July 22, 1969 P. R. L. B. DORAND 3,456,904

JET FLAP CONTROL

Filed June 20, 1967

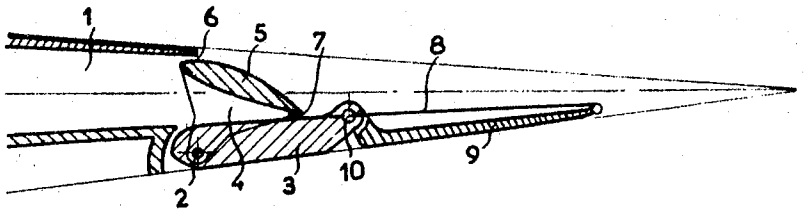

FIG. 1

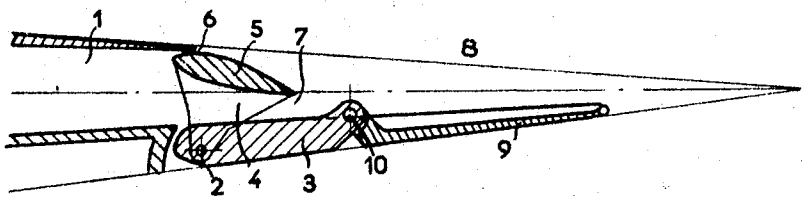

FIG. 2

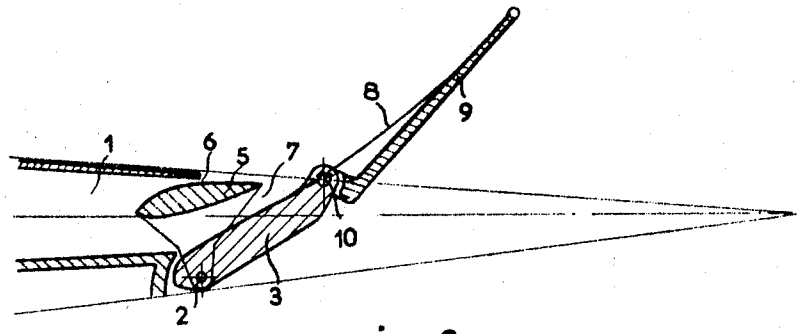

FIG. 3

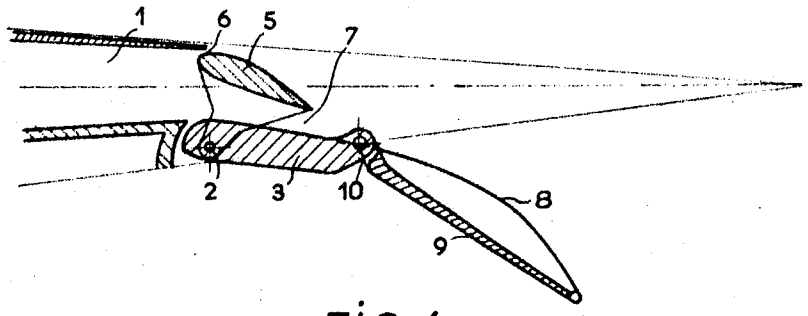

FIG. 4

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JET FLAP CONTROL

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Int. Cl. B64c 3/38, 9/00
U.S. Cl. 244—42 4 Claims

ABSTRACT OF THE DISCLOSURE

The present invention relates to jet flaps in the trailing edge of an aerofoil such as an aircraft wing or helicopter rotor blade of the kind in which a gaseous jet emitted through a jet slit enables the lift of the wing or blade to be controlled by adjusting the sense and degree of vertical deflection of said jet in such a manner that when the jet is emitted neutrally, that is without deflection, it produces a suction effect which tends to make the airflow cling to the aerofoil section surface, thus affording boundary layer control. By this invention there is provided means for controlling the jet orifice both as to its effective cross-sectional area and as to its splitting into two streams; this involves the provision of a secondary flap in addition to a jet deflector flap, and arrangements for the control thereof.

SUMMARY OF INVENTION

According to the invention a jet flap of an aerofoil comprises a jet deflector flap hingedly mounted on the aerofoil on a spanwise axis which is thus parallel to the jet slit such axis also being adjacent to and preferably aft of the jet slit. There is a secondary flap of aerofoil section which is mounted to swing articulately on the same axis. Operating and actuating means are provided, of any suitable known kind not forming part of the invention, which can swing either or both of the deflector flap and the secondary flap. The secondary flap both splits and controls the jet stream; this control is by varying the effective cross-sectional area of one of the split streams relative to the other and varying their total effective area.

A jet slit according to this invention is characterised by the fact that it combines a jet deflector flap which is hinged so as to be virtually a continuation of a well of the jet slit, and an aerofoil section secondary flap situated in the jet stream from the slit and which is articulated about the same axis as the jet deflector flap, the secondary flap being capable of movement independently of, or simultaneously with the deflector flap, in such a way as to vary the jet slit aperture which it divides into two adjustable sections.

Control of the outlet configuration of a jet slit of this type presents advantages. On the one hand, the aperture configuration may be adljusted according to the temperature of the jet efflux: for example, when the fluid is heated in order to increase the force of the jet, it is desirable to increase the effective cross-sectional area of the jet aperture. On the other hand, and especially in the case of helicopter flight the forward speed may be increased by cyclic control of the jet aperture, enabling the jet efflux to be increased along the trailing edge of the advancing blade and reduced along the trailing edge of the retreating blade, thus providing additional propulsive thrust. Further, in the event of a breakdown in the supply of fluid to the jet slit, the control device may enable the jet slit aperture to be reduced so as to adjust it to the air suppply provided by the action of centrifugal force on the air contained in the blade, taking advantage of boundary layer control to increase the effectiveness of the

deflector flap. In the same way, when functioning normally, simultaneous movement of both the aerofoil section flap and the deflector flap tends to give the jet the desired direction and has an effect analogous to a form of swivelling jet slit.

By way of example, the following description and attached drawings represent one form of jet slit according to the invention.

FIGURES 1 and 2 represent the jet slit in vertical section with the secondary flap in two different positions, the deflector flap being maintained in its neutral position.

FIGURES 3 and 4 represent the jet slit in two positions in which the deflector flap and secondary flap assembly is collectively moved respectively upward and downward.

As shown in the drawing, a jet slit **1** is formed in the trailing edge of the aircraft wing or helicopter rotor blade and it is supplied with fluid under pressure. A deflector flap **3** is hinged on the axis at **2**, adjacent to the lower edge of the jet slit **1**. It is controlled by an appropriate mechanism which does not constitute part of the present invention and is therefore not described or represented. Supporting lugs **4** of aerofoil section secondary flap **5** are pivoted about the same axis **2**, so that the secondary flap **5** is capable of rocking about this axis in the throat of the jet slit which it divides into two outlets **6** and **7**, the flap **5** being so situated that its upper convex surface moves in close proximity to the upper edge of the jet slit **1**. It is arranged that the upper outlet **6** always remains much narrower than the lower section **7**; the main object of the narrow slit **6** is to improve the airflow over the upper surface of the wing or rotor blade and over the upper surface of the secondary flap **5**, whilst the larger slit **7** produces the main aerodynamic effect, acting as a "jet flap." In FIGURE 1, the secondary flap **5** is shown tipped backward with its leading edge close to the upper edge of jet slit **1**, whilst its trailing edge is close to the deflector flap **3**, this latter being in its neutral position, the total aperture area of the jet slit being thus considerably reduced. In FIGURE 2, the secondary flap is tipped forward in such a manner that the aperture, constituted principally by the lower section **7**, is considerably increased whilst aperture **6** is reduced, though not commensurately.

In FIGURES 3 and 4, the whole assembly is shown in two positions in which the jet slit aperture remains constant, the jet being deflected upward in FIGURE 3 and downward in FIGURE 4 by simultaneously rotating deflector flap **3** and secondary flap **5** about axis **2**. With this object in mind the convex upper surface of the flap **5** is, or is nearly, arcuate about the axis **2**.

As mentioned above, the secondary flap **5** may, in the case of a helicopter rotor blade, be controlled by a cyclic mechanism in such a way as to open the aperture **7** along the trailing edge of the advancing blade and to close it along the trailing edge of the retreating blade, thus providing additional propulsive thrust by cyclically differentiating between the ejected mass-flows in these two respective cases.

The deflector flap may be constructed in any appropriate manner. However, the device according to the invention may be used with advantage in conjunction with a variable profile flap assembly constituted by a flexible metallic strip **8**, of which the leading edge is attached to flap **3** and its trailing edge is attached to the trailing edge of a second flap part **9** freely hinged at its leading edge **10** to the trailing edge of deflector flap **3**. The adjunction of such a variable profile flap to the rigid deflector flap **3** improves its "jet flap" effect.

The operating means for controlling the angular positions of the deflector flap and of the secondary flap, which per se do not form part of the invention, are of any suit-

able type, for instance such as described in my copending patent application Ser. No. 647,513 filed on June 20, 1967 for "Jet Flaps" or in the copending patent application Ser. No. 645,711 filed in the name of Marcel Kretz on June 13, 1967 for "Jet Flap Controlling Means" and assigned to the same assignee.

I claim:

1. An aerofoil such as an aircraft wing or a helicopter rotor blade provided with a jet slit on its trailing edge, with means for discharging a gaseous jet from said jet slit and with jet deflecting means comprising a deflector flap having a first main rigid part hinged on an axis parallel to and adjacent to an edge of the jet slit, a second rigid part hingedly attached to the first rigid part on a second axis parallel to the jet slit adjacent to the rear edge of said main part, a flexible surface element exposed to the gaseous jet discharged from said jet slit and attached to the main part of said deflector flap and to the trailing edge of the second rigid part of said flap, operating means to swing said main and second parts of the deflector flap whereby relative angular movements of the main and second parts cause curvilinear deflections of said surface element, and an aerofoil section secondary flap situated in the jet discharged from the slit and articulated about the same axis as the main rigid part of the deflector flap and operating means to swing the secondary flap about said axis and thereby to vary the total effective area of the jet outlet whilst splitting the jet into two streams of relatively variable cross sectional area.

2. An aerofoil according to claim 1 further comprising means to swing the secondary flap independently of the deflector flap.

3. An aerofoil according to claim 1 further comprising means to swing the secondary flap simultaneously with the deflector flap.

4. An aerofoil according to claim 1 wherein the secondary flap is so positioned and dimensioned that its upper convex surface moves, when swung about its axis, closely adjacent to the upper lip of the jet-slit with which it defines a first jet aperture, whereas its trailing edge defines together with the upper surface of the main part of the deflector flap a second jet aperture having a variable cross sectional area determined by the relative angular movement of said secondary flap and of said main part of the deflector flap, the said first jet aperture being always dimensionally less than the said second aperture.

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244—44