July 12, 1949. E. A. STALKER 2,476,001

AIRCRAFT WING FLAP AND AILERON COMBINATION HAVING BOUNDARY LAYER CONTROL

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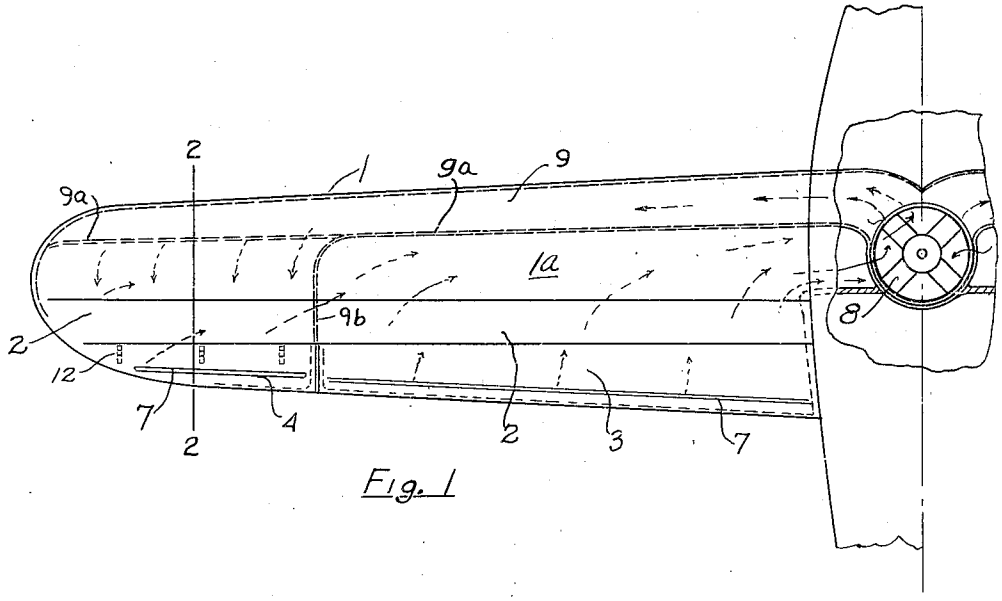

Fig. 1

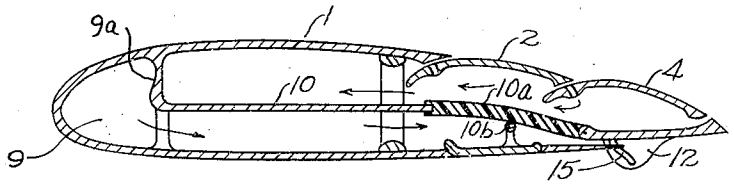

Fig. 2

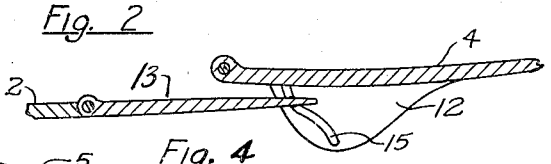

Fig. 4

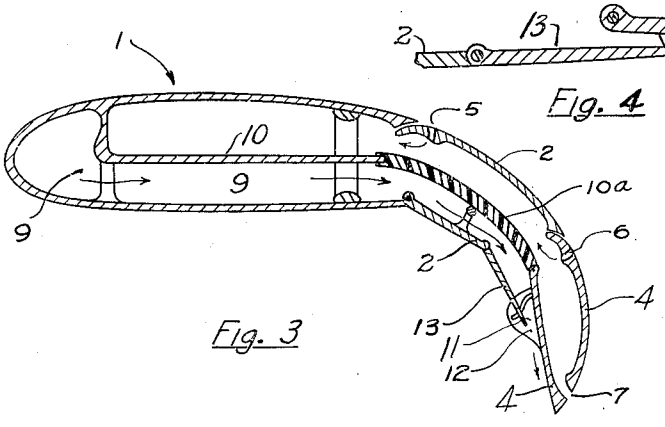

Fig. 3

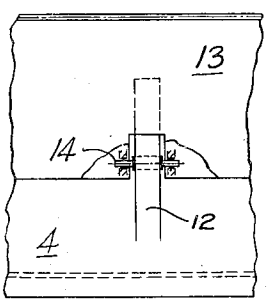

Fig. 5

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AIRCRAFT WING FLAP AND AILERON COMBINATION HAVING BOUNDARY LAYER CONTROL

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10 Claims. (Cl. 244—42)

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My invention relates to wings, and particularly to means for obtaining lateral control with highly cambered wings. When a wing is highly cambered so that it can deflect the relative wind through an angle of 90 degrees substantially no further lift is available from further cambering the wing (as by moving the aileron). Hence rotation of the aileron through a still larger angle is not an effective and satisfactory way in which to obtain lateral control under such conditions. It is possible however to secure a lift force by emitting a jet of fluid with a substantially downward direction. It is also possible to control the jet in coordination with the aileron so that there is a continuous functioning of lateral control as the airplane passes from high to low speed or vice versa.

It is therefore the principal object of the invention to provide for obtaining rolling moments from a wing in a high lift attitude where the relative wind is being deflected through a relatively large angle.

It is a further object to accomplish this control through the use of a jet discharge under properly controlled conditions.

It is a still further object to provide an aileron mechanism to control the jet mass.

I accomplish the above objects by the means illustrated in the accompanying drawings in which—

Fig. 1 is a top plan view of the wing;

Fig. 2 is a section along the line 2—2 of Fig. 1;

Fig. 3 is the same section as Fig. 2 with the flaps down;

Fig. 4 is a fragmentary detail of the flap mechanism; and

Fig. 5 is a bottom fragmentary view of the flap mechanism.

Referring to the drawing which discloses a preferred embodiment of my invention, the wing is shown generally at 1, it being understood that the construction of the opposite wing is similar. The wing is composed of the main body 1*a* and the control flaps 2 and 3, arranged in tandem. The flaps are pivotally connected to each other providing for adjustment thereof from the raised high speed position shown in Fig. 2 to the lowered high lift position shown in Fig. 3. As shown flaps are formed with generously curved upper surfaces of longer radius of curvature than the thickness of the adjacent portion of the wing, so that in the high lift position a smooth upper curved surface will be obtained, giving a wing with a highly cambered airfoil section.

Outwardly of the respective flaps 3 on opposite

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wings are located the ailerons 4, each aileron being arranged in tandem with its corresponding flap element 2. The ailerons are formed similarly to the flaps, but are arranged through the usual controls to be actuated in opposite directions on the opposite wings, while flaps 2 and 3 are arranged to be operated in the same direction.

Flap 2 has the slot 5 formed adjacent the forward or nose portion thereof while flap 3 and aileron 4 each have a slot 6 located adjacent the nose thereof and a second slot 7 located adjacent the trailing end thereof. Each of such slots extends over the major portion of the upper surface of the wing span and preferably over substantially the entire extent thereof as shown in Fig. 1.

A horizontal fixed wall 10 is provided in the interior of the wing forming an upper passage through which air may flow. A power driven blower 8 is suitably located with its intake in communication with the upper passage above wall 10, and provides for inducting air through each of slots 5, 6 and 7, thereby providing for energizing the boundary layer on the upper wing surface over the area in advance of the respective slots. The slots 5 and 6 may if desired be so located that in the raised position of the flaps, the effectiveness thereof is reduced, or eliminated by being entirely enclosed within the trailing ends of the wing portions immediately in advance thereof; or these slots as well as slot 7 may remain effective in all relative positions of the wing and flaps.

To maintain the passage above wall 10 during the movement and in the deflected position of the flaps, a flexible wall 10*a* is provided substantially coextensive with the flap 2, and is secured at its forward and rearward edges respectively with the corresponding non-flexible walls 10 of the wing main body, and the rearmost flap portion. In this way the flaps may be moved relative to each other and to the main body while providing a continuous upper passage for the flow of the inducted air. A rod 10*b* supported from the lower wall of flap 2 engages the under side of flexible wall 10*a*, and extends spanwise substantially centrally thereof to provide support therefor.

The air discharged from the blower is directed either directly or indirectly to a passage 9 on the leading edge of the wing defined by wall 9*a*. This passage is defined over the inner portion of the wing by a wall 9*a* which is coextensive with the vertical extent of the passage, thereby effectively segregating the discharge passage from the suc-

tion passage through which the air is drawn into the blower. At the outer portion of the wing, i. e. that portion having the aileron 4 and comprising in the form shown approximately the outer third of the wing, wall 9a extends downward only to laterally extending wall 10, forming a continuation of the discharge passage 9 in the lower portion of the wing. A chordwise wall 9b extending from wall 10 downward to the lower side of this continuation of the passage 9 encloses such passage and separates the same from the path taken by the inducted air. In this area, the flap 2 on its lower surface is formed with a hinged auxiliary flap 13 which extends rearwardly into overlapping relation with the lower surface of aileron 4. The aileron carries a cam plate 12 on its lower surface having grooves or slots 15 therein of predetermined configuration. Auxiliary flap 13 carries pin 14 which have sliding engagement in slots 15 to thereby control the angular relation between the flap and the lower surface of the flap, providing a greater or lesser degree of opening 11 through which the flow of air from lower passage 9 is discharged.

When the aileron is moved down by the pilot, the slot 11 is opened. The cam slot 15 is given such a shape that, as the flaps are lowered, the width of slot 11 is increased slowly at first and then more rapidly as the aileron approaches its extreme down position, the maximum change in the opening occurring with the flaps in the fully lowered position. Hence with the flaps 2, 3 and 4 depressed, a small additional displacement of the aileron gives a relatively large change in the size of the slot 11. The greater mass of air then discharged gives a high rolling force which is effective in a direction favorable to the control developed by the aileron itself.

All the flaps including the aileron are depressed to the high lift position shown in Fig. 3 and the aileron is moved either way from this initially depressed position to give lateral control. A movement opens the slot 11 quickly and an up movement reduces the slot width. Thus even with the flaps fully depressed and with the wing having such high camber as to deflect the relative wind through an angle of substantially 90°, a lift force is developed and readily controlled to provide the desired lateral control. The force of the jet discharge from slot 11 is under continuous control through the positioning of the ailerons, and a control force is thus developed by reason of the downward direction of the discharge which gives a rolling moment in the proper sense coordinated with the positions of the respective ailerons.

It will now be clear that I have described an effective means of obtaining lateral control for a wing operating near its maximum lift coefficient, this means comprising a slot in the lower surface and means to govern the quantity of air to be discharged from the slot. The discharged air passes from the blower along a passage forward of one of the spars and rearward under the spar to the slot in the lower surface.

While the forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. In combination in an aircraft, a wing main body, an aileron and a lift flap, means to support said body, flap and aileron in variable relation to form a wing, means to depress said flap and aileron through large angles to provide highly cambered airfoil sections, means defining a discharge slot in the wing lower surface, a blower in communication with said discharge slot to discharge a flow outwardly therethrough, the walls of said slot being formed to direct a slot discharge flow of air downward substantially normal to the said body in the depressed position of said aileron, and means operable coincidentally with the downward displacement of said aileron to increase the mass of air discharged from said discharge slot to produce an increase in rolling force.

2. In combination in an aircraft, a wing main body, an aileron and a lift flap, means to support said body, flap and aileron in variable relation to form a wing, means to depress said flap and aileron through large angles to provide highly cambered airfoil sections, a lower surface flap spaced from said aileron and forming therebetween a discharge slot, a blower having its discharge in communication with said discharge slot to cause an outward flow therethrough, means for adjustably supporting said lower surface flap at one chordwise end on the wing portion ahead of the aileron, and means supporting the other end of said lower surface flap from said aileron providing for control of said discharge slot in accordance with the position of said aileron.

3. In combination in an aircraft, a wing main body, an aileron and a lift flap, means to support said body, flap and aileron in variable relation to form a wing, means to depress said flap and aileron through large angles to provide highly cambered airfoil sections, a lower surface flap spaced from said aileron and forming therebetween a discharge slot, a blower having its discharge in communication with said discharge slot to cause an outward flow therethrough, means for adjustably supporting said lower surface flap at one chordwise end on the wing portion ahead of the aileron, means supporting the other end of said lower surface flap from said aileron providing for control of said discharge slot in accordance with the position of said aileron, and means providing for enlarging said discharge slot at an increasing rate as the aileron is moved toward its depressed position.

4. In combination in an aircraft, a wing main body, an aileron and a lift flap, means to support said body, flap and aileron in variable relation to form a wing on each side of the aircraft, means to depress the said flaps of opposite wings coincidentally through large angles to provide highly cambered airfoil sections for the wing, means to rotate the opposite ailerons differentially to either side of said highly cambered position, each said wing having a lower surface slot, power driven blower means within the aircraft having a discharge in communication with said lower slots to cause an outward flow therethrough, and means to control the discharge slot flows differentially in coordination with the rotation of the ailerons so that the slot at the down aileron receives the greater flow of air to produce a jet reaction rolling force.

5. In combination in an aircraft, wings on opposite sides of the aircraft, means for modifying the wing contour of opposite wings to develop rolling control of the aircraft over a predetermined range through selective change of lift of said opposite wings, each said wing having a discharge slot in its lower surface leading from the

wing interior, said slots in a modified contour of the wing opening downwardly and developing a substantial jet reaction component in the direction normal to the forward portion of said wing, a blower within the aircraft in communication with said slots to discharge a flow outward and downward relative to the forward portion of said wing to develop said jet reaction component producing a rolling moment effective independently and beyond the effective range of said modifying means, and means to control the jet volume discharged from said slots differentially with respect to the slots of opposite wings to control said jet reaction-produced rolling moments.

6. In combination in an aircraft, a wing main body, an aileron and a lift flap, means to support said body, flap and aileron in variable relation providing for adjustment from a raised high speed position to a depressed high lift position, said wing having an inlet slot in its upper surface in communication with the wing interior, a blower means having its inlet in communication with said inlet slot to induce an inward flow into said wing, means to depress said flap and aileron through large angles to provide highly cambered airfoil sections, a lower surface flap spaced from said aileron and forming therebetween a discharge slot in communication with the discharge of said blower means, and means to control the opening from said discharge slot coincidentally with the position of said aileron providing for increase in said slot opening and the mass of the jet discharge therethrough in response to a lowered position of said aileron.

7. In combination in an aircraft, a wing main body, an aileron and a lift flap, means to support said body, flap and aileron in variable relation providing for adjustment from a raised high speed position to a depressed high lift position, said wing having an inlet slot in its upper surface in communication with the wing interior, a blower means having its inlet in communication with said inlet slot to induce an inward flow into said wing, means to depress said flap and aileron through large angles to provide highly cambered airfoil sections, a lower surface flap spaced from said aileron and forming therebetween a discharge slot in communication with the discharge of said blower means, and means for rapidly increasing the opening of said discharge slot to provide for increased jet reaction from the mass of air discharged therefrom as the aileron is moved substantially into its depressed position.

8. In combination in an aircraft, wings on opposite sides of the aircraft each having a wing main body, a lift flap and an aileron, means for adjustably supporting said lift flap and aileron from said wing main body, each said wing having an inlet slot in its upper surface in communication with the wing interior, power driven blower means within the aircraft having an inlet in communication with said inlet slot to induce an inward flow into said wing, means to depress the lift flaps on opposite wings coincidentally through large angles to provide highly cambered airfoil sections for the wings adapted to deflect the relative wind through angles up to substantially 90°, means to rotate opposite ailerons differentially to either side of said highly cambered position, each said wing having a lower surface slot in communication with the discharge of said blower, and means to control the discharge slot flows differentially in coordination with the rotation of the ailerons so that the slot at the down aileron receives the greater flow of air to produce a jet reaction rolling force.

9. In combination, a wing main body, a flap supported in variable relation thereto to form a wing, means forming an induction slot in said wing, means forming a discharge slot in said wing in spaced relation to said induction slot, a blower in said wing, inlet duct means spaced from the leading edge of said wing establishing communication between said induction slot and the inlet side of said blower, and additional duct means extending along the span of said wing forwardly of said inlet duct means and having a rearwardly extending part laterally spaced from said inlet duct means and establishing communication between the discharge of said blower and said discharge slot.

10. In combination, a wing main body, a flap supported in variable relation thereto to form a wing, means forming an induction slot in said wing extending spanwise thereof, means forming a discharge slot in said wing extending spanwise and located in the laterally outward portion of the wing span, a blower, inlet means spaced from the leading edge of said wing establishing communication between said induction slot and the inlet side of said blower, and additional duct means extending along the span of said wing forwardly of said inlet duct means and having a rearwardly extending part laterally spaced from said inlet duct means and located outwardly of said wing for establishing communication between the discharge of said blower and said discharge slot.

EDWARD A. STALKER.

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Certificate of Correction

Patent No. 2,476,001 July 12, 1949

EDWARD A. STALKER

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 3, line 42, after the letter "A" insert *down*;

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of December, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.