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3,246,335

DOUBLE SLOTTED FLAP

Filed Jan. 15, 1964

FIG_1

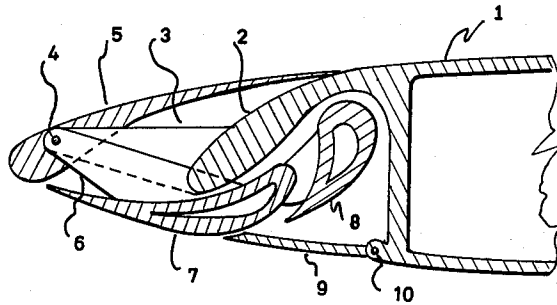


FIG_2

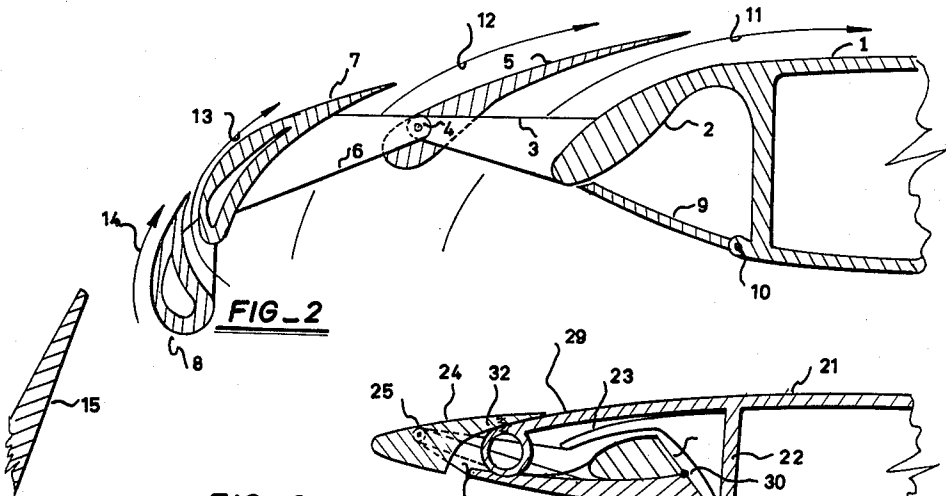


FIG_3

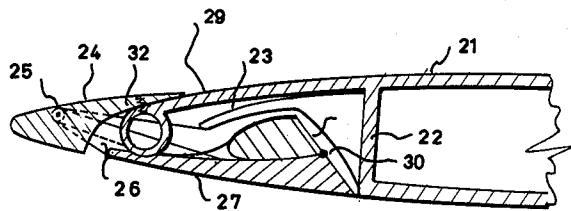
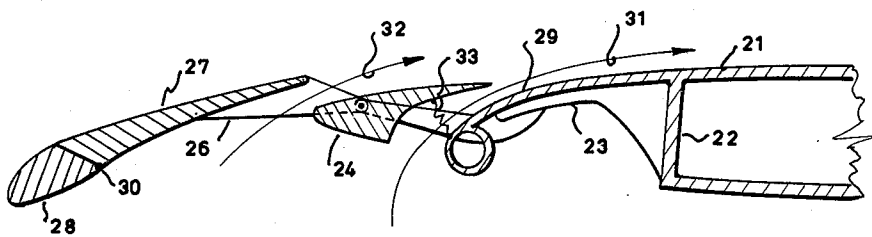


FIG_4



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1

3,246,335

DOUBLE SLOTTED FLAP

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The present invention relates to aircraft; more particularly it concerns high lift double slotted leading and trailing edge flaps for wings.

Introduction

The basic aerodynamic and structural criteria, and state of the art, of leading edge high lift devices are amply discussed in my U.S. Patent 3,128,966 hence these will not be repeated herein.

The purpose of this invention is to provide a simple pivotal structure for efficient double slotted leading and trailing edge flaps.

In this application, as shown in FIG. 1, I have mounted a movable upper flap plate which defines an upper leading edge slot with a permanently open intake mouth and with an exhaust mouth that can be closed, and a lower flap plate which can serve as a door to close the intake mouth of the upper slot, or to define, when extended, an additional slot between the lower plate and the flap's upper plate as will be shown later in detail.

It is another purpose of this invention to provide a leading edge structure of variable chord camber and thickness, as shown in FIG. 3, wherein a flap is shown folded inside a wing for high speed flight and unfolded for high lift flight.

The aforementioned objects and other objects of the invention are illustrated in the figures and specification.

FIGS. 1 and 2 show, retracted and extended, a cross-sectional view of an embodiment of my invention showing in addition to the two principal slots of my device, a third fixed slot in the lower flap plate.

FIGS. 3 and 4 show, retracted and extended, an alternate embodiment of my invention.

FIG. 1 shows a leading edge portion 1 of an airfoil having a bulbous fixed upstream edge 2 which supports a forwardly protruding bracket 3 on which there is mounted at spanwise axis 4 a pivoted upper curved flap plate 5.

Also contiguous to axis 4, but not necessarily at axis 4, there is mounted by bracket 6 a lower flap 7 having a rounded semi-cylindrical edge 8 of large radius located inside the contour of airfoil 1. Edge 8 is contiguous to the upper surface of airfoil 1. Flap fairing door 9, pivoted at axis 10, fair's plate 7 to lower surface of airfoil 1. Of particular interest is to note mating disposition of bulbous edge 2 and rounded edge 8 which cooperate to reduce volume occupied by high lift device 7 in the wing.

FIG. 1 has shown my structure in high speed position in which movable flap plates 5 and 7, and door 9, define stationary high speed leading edge outer surfaces for airfoil 1.

For slow speed position, plate 5 moves counter clockwise by about five degrees, plate 7 moves clockwise by about 150 degrees, and plate 9 moves clockwise by about 15 degrees after motion of plate 7; the structure is then in position shown in FIG. 2. By virtue of the shape of plates and door, and due to relative location of axis there is obtained, in magnificent cooperation, the structural formation of:

(a) A smooth airfoil nose exposed to the air formed by fixed bulbous edge 2 and door 9.

(b) A first contracting slot between plate 5 and bulbous edge 2 for high lift flow 11.

(c) A second contracting slot between plate 7 and plate 5 for high lift flow 12.

2

(d) The exposition to the airflow of fixed third slot between 7 and 8 for high lift flow 13. This slot is optional but advantageous; in the retracted position it is fully covered by plate 9.

Of particular importance is the mutual cooperation of high lift flows 12 and 11, which permit very high lift flows to develop on the wing.

Of great importance is relative location of axis 4 to plate 7 to define second slot slope; thus the structure has been drawn carefully to scale of 1"=5% wing chord. Slot gaps should be about 1½% of wing chord.

In FIG. 2, I show, as an optional feature of importance for trailing edge devices, the inclusion of a wing's trailing edge 15, in relation to which my airfoil 1 and its structure act as a multiple slotted trailing flap. Thus between the wing's trailing edge 15 and upstream edge of my airfoil positioned relative to 15 as a high lift trailing edge flap there is formed an additional fourth slot for high lift flow 14 between the wing 15 and my airfoil 1. As shown in FIGURE 2, my airfoil 1 is shown as an extended high lift flap relative to wing trailing edge 15. For cruise flight, my airfoil 1 should preferably be retracted below the wing's trailing edge as is usual and known in the art for flaps. For example, it may be retracted as shown in FIG. 1 of U.S. Patent 3,126,173 or by means of conventional tracks for Fowler type flaps.

FIGS. 3 and 4 show an alternate embodiment of my structure.

FIG. 3 shows a wing 21 supporting by means of forwardly protruding bracket 23 a fixed leading edge portion 24. At 24 there is mounted by bracket 26 a lower pivoted flap door 27 having an articulated edge 28 pivoted at axis 30. Plate 27 pushes upward flexible skin member 29 against compression spring 33 to provide a smooth upper surface between 24 and 21. Elements 33 and 29 may be recessed to receive compressed spring 33 if necessary. Of importance in FIG. 3 are:

(a) Small volume occupied by flap forward of spar 22, which small volume is obtained by folding portion 28 by about 180 degrees relative to 27.

(b) Cooperation of plate 27 to bias upwards skin 29 without a special skin actuator.

(c) Absence of movable door to fair plate 27 smoothly to under surface of wing.

FIG. 3 shows the device in high speed flight. For high lift, plate 27 is rotated clockwise by about 160 degrees, portion 28 is rotated clockwise by about 180 degrees and spring 33 pushes skin 29 downward against bracket 23. As a result, we have the structure of FIG. 4 in which there is noted

(a) A first slot between 29 and 24 for high lift flow 31.

(b) A second slot between 27 and 24 for high lift flow 32.

(c) A large camber and chord for combined elements 27 and 28 into a single efficient leading edge slot.

This invention pertains to the field of aerodynamics and teaches how to construct and shape the flaps, how to locate them relative to each other, where to articulate the flaps on the wings, and how to use them for high lift flight and high speed flight. The specific form of manipulation of the flaps is a mechanical aspect which can be done according to methods known in the art. For example flaps 5 and 7 of FIGS. 1 and 2 may utilize the mechanism shown in a structurally similar but aerodynamically different single slotted flap structure of FIG. 5 of my U.S. Patent 3,128,966, and the 180-degree rotation of element 28 of flap 27 in FIGS. 3 and 4 may be done by means of a crown gear and worm system mounted on airfoil element 27, for example as shown in FIG. 7 of my U.S. Patent 3,126,173, wherein flap element 64 can rotate 180 degrees with respect to airfoil element 60, to position 69.

3

Various modifications can be made without departing from the spirit of the invention. The structure is applicable to tail surfaces, ailerons and hydrofoils.

I claim:

1. A primary airfoil having a spanwise upstream edge portion, means defining a first high lift slot adjacent and to the rear of said upstream edge portion with said first slot having a slot intake mouth; an auxiliary airfoil mounted on said primary airfoil for movement between a high speed position in which said auxiliary airfoil has surfaces covering said slot intake mouth and a slow speed high lift position in which said auxiliary airfoil is moved downwardly and forwardly from said high speed position uncovering said intake mouth, to a camber increasing disposition in which said auxiliary airfoil is upstream of said intake mouth and upstream of said spanwise edge portion, with the surfaces of said auxiliary airfoil in said high lift position adjacent to said spanwise edge portion together with a surface portion of said spanwise edge portion of said primary airfoil defining opposite and contracting walls of a second high lift slot therebetween separate from and upstream of first slot for fluid flow across said second slot upstream of said intake mouth and upstream of said spanwise edge portion from below said airfoil to on top of said spanwise edge portion of said airfoil.

2. The structure of claim 1 further characterized in that said first slot has an exhaust mouth which in said high lift position ejects fluid flow from below said primary airfoil rearwardly and on top of said primary airfoil; and in that said fluid flow across said second slot is discharged rearwardly on top of said primary airfoil ahead of said exhaust mouth of said first slot, with the fluid flow from said second slot coming into reinforcing contact with the fluid flow from said first slot.

3. An airfoil having a fixed upstream spanwise edge portion, an articulated flap mounted on said airfoil upstream of said edge portion and having an upper flap member and a lower flap member with each of said flap members having a first spanwise edge and second spanwise edge; said flap members being adapted to have relative movement from a high speed disposition in which said flap members define substantially continuous leading edge surface portions of decreased camber for said airfoil ahead of and smoothly faired to said fixed upstream spanwise edge portion with said first spanwise edges of said flap members being located adjacent to said fixed upstream portion and said second spanwise edges being located ahead of said first edges and contiguous to each other, and a slow speed disposition in which said upper flap member is displaced relative to said airfoil to define the exhaust walls of a first slot and said second member is inverted about a spanwise axis adjacent to its second edge to a downwardly and forwardly position in which the surfaces of said lower member adjacent to and ahead of said second edge of said upper member, together with a surface portion of said second edge of said upper member, define contracting walls of a second slot for smooth upward fluid flow from below said lower flap member to over the top of said upper flap member.

4. A wing having an upper surface and a fixed bulbous upstream edge portion adjacent to said upper surface, a fixed bracket mounted on said wing projecting forwardly from said bulbous edge portion; an upper leading edge flap pivotally mounted on said bracket and having a span-

4

wise rounded edge ahead of said bulbous edge and spanwise thin flap edge portion above said bulbous edge; a lower flap pivotally mounted on said bracket and having a spanwise sharp edge adjacent to said rounded edge of said upper flap and a semi-cylindrical edge opposite to said sharp edge; said flaps being adapted to be moved from a high speed disposition in which their surfaces define a smooth high speed leading edge surface for said wing covering said bulbous edge with said thin edge being contiguous to said upper surface, with said rounded edge being contiguous to said sharp edge and with said semi-cylindrical edge being below said bulbous edge, to a high lift disposition in which said lower flap is inverted to a location in which said semi-cylindrical edge is ahead of and below said upper flap in which location the surfaces of said lower flap adjacent to its sharp edge, and said rounded edge, define the contracting walls of a first high lift slot, and in which said high lift disposition said thin edge of said upper flap is elevated above said upper surface with the undersurface of said upper flap and the upper surface of said bulbous edge defining contracting slot walls of a second high lift slot.

5. The structure of claim 4 further characterized in that an auxiliary door is located adjacent to the undersurface of said wing to cover said semi-cylindrical edge in said high speed disposition fairing said lower flap to the undersurface of said wing; said auxiliary door being located, when said lower flap is in said high lift disposition, extending between a portion of said bulbous edge and the undersurface of said wing.

6. The structure of claim 4 in which said semi-cylindrical edge has a large cross-sectional area and is mated below said bulbous edge and adjacent to said upper surface.

7. The structure of claim 5 in which said lower flap has, adjacent to said semi-cylindrical edge, an auxiliary fixed slot which in said high speed disposition is substantially completely covered by said auxiliary door.

8. The structure of claim 3 further characterized in that said lower flap member has a fixed third high lift slot, and in that said airfoil has a door fairing which covers said third slot when said lower flap member is in said high speed disposition.

9. The structure of claim 1 further characterized in that said auxiliary airfoil is mounted on said primary airfoil for pivotal movement about a pivotal axis fixed with respect to a portion of said primary airfoil, said secondary airfoil being adapted to be inverted about said pivotal axis from said high speed position to said high lift position.

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