May 12, 1942. J. M. DILLON 2,282,647

AIRFOIL

Filed Jan. 13, 1940 2 Sheets-Sheet 1

Fig. 1.

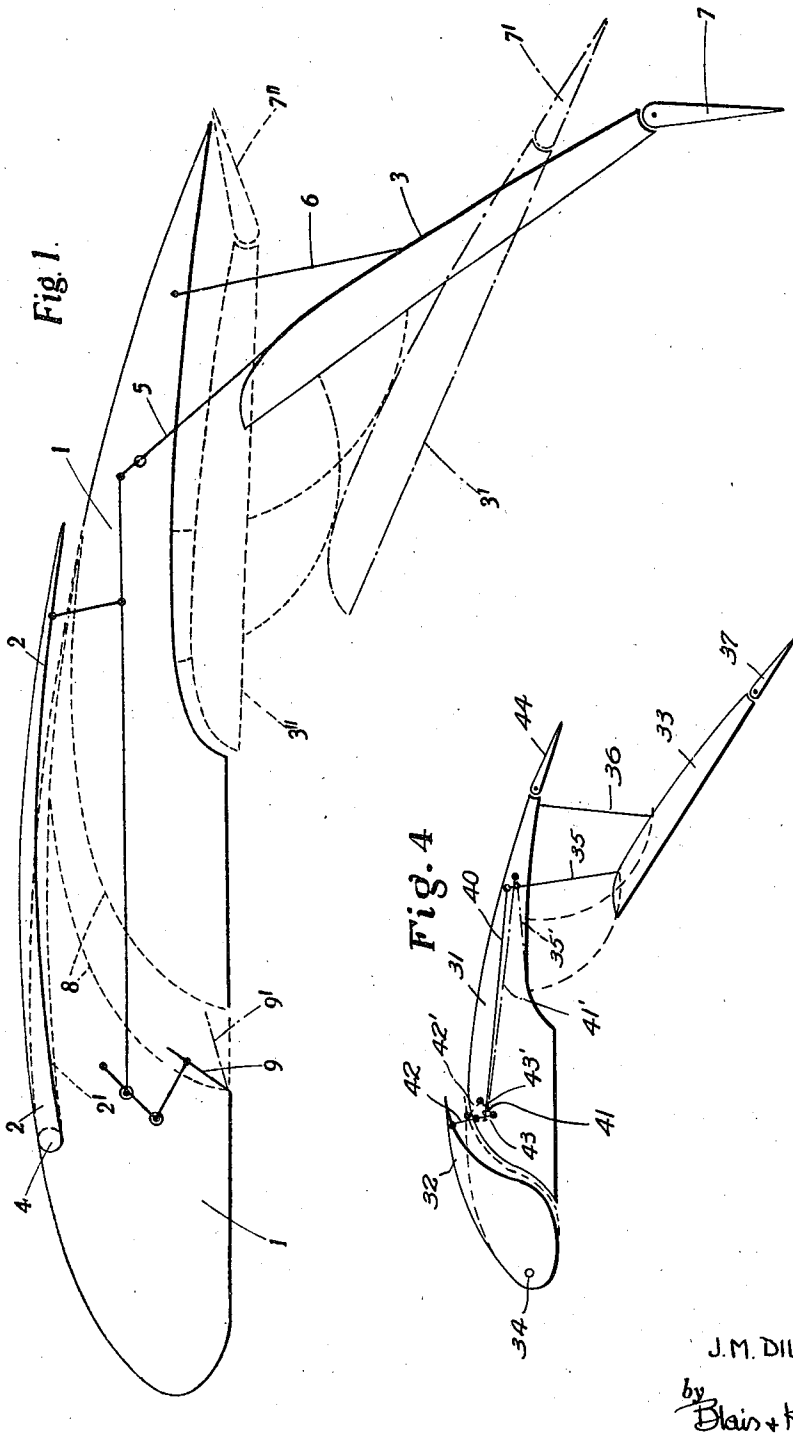


Fig. 4

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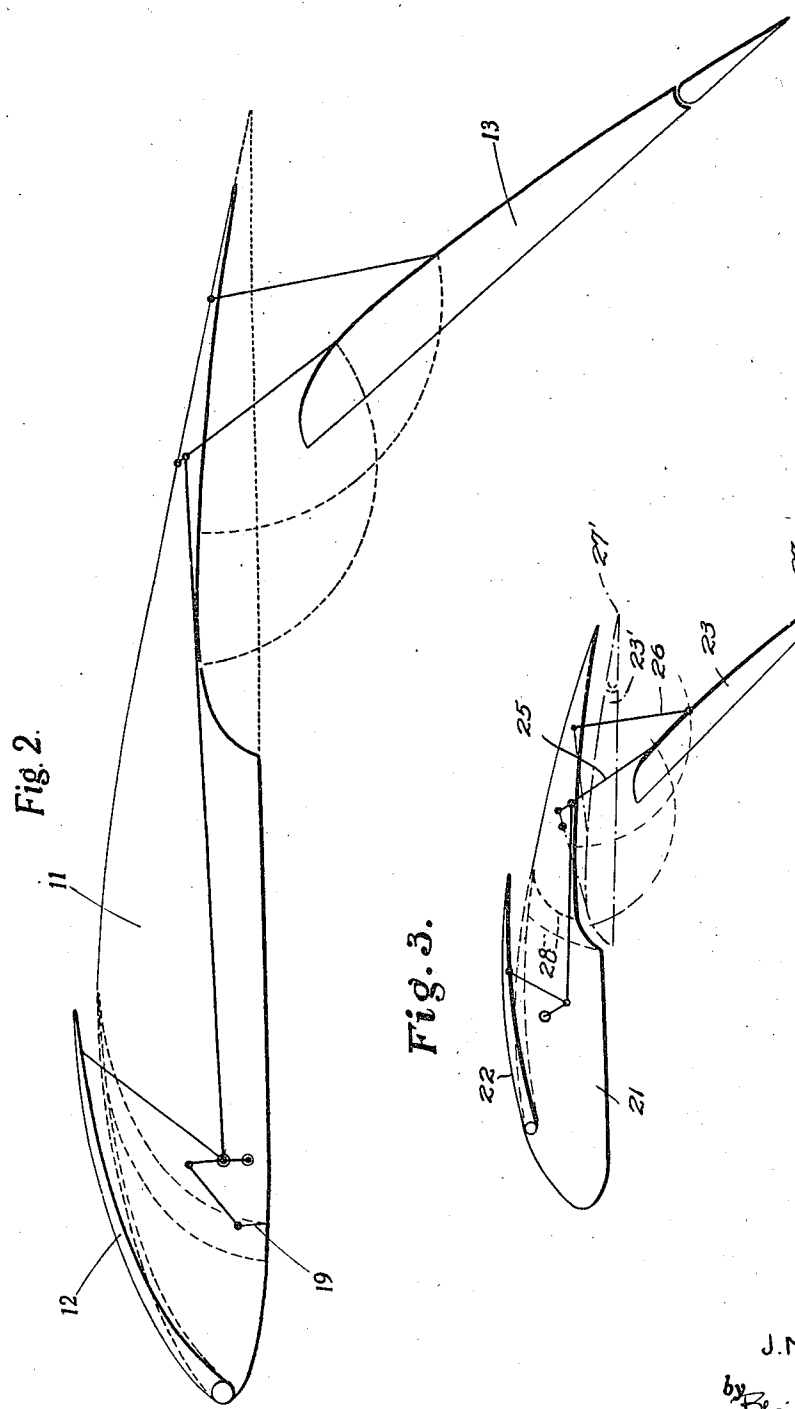


Fig. 2.

Fig. 3.

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AIRFOIL

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3 Claims. (Cl. 244—42)

This invention relates to improvements in or relating to aerofoils, and more particularly, but not necessarily exclusively to an improved aeroplane-wing construction.

One of the objects of the present invention is to provide an improved form of aeroplane wing which enables the lift available to be increased above that normally available when desired, for example, when taking off, whilst avoiding the introduction of any undesirable drag when the machine is air borne and progressing under conditions of normal flight.

A further object of the present invention is to provide an efficient form of aerofoil or wing capable of being easily changed from a condition providing maximum lift into a condition offering minimum resistance and vice versa, so enabling heavy loads to be lifted, low landing speeds to be practised and very high overall efficiency to be attained.

According to the present invention there is provided an aerofoil, wing or the like comprising a main body portion, a lower section, hereinafter called an auxiliary section, capable of being moved into a position adjacent to the underside of said body portion and into a position in which it is disposed rearwardly and downwardly with respect to said body portion, an upper section which is movable with respect to said body portion, and provision whereby air may be permitted to flow through said wing.

The aforesaid provision for air flow through said wing may consist of one or more passageways having inlets and/or outlets which are preferably of variable effective area and the desired control may in some cases be attained either directly or indirectly by the movable upper section or by the movable auxiliary section. Thus, for instance, said upper section may be adapted to cover the said outlet or outlets when in its closed position and uncover them when in its opened position and/or the auxiliary section may be adapted to cover said inlet or inlets when it is in its closed position and to uncover them when it is in its opened condition. In cases where said upper section and/or said auxiliary section directly control the air-passageway or passageways they may, if desired, overlap the opening or openings in the body portion to any desired extent. Thus, for instance, by suitably extending the upper section the effective outlet may be located towards the rear of the aerofoil or wing although the actual passageway opening may be located for instance anywhere between the nose portion of such aerofoil or wing and the maximum ordinate thereof. I find that in many cases it is desirable to provide one or more air inlet openings in advance of the maximum ordinate of a wing and to provide the associated air outlet opening or openings to the rear of said maximum ordinate, but I do not wish to imply that there are limitations in this respect as the inlets and outlets may for instance be located either behind or in front of such ordinate.

In cases where indirect control of the effective opening of the above-mentioned passageway or passageways is desired I may employ subsidiary flaps or the like and these may, if desired, be connected with the auxiliary section and/or with the upper section by any suitable link system or in any other suitable manner.

The aforesaid means for controlling the effective area of the passage or passages through the body portion may be adapted wholly to close such passage or passages if desired or the arrangement may be such that when said means are in positions exerting maximum closing effect said passage or passages is or are not wholly closed.

The aforesaid upper section of an aerofoil or wing according to the present invention may be hingedly connected at its leading edge to a point on the body portion lying for instance between the leading edge of such body portion and the point coincident with the maximum ordinate of said body portion. In a further arrangement said upper section may extend to or around the nose of the body portion so that in effect a part of said upper section constitutes the nose portion of the composite aerofoil or wing.

The auxiliary section of an aerofoil or wing according to the present invention may be pivotally mounted on links or the like which in turn are pivotally mounted on the body portion of such aerofoil or wing. Said auxiliary section may itself be in the form of an aerofoil and the disposition of said body portion and auxiliary section is preferably such that when the latter is closed against the former a continuous surface is provided along the underside of said aerofoil or wing. Similarly in respect of the upper section it is desirable to arrange the parts so that when such section is closed a continuous upper surface is formed, i. e. one which will result in proper laminar flow being maintained and any undesirable turbulence avoided when air flows thereover.

When the aforesaid movable upper and auxiliary sections are closed the resultant composite aerofoil may be either of symmetrical or asymmetrical form. I find, however, that in some

cases it is preferable to adopt the symmetrical form so that the benefits to be derived from that form are available for normal flying whilst the benefits to be derived from the asymmetrical form are available when taking-off or landing.

The aforesaid upper section and auxiliary section may, if desired, be interconnected by links or the like so that they are caused to move in unison or they may be subjected to individual control such as hydraulically actuated control means or any suitable form of gearing. In some cases the actuation of such movable parts may be effected in part automatically by the air-flow although it will be necessary to provide means for enabling the above-mentioned upper section to be maintained in its closed position when desired in view of the fact that in some circumstances there will be a tendency for said section to move from its closed position when air flows thereover.

The aforesaid passage or passages through the body portion of a wing or aerofoil according to the present invention may be provided with their inlet and outlet openings in any desired positions along the upper surface and the lower surface respectively of such body portion and to some extent the desirable positions may depend upon the type of aerofoil or wing concerned, for instance upon the camber of such aerofoil or wing. In some cases I find, however, that the outlets for such passages are advantageously located about midway along the chord of a wing.

The inlets to and/or outlets from the aforesaid passages are preferably protected by lattice or the like and/or by structural parts of the wing and, if desired, conduits or the like may interconnect said inlets and outlets although the interior of the body portion of the wing or compartments therein may be relied upon for attaining the requisite interconnection.

A composite wing or aerofoil according to the present invention preferably includes a trailing flap and this may be of the so-called split, plain or slotted kind. Thus, for instance, a flap may advantageously be pivotally mounted on the trailing end of the above-mentioned auxiliary section of a wing according to the present invention and in such cases actuation of such flap may be effected simultaneously with or independently of actuation of said auxiliary section itself. I find that in many cases a trailing flap mounted on the trailing edge of the auxiliary section of a wing greatly assists the operation of that section. Thus as soon as said section is moved from the body portion so admitting air therebetween and assuming that said trailing flap is turned upwardly the reaction on said flap tends to urge the auxiliary section in its opening direction. Conversely when said auxiliary section is open and said flap is turned downwardly the resultant reaction tends to close said auxiliary section, the result being that by operation of said flap the movements of said auxiliary section may be to a large extent controlled automatically.

The upper section of a composite wing according to the present invention may be in the nature of a movable part of the wing structure or it may be more in the form of a covering element capable of being moved towards and away from the main wing structure. It will be appreciated that such upper section exerts a very pronounced influence on the flow of air over the wing by reason of its position with respect to the rest of the surface of the wing and/or by reason of its control over the flow of air through the passage or passages extending through the main body portion of the wing.

The aforesaid upper and/or auxiliary section or sections of a wing according to the present invention may be of uniform chord length or they may be of diminishing chord length, i. e. they may taper from the root portion towards the tip portion and they may extend over the full width of the wing concerned or only over one or more parts thereof. Moreover, such movable parts may be adapted to turn about a hinge pin or the like extending along the full lengths of such parts or they may be pivoted in a universal manner at say their tip portions and their innermost edges may be adapted to turn in an angular manner. By adopting the latter arrangement in conjunction with tapering movable sections there is a reduction in any drag exerted when the wing is in use as the tendency for air to flow around such sections is reduced.

A composite wing according to my invention may include a tail flap provided at the trailing edge of the body portion and this may be so mounted that as it is turned downwardly an air passage is formed between it and said body portion.

In order that the present invention may be well understood I will now describe by way of example some embodiments thereof with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic side view of one form of composite wing,

Figure 2 is a diagrammatic side view of another form of composite wing,

Figure 3 is a similar view of a still further form of wing, and

Figure 4 is a similar view of yet another form of composite wing.

Referring to Figure 1 of the drawings the wing comprises three principal parts, a main body portion **1**, an upper section **2** and an auxiliary section **3**. The upper section **2** is shown in full lines in its opened position and the closed position is shown in dotted lines at **2'**. The auxiliary section **3** is shown in full lines in its fully opened position and in two intermediate stages of its opening in chain lines **3'** and dotted lines **3''** respectively.

The upper section **1** is pivoted along its leading edge so that it can be turned angularly through the desired range of movement, the pivotal axis being designated **4**. Said upper section **2** and said body portion **1** are so formed that when the former is closed it rests within the latter so presenting a smooth surface over the top of the composite wing and conforming exactly with the camber of the wing.

The auxiliary section **3** co-operates with the main body portion **1** in such a way that when the former is closed it also rests within said body portion so forming a smooth under surface.

The auxiliary section **3** is in this example pivotally suspended on pairs of links of which only one pair **5**, **6** appears in the drawings. Said links **5** and **6** are themselves pivoted to the main wing structure and are so disposed that said auxiliary section during its opening movement not only turns angularly but also moves downwardly and rearwardly.

An angularly adjustable flap **7**, is provided at the trailing edge of the auxiliary section **3**, such flap being indicated at **7'** and **7''** when the auxiliary section is in the positions **3'** and **3''** respectively.

One or more air-passages is or are provided

through the main body portion of the wing, one such passageway being indicated by numeral 8. The inlet to said passage 8 is in this example controlled by a flap 9 which is angularly mounted and adapted to be turned inwardly for uncovering said inlet. Said flap 9 may be operated in any convenient way, such for instance as by means of the links diagrammatically shown and serving to couple such flap to the above mentioned link 5; with such an arrangement said flap 9 is caused to open as the auxiliary section opens and to close as the latter closes.

The above-mentioned passageway is shown rearwardly curved and its opening is located under the trailing part of the upper section 2. In this way said upper section itself controls the effective area of the outlet from said air passage 8, although it is of course to be understood that for this purpose the trailing edge of said upper section need not necessarily terminate adjacent to said outlet, but may extend to any desired distance therebehind so in effect exerting secondary control over the position at which air flow actually emerges.

The actuation of the upper section 2 of the composite wing is effected with the aid of the link system diagrammatically shown and by coupling the parts 2, 3 and 9 they can all be actuated from one control such as a hand control either directly or through the medium of a servo motor.

The flap 7 is preferably actuated independently from the rest of the movable parts although in some cases this may also be coupled to other parts so that the desired movement can be attained by actuation of a single control.

When the parts 2, 3 and 9 are in their closed positions the composite wing will be in its normal or high speed condition and it may then be of asymmetrical or symmetrical form as may be desired, or of any desired characteristics. If now it is desired to increase the lift characteristics for example when taking-off or when landing, then the auxiliary section 3 is lowered. This lowering operation can be greatly facilitated in cases when the machine is air borne if as soon as the auxiliary section 3 is lowered into the position shown at 3'' the flap 7 is turned in the position shown at 7''. It will be appreciated that the lowering of the section 3 permits of air to flow between said section and the main body portion 1 and the reaction on the flap 7 in the position shown at 7'' establishes a strong tendency for the section 3 to open still further, such flap may indeed entirely close the gap between the trailing edges of the body portion and auxiliary section.

In certain circumstances, dependent inter alia on the angle of attack the air flow over the top surface of a wing becomes turbulent but by means of the upper section 2 of the present wing this is avoided not only by reason of the fact that movement of said upper section opens the air passage 8 so providing a subsidiary air flow which sweeps over the turbulent area but also by reason of the resultant change in camber of the wing itself. The desired outward movement of the upper section as well as the opening of the flap 9 takes place simultaneously as above described.

As soon as the auxiliary section has been moved to the desired opened position the flap 7 may be turned to its normal position, i. e., one of alignment with said section but when it is desired to close the auxiliary section, for instance when a machine fitted with wings according to the present invention is air borne, the flap 7 may be turned downwardly into the position shown in Figure 1, whereupon the air flow exerts a strong thrust tending to close the auxiliary section.

Figure 2 of the accompanying drawings shows a wing comprising a main body portion 11, an upper section 12 and an auxiliary section 13. The auxiliary section 13 is in this example similar to that described with reference to Figure 1 and need not be again described. The upper section 12 differs from the section 2, however, in that it is pivotally mounted at 14 to the leading edge of the body portion. An air-passageway 16 is provided through the body portion 11 and this passage is also located nearer to the nose portion of the wing than in the case shown in Figure 1. Said air-passage 16 is controlled at its inlet end by a flap 19 and its outlet end is controlled directly by the upper section 12. The parts 12, 13 and 19 and the flap 17 provided at the trailing edge of the section 13 may be actuated simultaneously by the use of interconnecting links of the kind diagrammatically shown in the figure.

Figure 3 shows a wing including a main body portion 21, an upper section 22 and an auxiliary section 23 said latter section being shown in full lines in its fully opened condition and in chain lines in an intermediate position. The part 23 operates in a manner similar to the parts 13 and 3 in Figures 2 and 1 respectively and therefore requires no further description. The part 22 also resembles the part 2 in Figure 1 subject to being a little shorter than said latter part. An air passage 28 is provided through the body portion 21 and the inlet is provided further from the nose of the body portion than in the case of Figures 1 and 2 say about midway along the chord of the wing, and is controlled directly by the nose portion of the auxiliary section 23. In this way the use of any subsidiary flap or the like for controlling the inlet to such passage is avoided.

The parts 22 and 23 move in paths similar to those of the corresponding parts described with reference to Figures 1 and 2 and they may be interconnected by any suitable system of links such for instance as that diagrammatically shown. It will be observed that the link system differs a little from that shown in Figure 1 in that the link system actuating the upper section 22 is connected to the link 25 below the latter's anchor point whereas in Figure 1 said connection is above the anchor point of the corresponding link 5. The auxiliary section 23 is provided at its trailing edge with a flap 27 as in the case of the earlier examples and this may be actuated in a similar way.

In the embodiment shown in Figure 4 the wing comprises a main body portion 31, an upper section 32 and an auxiliary section 33. The latter section is similar to the corresponding sections described in the earlier examples in that it includes a trailing edge flap 37 and is movable in a similar path. The upper section 22 differs very extensively, however, from the upper sections shown in the earlier figures more particularly in that it itself forms the nose portion of the composite wing. Said upper section 32 is angularly adjustable about the axis 34 between the opened position, shown in full lines and the closed position shown in chain lines. In this arrangement the upper section when opened creates an air-passage 38 extending through the

wing and the effective area of such passage is determined by the particular position of said section. It is desirable for said upper section to have an inner contour more or less similar to that shown so that any air flow through the wing issues in a suitable direction for establishing and maintaining a smooth flow of air over the upper surface thereof.

The parts **32** and **33** are interconnected by a link system but the links operate in a manner different from that of the link systems diagrammatically shown in Figures 1, 2 and 3. The systems shown in Figures 1 to 3 result in positive movement being imparted to the upper section in both an opening and in a closing direction whereas in the arrangement according to Figure 4 the section **32** is closed positively as the section **33** is closed, but it is permitted to open under the influence of the air flow as said section **33** is opened. Thus the forward link **35** of the links **35**, **36**, supporting the section **33** is pivotally connected to a link **40** and said link has a slot at its end **41**. A link **42** is pivotally connected at one end to the upper section **32** and at its other end to another link **43**, the lower end of said link **43** being pivoted to the structure of the body portion **31** of the wing. The link **43** passes through the above mentioned slot in the end **41** of the link **40**, the length of such slot being such that the link **43** is free to turn from the position shown in full lines to the position shown in chain lines at **43'**. Assuming that the section **33** is closed the link **41** will be drawn back to the chain line position **41'**, the link **43** will be drawn to the position **43'** and the link **42** will occupy position **42'** so closing the section **32**. If now the section **33** is opened the link **40** will slide with respect to the link **43** and the latter will be free to turn in an anti-clockwise direction as seen in the figure so permitting the upper section **32** to open as soon as the air flow induces such opening. The extent to which said upper section **32** is permitted to open will of course depend upon the extent of free play afforded by the slot in the link **40**, i. e. upon the extent of opening of the section **33**.

The main body section **31** shown in Figure 4 also differs from those shown in the earlier figures in that it includes an adjustable tail flap **44**. It will be readily appreciated that such tail flap may, however, also be included in the arrangements shown in the earlier figures if desired.

If desired the mounting for the auxiliary sections described in the above embodiments may be such that said sections when fully opened contact at the leading edges with the underside of the associated main body portion, e. g. the leading edge of the auxiliary section may extend to a greater distance in front of its point of pivotal suspension. In this way there would be provision for exerting very great drag and this may be beneficial for instance for braking purposes when landing.

Whilst I have hereinbefore described some embodiments of wings according to the present invention I wish it to be understood that the details may be varied or modified without departing from the scope of such invention. Thus, for instance, the upper section may cover any desired part of the chord of a wing and extend for example from a point at or adjacent to the leading edge of a wing to a point which may be in front of the maximum ordinate of the wing, substantially in alignment with said ordinate or any desired distance to the rear thereof. Moreover, the auxiliary section may be of any desired length and terminate in front of, in alignment with or to the rear of the body portion of the wing and it may be adapted to turn through any desired angle and attain for instance in its fully opened condition a position in which it is disposed at 40° to 50° with respect to the body portion of the wing dependent upon the camber and chord length of said auxiliary section. In cases where said auxiliary section, when in its closed position, terminates in advance of the trailing edge of the body portion the arrangement may be such that movement of said section does not vary the chord of the composite wing. In general, however, I prefer to use an arrangement in which movement of said auxiliary section brings about variations in the length of the chord of the composite wing.

An aerofoil, wing or the like according to the present invention may, of course, be used on aeroplanes, gliders or any other aircraft.

I claim:

1. An aerofoil comprising a main body portion, an auxiliary section movably disposed on the underside of said body portion and extending towards the front of the aerofoil from a point adjacent to the trailing edge thereof, means for moving said auxiliary section into a position wherein it nests against the underside of said body portion and into a position in which it is rearwardly and downwardly disposed with respect to said body portion and forms an air passage extending therebetween, an upper section movably mounted with respect to said body portion and at least one passage extending through said body portion for the flow of air from the under surface of said aerofoil to the upper surface thereof, the inlet to said last-mentioned passage being controlled by movements of said auxiliary section and the outlet from said passage being controlled by movement of said upper section.

2. An aerofoil comprising a main body portion, an auxiliary section movably disposed on the underside of said main body portion and extending towards the front of said aerofoil from a point adjacent to the trailing edge thereof, means for moving said auxiliary section into a position wherein it nests against the underside of said body portion and into a position in which it is rearwardly and downwardly disposed with respect to said body portion and forms an air-passage extending therebetween, an upper section movably mounted with respect to said body portion and at least one passage for the flow of air from the under surface of said aerofoil to the upper surface thereof, the inlet to and outlet from said last-mentioned passage being controlled by said auxiliary section and by said upper section respectively and said two sections being interconnected by linkage so arranged that movement of said auxiliary section into its limit position towards said body portion positively closes said upper section against said body portion whilst movement of said auxiliary section away from said body portion frees said upper section for opening movement under the influence of the flow of air around said aerofoil.

3. An aeroplane wing comprising a body portion, an auxiliary section movably disposed on the underside of said wing and extending from a point adjacent to the trailing edge of the wing to a point approximately in alignment with the mid-point of the chord thereof, means for moving said auxiliary section into a position in which

it nests against said body portion and forms therewith a composite undersurface of aerofoil contour and into a position in which it is rearwardly and downwardly disposed with respect thereto and forms an air-passage extending therebetween, an upper section angularly mounted with respect to said body portion and capable of moving into a position in which it nests against said body portion so as to form therewith a surface of aerofoil shape and into a position in which it changes the camber of said wing, an adjustable tail flap fitted to the end of said auxiliary section and at least one passage for the flow of air from the underside of said wing to the upper side thereof, the inlet to said last-mentioned passage being controlled by movements of said auxiliary section and the outlet being controlled by movements of said upper section the trailing edge of which extends over said outlet up to a point in alignment with the maximum ordinate of the wing.

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