Aug. 11, 1942. E. R. BREWSTER 2,292,360

AIRFOIL LIFT COEFFICIENT VARYING MEANS

Filed July 15, 1939 2 Sheets-Sheet 1

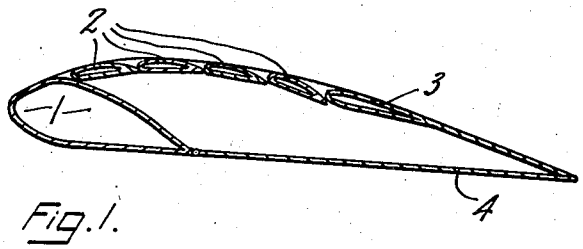

Fig. 1.

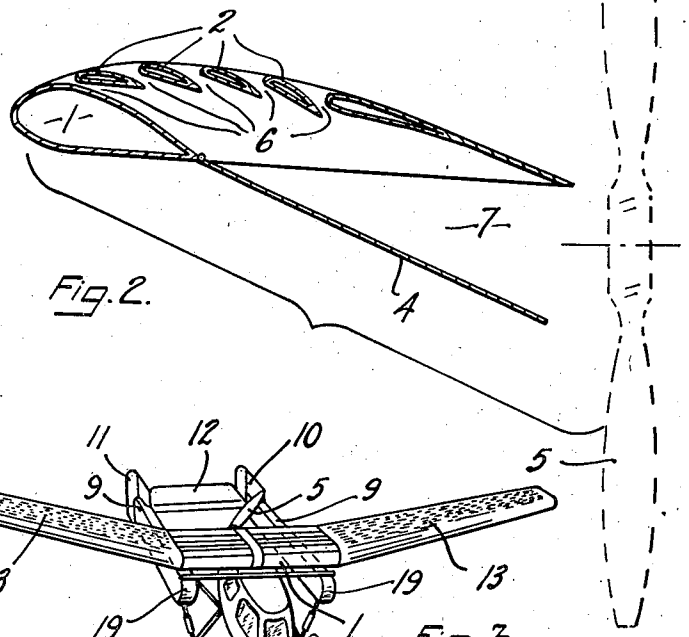

Fig. 2.

Fig. 3.

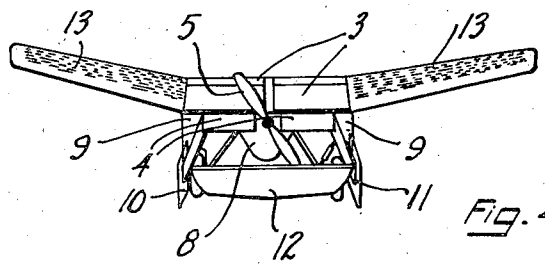

Fig. 4.

Inventor
E. R. Brewster
By E. F. Wenderoth
Atty

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AIRFOIL LIFT COEFFICIENT VARYING MEANS

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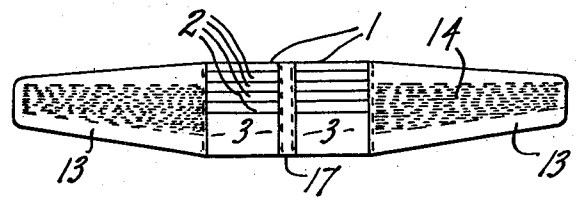

Fig. 5.

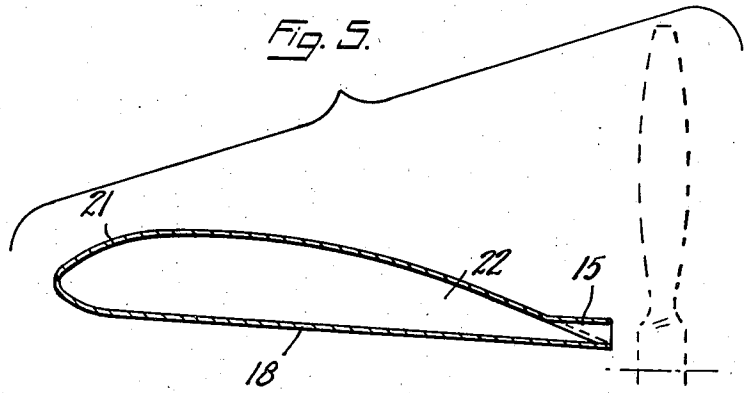

Fig. 6.

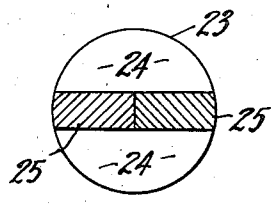

Fig. 7.

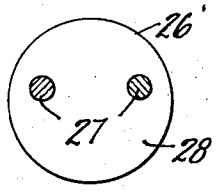

Fig. 8.

Inventor:
E. R. Brewster.
By E. F. Neuerburth
Atty

Patented Aug. 11, 1942 2,292,360

UNITED STATES PATENT OFFICE

2,292,360

AIRFOIL LIFT COEFFICIENT VARYING MEANS

Edgar Roy Brewster, New Plymouth, New Zealand

Application July 15, 1939, Serial No. 284,788
In New Zealand August 4, 1938

4 Claims. (Cl. 244—42)

It has previously been proposed to increase the lift coefficient of the wings of an aeroplane by drawing the air downwardly through an apertured upper wing surface by means of an extractor mounted in the fuselage of the aeroplane. While such means are effective in removing the boundary layer, it is obvious that certain disadvantages are entailed principally due to the increase in weight of the extracting unit and the extra space and expense involved, and general complication of the method.

The above proposal takes advantage of, or embodies a known principle of aero-dynamics, that the maximum lift coefficient of a wing is dependent upon the degree that the air flow may be bent downwardly without stalling of the wing.

By my invention, I provide an entirely novel method and means which may be employed merely to substantially remove the boundary layer from the upper surface of the wings, but may also be adjusted to give a very much greater lift coefficient at any incidence, and to enable the use of much greater incidences if desired, without the wing stalling, very much lower speeds being possible than practical heretofore, except in special types of aeroplanes such as the autogyro.

It is not usual at present in landing to employ the engine power at all, but this invention enables a substantial proportion of the power of the engine to be used for supporting the aeroplane during landing manoeuvres, thus enabling the usual method of support derived from the forward speed to be partly dispensed with and thereby enabling a great reduction in landing speeds.

As aeroplanes are at present constructed, the power applied by their engines to the air by means of an airscrew cannot be converted into lift until that power has first been converted into speed, from that speed the lift is then gained by the movement of the wings through the air.

At all times when the medium of speed cannot be fully utilised some proportion of the power available is in enforced idleness.

Only for take-off and for top speed can the full engine power be made use of. When gliding down the force of gravity supplies the forward thrust and the power cannot usually be employed at all.

An air-screw then is used at present solely for forward propulsion except that it is well known that lift can be derived from the slip-stream thrown back from a tractor air-screw.

In that aspect of the invention and in its simplest form in which the lift coefficient is increased by the substantial removal of the boundary layer from the upper surface of the wings, the invention may be said to consist in a method of increasing the lift coefficient of the wings of an aeroplane consisting in utilising a portion of the partial vacuum created by the usual propeller to draw away a substantial portion of the boundary layer on the upper surface of the wings.

In that aspect of the invention in which variation of the lift co-efficient is aimed at, the invention may be said to consist in a method of increasing the lift co-efficient of the wings of an aeroplane consisting in utilising a variable portion of the partial vacuum created by the usual propeller to downwardly bend to the desired degree the air passing over a portion or portions of the upper surface of the wings.

The invention consists in these features and in the features and arrangements and combinations of parts hereinafter referred to and more particularly pointed out in the claims.

In one way of carrying this invention into effect, the trailing edge of the wing or aerofoil is split or in other words a hinged flap, somewhat akin to the usual landing or braking flap employed at present in air craft is provided, so that the propeller creates a strong suction behind this flap when such flap is open.

By providing the propeller or propellers at the rear of the hinged flap so as to create the suction behind such flap, the engine is used directly to increase the lifting force when desired and when otherwise not fully occupied developing forward speed.

The cutting out of any proportion of the disc area of the propeller by the opening of the hinged flap reduces the forward thrust of such propeller. Thus, when landing, instead of throttling down being necessary, my method enables the power applied through the propeller to be diverted to another purpose than solely for forward speed, namely supporting the aeroplane.

By my invention an aeroplane pilot may at will use any proportion of the engine power to create forward thrust and any proportion to increase the lift of the wing according to the division of the disc area of the propeller, thereby the aeroplane can be sustained in flight at very low speeds, especially in landing.

By means of differential operation of the flaps coupled with a central division of the wing the lift on the two halves of the wing may be increased unequally or the lift may be increased on one half only, for the purpose of lateral control and banking when turning.

The use of the propeller-created suction through the wing completely prevents what is generally referred to as the "stalling" of the wing up to very high incidence angles and the wing continues to increase its lift with increase of incidence until extremely high incidences are reached much beyond those practical by other means.

In its simplest form where the suction of the propeller is applied through the wing to a simple perforated upper surface, this invention will be effective, but an improved result may be obtained by the use of a top surface which is constructed wherever convenient as a series of small aerofoils so arranged as to be opened or closed when desired.

It will be realised that more than one engine can be used at the trailing edge and the disc area of each propeller likewise divided up into proportions for thrust and lift.

This invention enables the use of the otherwise idle percentage of the available power to develop the lift of a wing and so support the aeroplane during slow flight and slow landing speed, but the invention is also efficient in removing the boundary layer and efficient in the prevention of the stalling of the wings at high angles of incidence, while lateral control can satisfactorily be applied by means of this invention.

While the invention will be described with reference to the accompanying purely illustrative drawings, it is to be clearly understood that the drawings are not to be deemed to limit the broad scope of the invention as hereinbefore disclosed in any manner.

The invention will now, however, be described with reference to the accompanying drawings in which—

Figure 1 is a diagrammatic transverse section through a wing of an aeroplane constructed according to the present invention, with the special construction of the low-speed aerofoils and hinged lower wing-surface in closed position,

Figure 2 is a diagrammatic transverse section through such wing with the special construction of the low-speed aerofoils and hinged lower wing surface in open position, and with the propeller indicated by dotted lines,

Figure 3 is a perspective drawing of an aeroplane constructed according to the present invention,

Figure 4 is a rear elevation of such aeroplane showing the low-speed aerofoils and hinged lower wing surfaces,

Figure 5 is a plan of the wing employed in the construction shown in Figures 3 and 4,

Figure 6 is a diagrammatic vertical section through the wing of an aeroplane, illustrating an arrangement wherein fixed ducts are provided to remove the boundary layer.

Figure 7 is a diagram illustrating the manner in which the disc area of the propeller is divided up by the employment of the construction illustrated in Figures 1 and 2 of the drawings, and

Figure 8 is a diagram illustrating the manner in which the swept disc area of the propeller is divided up by the construction illustrated in Figure 6.

In the construction shown in Figures 1 and 2, the wing section consists of a fixed front aerofoil 1 which may house the fuel tank, a series of pivoted aerofoils 2, a rear fixed aerofoil 3 and a lower hinged wing surface 4.

The aerofoils 2 and hinged lower wing surface 4 are suitably actuable so that when it is desired to fly slowly they may be moved to the positions shown in Figure 2, in which the propeller 5 draws the air through the gaps 6 and passage-way 7, thus reducing the pressure above the wing and giving an increased lift thereto. At this stage there is of course some lift on the underside of the wing developed by the impact force of the air struck thereby.

The propeller 5 is of course so located as to be most effective in drawing the air through the passageway 7 when the lower wing surface is hinged downwardly as shown in Figure 2.

When the wing is in the position shown in Figure 1, the flight is normal.

In the construction shown in Figures 3 to 5 the wing middle is provided with fixed and hinged aerofoils as in Figures 1 and 2, and a pusher propeller 5 is employed driven by an engine mounted at the rear of the cabin 8 which is slung below the wing middle, two fuselage members 9 being provided projecting rearwardly to support the rudders 10 and 11 and elevator 12.

The outer portions 13 of the wings are provided with holes 14 and the interior of such outer portions is in communication with the interior of the middle portion so that the effect of the suction of the engine is spread substantially along the full span of the wing.

The aerofoils 2 and the holes or apertures 14 are provided in a selected portion or portions of the upper surface of the wing. By the term "selected portion or portions" I mean any portion or portions of the upper surface of the wing where there is no direct frontal or substantially frontal impact of air when the aeroplane is in motion.

With the usual wing, when the critical angle is exceeded, a current of air creeps forward from the trailing edge of the wing above such wing and robs the wing of lift and causes stalling.

By the use of my invention, a current is induced to flow down from the front of the wing to the trailing edge, above the wing, and by preventing a forward current of air prevents stalling.

It will be realised of course that it is possible to hinge the top surface of the wing and by the use of the power at the rear of the hinged flap, get the same effect as that obtained with the lower surface of the wing split, although most probably to a lesser degree; also if desired both the upper and lower surfaces can be hinged.

Referring to Figure 5, the middle of the wing is provided with an internal transverse partition 17 and the lower wing surfaces are independently controlled to permit banking to be obtained by their use and so dispense with ailerons.

The hinged aerofoils 2 and lower wing surfaces 4 may be spring-loaded so as to automatically come into operation when the speed of the aeroplane drops, or they may be actuated mechanically or manually or by pneumatic, hydraulic or electrical means. I may for instance employ any suitable adaptation of the known means for operating the landing or braking flaps in aircraft for effecting the desired controlling operations.

The design may be such that in normal flight they are slightly open and the degree of opening is variable automatically or as desired.

The aeroplane shown in Figures 4, and 5 may be provided with auxiliary tractor motors at 19 (Figure 3).

In Figure 6, fixed ports 15 are provided in the trailing edge of the wing 18 in proximity to the propeller 20, apertures being provided in the upper surface of the wing between 21 and the trailing edge.

In Figure 7 the disc area of the propeller is represented by the area of the circle 23, the proportion of the disc area used for forward flying is represented by the portions 24 and the portion of the disc area used for lift is represented by the cross-hatched portions 25, which are of course variable relatively to the portions 24, and are variable relatively to each other for banking purposes.

In Figure 8, the disc area of the propeller is represented by the area of the circle 26, the portions 27 being used for lift and the portion 28 for forward thrust.

It will of course be obvious that the invention could be applied to a plane in which a plurality of pusher motors are employed.

Ailerons of the usual type may of course be employed.

The invention may of course be applied to a plane having more than one wing, such as a biplane.

In operation and having regard to the application of the invention substantially for the purpose of removing the boundary layer, it will be clear that the partial vacuum created by the propeller 20 operates to induce a partial vacuum in the duct 15 through to the interior of the wing 22 thus drawing a portion of the air passing over the selected portion or portions between 21 and the trailing edge downwardly through the wing and out through the duct 15, thus reducing the pressure over the upper surface of the wings, thereby increasing the lift.

When the invention is applied to obtain a variable lift coefficient depending upon the desires of the operator, the operation is substantially the same as previously described except for the fact that the area of the apertures in the selected portion or portions of the upper surface of the wings may be varied in conjunction with a desired variation in the opening of the flap 4 to increase the degree of forward speed or of lift as may be desired.

Without making the statement other than one of assumption and not of fact, it is believed that in employing my invention with adjustable controls the best forward speed would be attained when the apertures in the selected portion or portions of the upper surfaces of the wings and the hinged flap 4 are opened just sufficiently wide to result in the downward rush of air substantially removing the boundary layer.

The invention is most effective where the wing apertures are directly opposite the hinged flap and the propeller. Where the apertures are provided at a distance along the wing from such hinged flap and the propeller, the air flow is less direct.

It will be realised that the invention is most readily applicable to a plane having a geodetically constructed wing.

I claim:

1. In an airplane having a pusher propeller, the combination comprising a fuselage, a wing on said fuselage having a passage way therethrough extending from the upper to the lower surface of said wing, a plurality of hinged aerofoils located in the plane of the top surface of said wing to control the opening of said passage way at the top surface of said wing, a flap hinged at its forward edge at the lower surface of said wing in front of said pusher propeller to control the opening of said passage way in the lower surface of said wing so that when said flap is open the trailing edge of the wing is split open against the pusher propeller located behind said flap and an inflow of air to said propeller passes through said passage way from the upper surface of said wing thereby increasing the lift coefficient of the wing.

2. In an airplane having a pusher propeller, the combination comprising a fuselage, a wing on said fuselage having a passageway therethrough extending from the upper to the lower surface of said wing, a plurality of aerofoils located in the plane of the top surface of said wing at the opening of said passage way at the top surface of said wing, a flap hinged at its forward edge at the lower surface of said wing in front of said pusher propeller to control the opening of said passage way in the lower surface of said wing so that when said flap is open the trailing edge of the wing is split open against the pusher propeller located behind said flap and an inflow of air to said propeller passes through said passage way from the upper surface of said wing thereby increasing the lift coefficient of the wing.

3. In an airplane having a pusher propeller, the combination comprising a fuselage, wings on said fuselage at each side thereof, each of said wings having a passage way therethrough extending from the upper to the lower surface of each wing, a plurality of hinged aerofoils located in the plane of the top surface of each wing to control the opening of said passage way at the top surface of each wing, a differentially operable flap hinged at the lower surface of each said wing in front of said pusher propeller opening the trailing edge of said wings against said propeller in relatively variable openings so as to increase the lift on either wing unequally at the will of the operator in order to provide lateral control.

4. In an airplane including a fuselage, the combination of wings on said fuselage and a pusher propeller adjacent the trailing edge of said wings one of said wings having a passageway extending therethrough from top to bottom thereof and flap means mounted on said wing adjacent the trailing edge of said wing under the control of the pilot to vary the effective disc area of said propeller whereby the proportion of the air stream created by said propeller passing through said passageway may be varied.

EDGAR ROY BREWSTER.