Aug. 30, 1932. E. P. GAINES 1,874,278

AEROFOIL

Filed Aug. 28, 1929 2 Sheets-Sheet 1

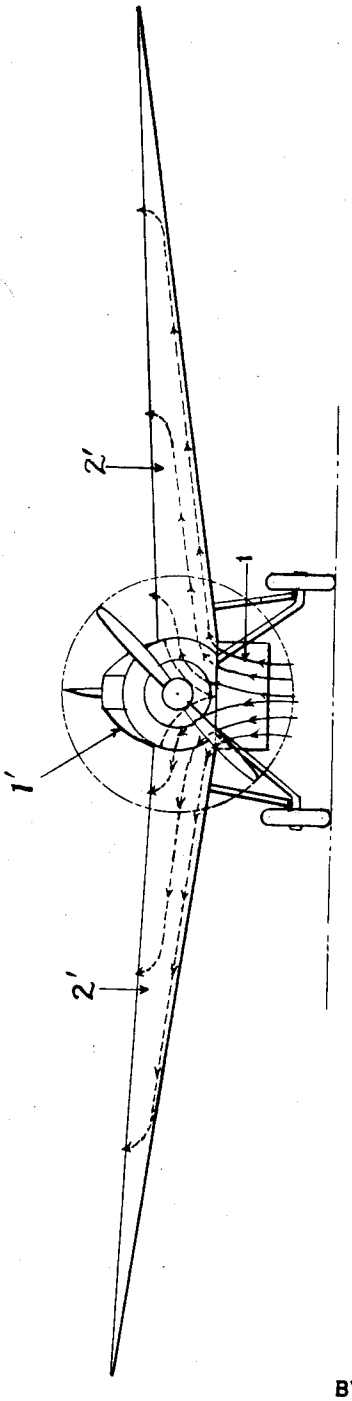


Fig. 1.

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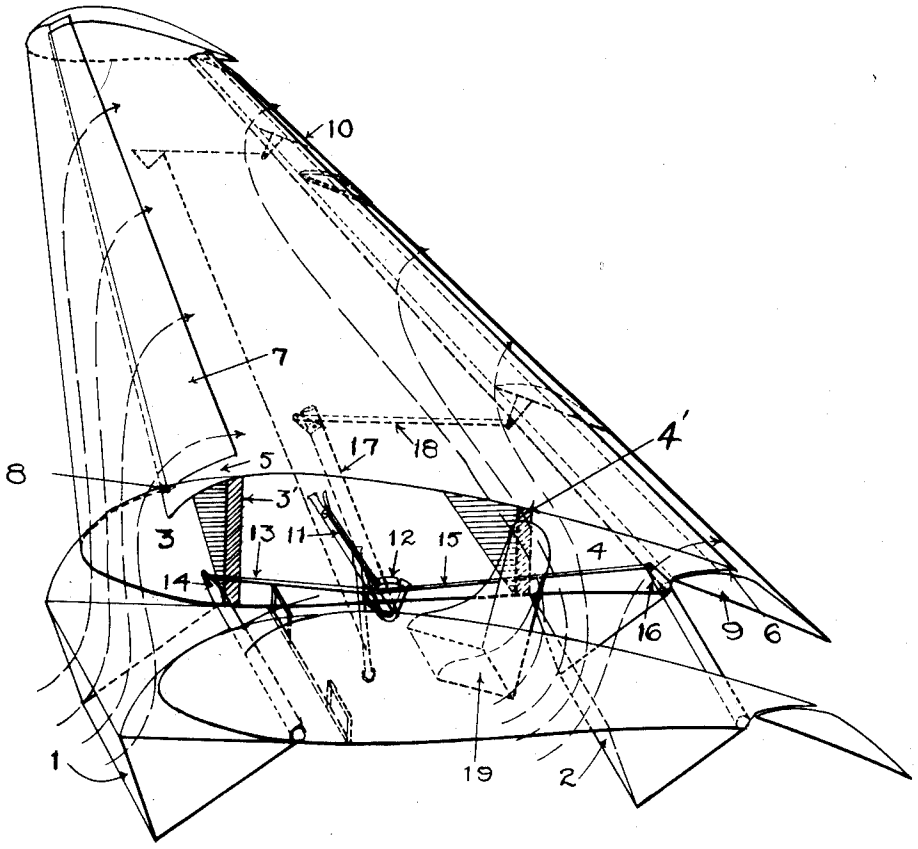


Fig. 2.

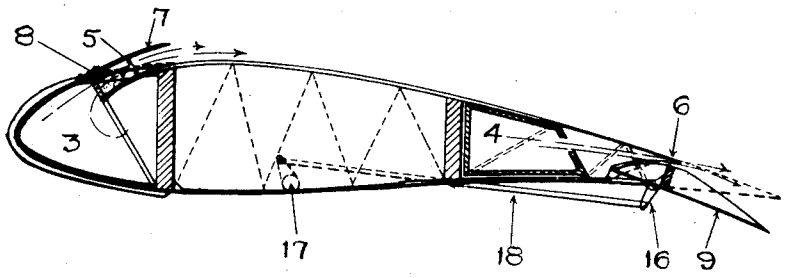


Fig. 3.

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UNITED STATES PATENT OFFICE

EDMUND P. GAINES, OF COLUMBIA, SOUTH CAROLINA

AEROFOIL

Application filed August 28, 1929. Serial No. 388,924.

My invention relates to aircraft and more particularly to aerofoils.

It is already known that when an aerofoil is inclined at an angle to the air thru which it is translated or which acts against it, that the lift coefficient of such aerofoil increases with the increase of its angle of attack up to a certain critical angle which past experiments indicate varies between 12° and 20°. After this critical angle is passed the value of the lift coefficient of the aerofoil decreases owing to a discontinuity of the air flow over the upper surface of the aerofoil, which disturbed air flow, i. e., eddying air or vortices, is known as "burbling". When burbling begins the air ceases to exert its full suction effort and the lift coefficient rapidly falls off. Experiments further show that burbling occurs first in the vicinity of the center of the aerofoil and continues outwardly progressively toward the tips.

To prevent burbling it has heretofore been proposed to provide aerofoils with a leading edge portion and with a main portion adapted to be set with respect to each other to leave a longitudinally extending open slot thru the aerofoil. It has also been proposed to provide in the upper surface of an aerofoil slots or openings thru which air is adapted to escape, the escaping air being directed rearwardly to sweep away the dead air caused by the forward movement of the aerofoil thru space. In neither of said previously suggested schemes, however, is any provision made for controlling the volume of air escaping over the top surface of the aerofoil, nor is any provision made for directing a greater volume of air over the center or inner end portion thereof than over its outer end or ends. Moreover, with the object in view of retarding burbling, no one has suggested an arrangement whereby the air is taken in thru a control inlet, directed laterally thru air passages formed interiorly of the aerofoil, and liberated onto the upper surface thereof as well as onto the upper surface of a hinged flap or aileron fastened to or adjacent to the trailing edges of the wing. Nor has any one proposed ejecting air over the upper surface of the aerofoil from slots in air passages transverse to the line of flight, in combination with a simultaneously operated flap or aileron fastened to or adjacent to the trailing edge of the wing.

According to the present invention there is provided in the aerofoil or aerofoils one or more interior air passages thru which the air escaping therefrom onto the top surface of the aerofoil is directed. Where a taper wing or aerofoil is provided the air passages either taper outwardly or have open thereto tapering slots or outlets (or both) so that a greater volume of air may be directed onto the upper surface of the aerofoil nearer to its inner end or mid-section than to its outer end or tips. Where non-tapering wings or aerofoils are provided, and trailing edge flaps or ailerons are used in conjunction with air passages and slots, the passages may be of uniform cross section and the slots of uniform width. With each said air passage there is associated an appropriate manually controlled air scoop, for regulating the volume of air admitted to said air passages. One of the air passage outlets is located nearer to the leading edge of the aerofoil than to its trailing edge, whereas the other of said passages has its outlet so related to the trailing edge flap or aileron as to admit of an air discharge over its upper surface. Preferably the air scoop or scoops and the trailing edge flaps or ailerons are so interconnected as to provide for their simultaneous operation; the scoop or scoops being opened to admit air to the air passages simultaneously with the movement of the trailing edge flaps or ailerons. The flaps or ailerons incidentally, in their normal position, preclude the escape of air from the trailing edge or rearwardly located slot. It is only when said flaps or ailerons are biased downwardly that need for an air discharge over the upper surface occurs. Air thus controlled and directed not only eliminates burbling over the aerofoil surfaces as higher angles of attack than heretofore, but it accomplishes the desired end in a structurally simple and entirely satisfactory manner subject at all times to perfect manual control. To force

the air into, thru, and out of the air passages onto the aerofoils or surfaces, atmospheric pressure or atmospheric pressure plus the slipstream, or both of these plus the blast of the propeller may be utilized. Moreover, if desired, the heat dissipated by the power plant, thru preheating the air in circulation, may be utilized to prevent the formation and accumulation of ice on the aerofoil surfaces or wings.

Other objects and advantages of the invention will be hereinafter set forth.

In the drawings, wherein like reference characters denote like or corresponding parts,

Fig. 1 is a front view of a low wing monoplane having tapered wings;

Fig. 2 is a diagrammatic view showing the wing construction and its relation to the fuselage or machine, and

Fig. 3 is a cross-section of the wing adjacent to the fuselage showing certain details of construction.

As intimated, the invention is shown as embodied in a low taper wing monoplane in which the fuselage is designated as 1′ and the opposed wings as 2′. Air scoops 1 and 2 are built into the bottom of the fuselage 1′ in a manner such that their leading edges may be lowered to divert the slipstream into transverse air passages 3 and 4 which extend lengthwise the wings or aerofoils 2′. Air passage 3, as herein shown, is the space between the front wing beam 3′ and the leading edge of the aerofoil. It is formed by placing the usual metal or wood nose covering inside the nose ribs (not shown). Air passage 4 is a box-like structure located behind the rear beam 4′ of the wing and is attached inside the wing ribs (not shown). Preferably the box-like structure is braced interiorly by means of small diagonal streamline struts whose major axes are parallel to the wing beams. The rear wall of the box-like structure is provided with an oblong slot or slots thru which the air escapes to an airgap or outlet 6 provided at the trailing edge of the main portion of the wing. For reasons hereinafter pointed out, the air passages 3 and 4 taper or decrease in cross-sectional area from the inner to the outer end of the wing, the taper idea being also carried out in the formation of the wing slots or air outlets thru which the air in circulation is liberated onto the upper surface of either the wing proper or wing flap or aileron with which the wing is equipped. The wing flap as herein shown is designated as 9 and the aileron mounted at the outer end of the wing, is designated as 10. In its "up" position, the wing flap 9 closes the air slot 6 whereas in its "down" position said slot is uncovered to provide for the escape of air. That which is true of the wing flap 9 in this respect is true also of the aileron 10. A shutter 7 for the forward or leading edge slot is normally held closed by the spring hinge 8 that the continuity of the aerofoil section may be maintained at low angles of attack.

The operation of the arrangement is as follows: Consider the aerofoils or wings set for normal cruising operation as shown by the dotted portions of Fig. 3, i. e., with shutter 7 closed, wing flap 9 up, and aileron 10 in neutral position. The pilot, in his seat 19 moves the lever 11 shown in Fig. 2 to the forward notch of the quadrant 12. Thus moved, rod 13 pushes arm 14 forward to open the air scoop 1. At the same time, rod 15 pulls arm 16 forward to open the air scoop 2. Also, torque tube 17 rotates counter-clockwise pulling wing flap 9 down by means of the rod 18. With the parts thus positioned, air is caught from beneath the fuselage by scoops 1 and 2 and is deflected into the transverse air passages 3 and 4 by suitable partitions placed transversely of the fuselage at the rear extremity of the air scoops. Shutter 7 is opened by a combination of the air pressure from within and the suction occurring over the upper surface of aerofoil. (Shutter 7 can be hinged at its rear edge and may be opened downward and inward by mechanical means if desired or, if preferred, it may be entirely omitted.) Air gap 6 is opened by the lowering of the wing flap 9. The air is propelled thru the air passages 3 and 4 and out thru the slots 5 and 6 by the combination of forces of atmospheric pressure plus slipstream and propeller blast as well as by the partial vacuum existing over the upper surfaces of the aerofoil. If desired, by sweeping the wings back, the flow of air in the air passages can be accentuated.

The system as herein shown is semi-automatic as the resultant air forces acting on the air scoops 1 and 2 tend to balance those forces acting on the wing flap 9. Accordingly, but little force is required to operate the control device or lever 11.

Prevention of ice forming on the wings is accomplished by diverting the heated air from the power plant (not shown) into the air scoops 1 and 2 and thence thru the air passages 3 and 4 from which it escapes.

While I have described my invention in detail in its present preferred embodiment, it will be obvious to those skilled in the art after understanding my invention that various changes and modifications may be made therein without departing from the spirit or scope thereof. I aim in the appended claims to cover all such modifications and changes.

What I claim is:

1. In aircraft, a fuselage; an aerofoil provided with an interior air passage transverse to the direction of flight and thru which air passes outward within said aerofoil, having an outlet opening thru which the air within

said passage is adapted to escape, and having an inlet opening positioned adjacent to said fuselage, and a movable trailing edge flap adapted, by its movement, to control said air escape.

2. In aircraft, a fuselage; an aerofoil provided with an interior air passage transverse to the direction of flight and thru which air passes outward within said aerofoil, having a trailing edge outlet opening thru which the air within said passage is adapted to escape, and having an inlet opening for said interior air passage positioned adjacent to said fuselage, and a movable trailing edge flap adapted, by its movement to cover and uncover said opening.

3. In aircraft, a fuselage; an aerofoil provided with an interior air passage transverse to the direction of flight and thru which air passes outward within said aerofoil, having an outlet opening thru which the air within said passage is adapted to escape, and having an inlet opening positioned adjacent to said fuselage through which air passes into said interior air passage, and a trailing edge flap mounted in such relation to said outlet opening as to admit of the air escape directly onto its upper surface.

4. In aircraft, a fuselage; an aerofoil provided with an interior air passage transverse to the direction of flight and thru which air passes outward within said aerofoil, having an outlet opening thru which the air within said passage is adapted to escape, and having an inlet opening adjacent to said fuselage through which air is adapted to enter said passage, and a trailing edge flap mounted in such relation to said outlet opening as to admit of the air escape directly onto the upper surface of the trailing edge flap at a point rearwardly removed from its leading edge.

5. In aircraft, an aerofoil provided with an air passage having an inlet opening and an outlet opening, a closure for said inlet opening, and a closure for said outlet opening operable automatically under the influence of the varying air forces produced by the opening and closing of said inlet opening.

6. In aircraft, an aerofoil provided with an interior air passage transverse to the direction of flight and having an inlet opening and an outlet opening in the upper exterior surface of said aerofoil, a closure for said inlet opening, a wing flap movable to cover and uncover said outlet opening, said wing flap being so related to said outlet opening so as to admit of an air discharge over the upper surface thereof when said outlet opening is uncovered, and a mechanical connection between said closure and said wing flap for coordinating the movements thereof.

7. In aircraft, an aerofoil provided with separate interior air passages each having an inlet opening and an outlet opening, a wing flap normally closing one said outlet opening, separate closures for said inlet openings and means operable to move said wing flap to uncover one said outlet opening simultaneously with the opening movement of said inlet closures.

8. In aircraft, an aerofoil provided with separate interior air passages each having an inlet opening and an outlet opening, a wing flap carried by and movable relatively to said aerofoil, one said outlet opening being adapted to discharge air over the upper surface of said aerofoil nearer to its leading edge than to its trailing edge, and the other said outlet opening being adapted to discharge air over the upper surface of said wing flap, separate closures for said inlet openings, and means for operating both said closures simultaneously with the movement of said wing flap.

9. In aircraft, an aerofoil provided with separate interior air passages transverse to the direction of flight each having an inlet opening and an outlet opening, separate closures for said inlet opening, an air scoop positioned adjacent to the inner end of said aerofoil for causing air to flow in said inlet opening, a control device, and a connection extending between said control device and each said closure for operating all of said closures simultaneously.

10. In aircraft, an aerofoil provided with separate interior air passages each having an inlet opening and an outlet opening, separate closures for said inlet openings, a wing flap, a control device, and a connection between said control device and each said closure and said wing flap for moving said wing flap and operating all of said closures simultaneously.

11. In aircraft, an aerofoil consisting of a main section containing an air passage substantially transverse to the direction of flight, having formed therein an outlet slot and having an inlet opening formed adjacent to the inner end of said section; a wing flap associated with said main section; and common means to lower the wing flap and at the same time cause air to flow into said inlet opening, through said air passage along the span of said aerofoil and out through said outlet slot.

12. In aircraft, an aerofoil provided with an interior air passage transverse to the direction of flight and having an inlet opening and an outlet opening in the upper exterior surface of said aerofoil, a closure for said inlet opening adapted, when open, to direct outside air through said inlet opening, a flap closure for said outlet opening, and means for operating both said closures simultaneously.

13. In aircraft, an aerofoil provided with an interior air passage transverse to the direction of flight and having an inlet opening and an outlet opening in the upper exterior

surface of said aerofoil, a closure for said inlet opening adapted, when open, to direct outside air through said inlet opening, a wing flap normally closing said outlet opening, and means for movng said wing flap to uncover said outlet opening simultaneously with the opening of said inlet opening.

14. In aircraft, an aerofoil provided with an interior air passage transverse to the direction of flight and through which air passes outwardly within said aerofoil and having an outlet opening through which the air within said passage is adapted to escape and having an inlet opening positioned adjacent the inner end of said aerofoil, and a trailing edge flap mounted in such relation to said outlet opening as to admit of the air escape directly onto its upper surface.

In testimony whereof I hereunto affix my signature.

EDMUND P. GAINES.