to start and stop it. Extending from the motor is a drive sleeve 26 in which is splined a drive shaft 27 preferably having interposed therein a suitable number of spaced universal joints 28 of approved construction, and journaling said shaft are appropriate bearings 29 fixed to the spar 12, the shaft being shiftable longitudinally in said bearings. Fixed to the shaft 27 are spaced spherical cams 30 each to coact with a set of push rods 17, as seen in Figure 2, and the cams are spaced about the shaft so that, as the shaft turns, the shutters of a row longitudinally of the wing, as before described, will be operated in sequence. Thus, to illustrate: assuming a row of shutters longitudinally of the wing, first one shutter at the base end of the wing will be actuated, then the next in line, then the next etc. This will hold true for each longitudinal row of shutters transversely about the leading edge of the wing.

Fixed to the shaft 27, as seen in detail in Figure 5, is a collar 31 and suitably pivoted upon the spar 12 is a lever 32 operatively coacting at one end with said collar. Connected to the opposite end of said lever is a control rod 33 which may be manually operated from a point within the fuselage 10 to actuate the lever and shift the shaft 27 endwise. Thus, the shaft may be moved in one direction to dispose the cams 30 in active position beneath the inner ends of the sets of push rods 17 to coact therewith, and in the opposite direction to dispose said cams in inactive position out of line with the sets of push rods. In the inactive position of the cams, all of the push rods 17 will, of course, stand retracted while, also, all of the shutters 21 will likewise stand retracted in normal folded position so that the overshoe 24 will normally present a substantially smooth surface at its outer face.

Assuming now that the motor 25 is operating and that the cams 30 are disposed in active position, as previously described, it will be seen that the push rods 17 of each set will be actuated in sequence to, in turn, swing out, in sequence, the overlying transverse belt of shutters against the tension of the overshoe 24. Furthermore, due to the spacing of the cams, the shutters of each longitudinal row will, as previously described, be swung out in sequence with the result that the overshoe will be locally flexed progressively and thus rippled along a number of longitudinal bands or zones while also, the bands or zones of local flexing will succeed each other or progress transversely about the leading edge of the overshoe. Thus, any ice incrustation upon the leading edge of the overshoe will be cracked and broken up. At the same time, the push rods, under the action of the cams 30, will tend to hammer against the shutters and vibrate the same so that the disrupted ice upon the leading edge of the overshoe will be dislodged and shaken therefrom.

In Figures 6, 7 and 8 of the drawings, I have shown a variation of the invention wherein a por-

tion of the fuselage of an aeroplane is conventionally shown at 34 and the engine at 35, the engine being provided with an exhaust pipe 36. A wing of the aeroplane is shown at 37, the metal leading edge of the wing at 38 and a spar at 39.

Suitably pivoted at the outer side of the leading edge 38 of the wing are mating overlapping shutters 40 tapered in thickness and curved to conform to the curvature of said edge, the shutters, when closed, providing a substantially smooth surface. Any approved number of shutters transversely about the leading edge of the wing may, of course, be employed and, as will be observed, the shutters extend the full length of the wing. In the present instance, I have shown three shutters.

Formed in the shutters, throughout the length thereof, are heating chambers 41 and at the base end of the wing, the shutters are provided with nipples 42 to communicate with said chambers while at the tip of the wing, the shutters are formed with exhaust openings 43 for said chambers. Interposed in the exhaust pipe 36 of the engine 35 is a manually operable control valve 44 of approved construction and connecting said pipe with the several nipples 42 is a branched flexible conduit 45. In one position of the valve, the exhaust gases from the engine may be discharged into the air. In another position of the valve, a portion or all of the exhaust gases may be directed through the conduit 45 into the heating chambers 41 of the shutters 40. The specific construction of the valve is of no concern.

Fixed to the inner sides of the shutters 40 are sets of ears 46 aligned transversely of the leading edge 38 of the wing and provided with slots 47. The sets of ears are appropriately spaced apart longitudinally of the shutters 40 and pivotally connected thereto are sets of push rods 48. These push rods are slidable through suitable glands 49 at the inner side of the leading edge 38 and, of course, the slots 47 are provided to accommodate the swinging travel of the shutters. A bracket 50 is provided for each set of rods, these brackets being like the brackets 15 previously described, and extending through the brackets is a longitudinally movable shaft 51 corresponding to the shaft 27. Fixed on the shaft to coact with each set of rods 48 is a spherical cam 52, the shaft being movable endwise to dispose the cams in active or inactive position, as also previously described. Surrounding the push rods 48 are volute springs 53 acting against nuts 54 adjustable for tensioning said springs, the springs serving to normally hold the shutters 40 closed or folded.

In this variation, the cams 52 will, of course, be fixed in identical relation on the shaft 51 so that when the shaft is shifted to dispose the cams in active position, the several push rods connected to any single shutter will, as the shaft rotates, be actuated simultaneously. However, the shutters will, as the shaft is rotated, be swung up in sequence transversely about the leading edge of the wing. By manipulating the valve 44, exhaust gases from the engine 35 may be directed into the chambers 41 of the shutters for heating said shutters and loosening the bond of any ice incrustations thereon when the vibration of the shutters set up by the cams 52 and push rods 48 will serve to shake the ice free and dislodge the ice from the shutters.

In Figure 9 of the drawings, I have shown still another variation wherein a cam, corresponding to one of the cams 52, is indicated at 55 and the shaft at 56, this shaft corresponding to the shaft

51. Surrounding the cam 55 is a yoke 57 having a stem 58 into which is adjustable a push rod 59 secured by a lock nut 60. Thus, in this variation, the shaft 56 will not be shiftable endwise while, however, the cams 55 will, as will be appreciated, serve to normally lock the shutters positively closed or folded in collapsed position.

Having thus described my invention, what I claim is:

10 1. A de-icing mechanism for an airfoil having a leading edge, said mechanism including a plurality of curved companion shutters pivoted on axes substantially parallel with the surface of said airfoil and normally overlying said edge close thereto in mating closed relation to form a shield of attack extending close about said edge in conformity with the curvature thereof and housing and protecting said edge, and means for swinging said shutters.

20 2. A de-icing mechanism for an airfoil having a leading edge, said mechanism including a plurality of curved companion pivoted shutters normally overlying said edge close thereto in mating closed relation to form a shield of attack extending close about said edge in conformity with the curvature thereof and housing and protecting said edge, said shutters being disposed in rows longitudinally of said edge, and means for swinging the shutters of each row in sequence and progressing from row to row about the leading edge transversely thereof.

30 3. A de-icing mechanism for an airfoil having a leading edge, said mechanism including a plurality of curved companion shutters pivoted on axes substantially parallel with the surface of said airfoil and normally overlying said edge close thereto in mating closed relation to form a shield of attack extending close about said edge in conformity with the curvature thereof and housing and protecting said edge, means for swinging said shutters, and an elastic overshoe overlying said shutters and normally retaining the shutters closed.

40 4. A de-icing mechanism for an airfoil having a leading edge, said mechanism including a plurality of curved companion pivoted shutters normally overlying said edge close thereto in mating closed relation to form a shield of attack extending close about said edge in conformity with the curvature thereof and housing and protecting said edge, said shutters being disposed in rows longitudinally of said edge, means for swinging the shutters of each row in sequence and progressing from row to row about the leading edge transversely thereof, and an elastic overshoe overlying said shutters and normally retaining the shutters closed.

5. A de-icing mechanism for an airfoil having a leading edge, said mechanism including a plurality of curved companion pivoted shutters normally overlying said edge close thereto in mating closed relation to form a shield of attack extending close about said edge in conformity with the curvature thereof and housing and protecting said edge, said shutters being provided with heating chambers, means for swinging said shutters, and means for heating said chambers.

6. A de-icing mechanism for an airfoil having a leading edge, said mechanism including a plurality of curved companion pivoted shutters normally overlying said edge close thereto in mating closed relation to form a shield of attack extending close about said edge in conformity with the curvature thereof and housing and protecting said edge, said shutters being provided with heating chambers, means for swinging said shutters, and means for directing heated exhaust gases through said chambers.

7. A de-icing mechanism for an airfoil having a leading edge, said mechanism including a plurality of curved companion pivoted shutters normally overlying said edge close thereto in mating closed relation to form a shield of attack extending close about said edge in conformity with the curvature thereof and housing and protecting said edge, the shutters being provided with heating chambers, means for directing a heating medium through said chambers for heating the shutters and weakening the bond of any ice incrustation thereon, and means for vibrating the shutters simultaneously with the heating thereof.

8. A de-icing mechanism for an airfoil having a leading edge, said mechanism including a plurality of curved companion pivoted shutters normally overlying said edge close thereto in mating closed relation to form a shield of attack extending close about said edge in conformity with the curvature thereof and housing and protecting said edge, said shutters being disposed in rows longitudinally of said edge, spaced brackets fixed within the airfoil, a set of radial push rods slidably mounted upon each bracket to each severally coact with a corresponding shutter of the several rows, a drive shaft, and cams fixed to the shaft to each coact with a set of push rods, the cams being stepped about the shaft for actuating the push rods and swinging the shutters of each row in sequence and progressing from row to row about the leading edge transversely thereof.

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