July 9, 1946. W. D. VAN ZELM 2,403,770

AILERON

Filed Nov. 4, 1942 2 Sheets-Sheet 1

FIGURE 1.

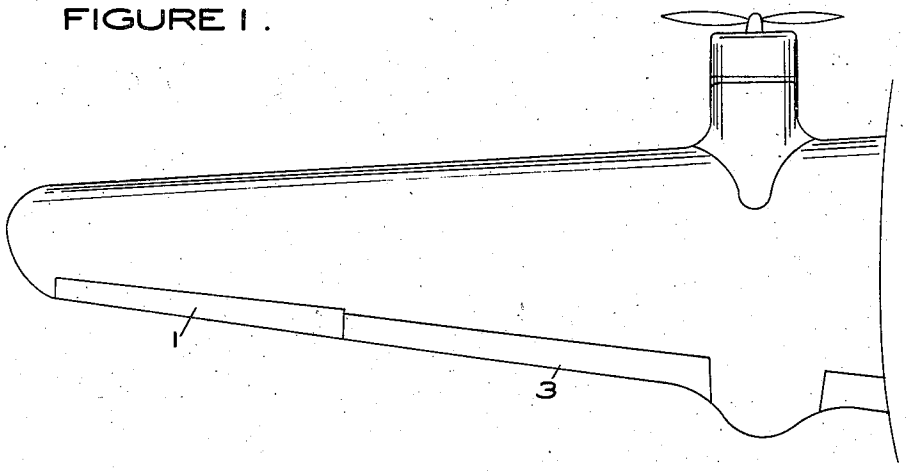
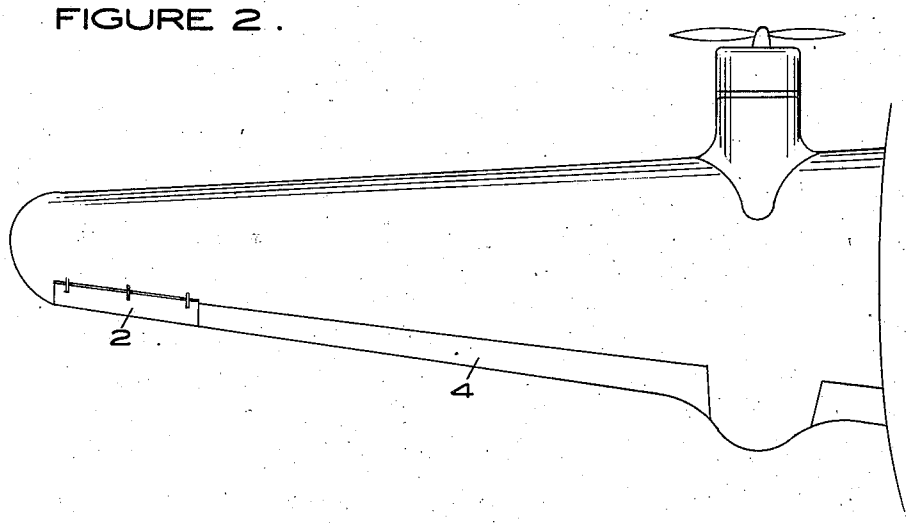


FIGURE 2.



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Filed Nov. 4, 1942 2 Sheets-Sheet 2

FIGURE 3.

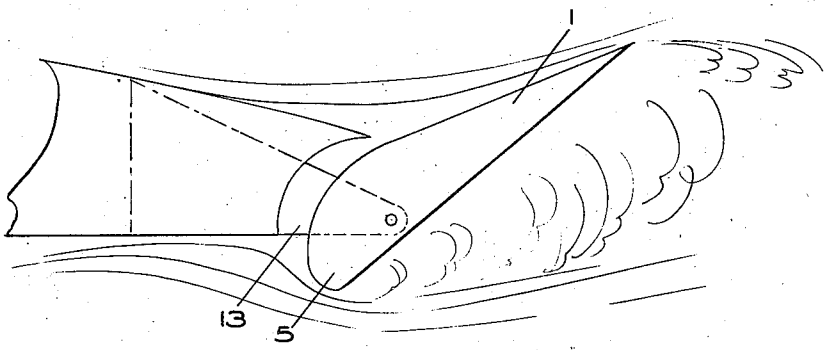


FIGURE 4.

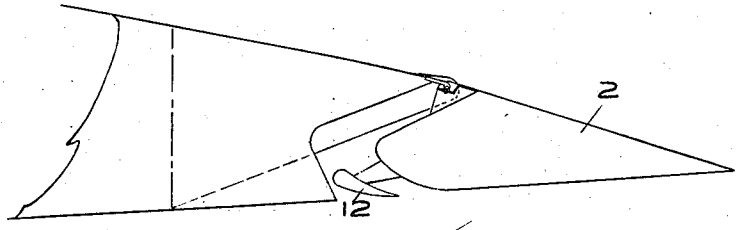


FIGURE 5.

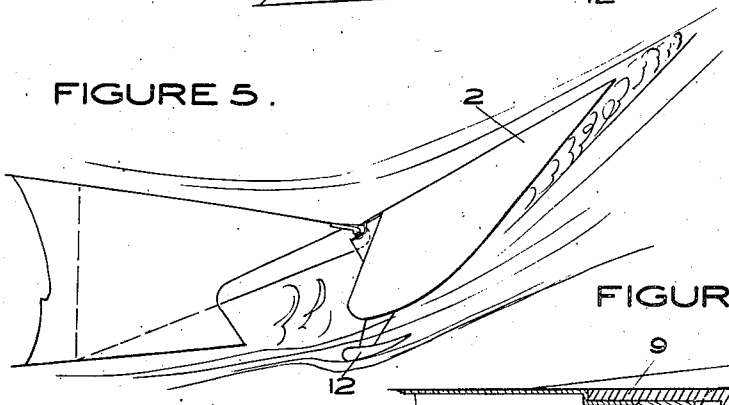
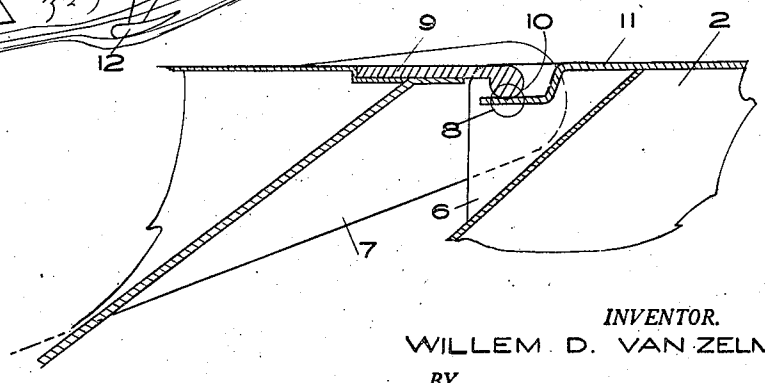


FIGURE 6.



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UNITED STATES PATENT OFFICE

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Application November 4, 1942, Serial No. 464,447

8 Claims. (Cl. 244—90)

1

This invention relates to an aileron or control surface for a wing or airfoil of greatly increased efficiency as compared to the type of aileron or control surface commonly used.

The aerodynamic efficiency of the airplane is greatly reduced by the fact that the provision for lateral control, namely, the ailerons, limits the flap area, and as a result increases the take-off distance or decreases the take-off load of an airplane. By applicant's device, the same lateral control is provided with less aileron area which results in a greatly increased length of flap with the resultant increase in lift and shortened take-off distance.

Frise ailerons have been generally adopted because they furnish aerodynamic balance resulting in low control forces, and also because the nose shape which protrudes into the airstream upon an upward deflection of the aileron, produces an increase in air drag which helps in turning the airplane. This last feature is commonly described as furnishing positive yaw or at least, as reducing the inherent adverse yaw of the ailerons.

In their general acceptance, the defects of the Frise ailerons have been completely overlooked. The nose of the Frise ailerons has a large amount of motion with respect to the wing, and a clearance slot must be provided which results in air leakage from the bottom to the top surface of the wing. This results in increased drag and reduces the rolling moment of the aileron beyond approximately 15° up motion. This last effect is due to the nose balance, which protrudes into the airstream below the wing, acting as a spoiler and effectively stalling the aileron. This is illustrated in Fig. 3 of the drawings.

In short, the Frise aileron obtains its reduction of hinge moments, at the expense of rolling moments. It is an object of the present invention to provide an aileron with provisions for reducing the hinge moments and at the same time provide increased rolling moments.

Another object of the invention is to provide a balanced aileron which has better structural efficiency than the ordinary balanced Frise type.

A further object of the invention is to provide an aileron which, for all positions, will prevent the flow of air between the lower surface and upper surface of the wing, and thus cause all of the airflow on the under surface of the wing to flow over the lower surface of the aileron.

A still further object is the provision of an aileron structure which does not interfere with the air flow of the under side of the wing but

2

causes a smooth flow of the aileron and practically eliminates the spoiler effect.

Further and other objects will become apparent from the description of the accompanying drawings which form a part of this disclosure and in which like numerals refer to like parts.

In the drawings:

Figure 1 shows a conventional wing and aileron assembly.

Figure 2 shows, by way of comparison, the improved wing and aileron assembly.

Figure 3 shows the spoiler effect of the Frise type aileron.

Figure 4 shows the improved aileron in the neutral position.

Figure 5 shows the improved aileron at a large upward deflection.

Figure 6 is a partial section showing the seal at the hinge of the aileron.

Figure 1 shows a wing, having aileron 1 and flap portion 3.

Figure 2 shows the same wing with an aileron 2 designed to give the same rolling moment as that of aileron 1. By using this improved aileron, it will be noted that the flap portion 4 is increased by the amount that the aileron 2 is decreased.

In Figure 3 is shown a wing having the conventional Frise aileron 1, and it is shown at a large upward deflection. It will be noted that the nose balance portion 5 extends a considerable distance below the lower surface of the wing and acts as a spoiler and effectively stalls the aileron, as shown by the representation of turbulence at the lower rear portion of the aileron.

Figure 4 shows a wing having the improved aileron 2. This aileron is secured to the wing by a hinge comprising brackets 6 and 7, bracket 6 being secured to the aileron and bracket 7 being secured to the wing. A hinge pin is represented by the circle 8. It is common practice to employ three hinges for securing the aileron to the wing. Strip 9 is secured to the wing and extends between the hinges. This strip has a bead portion 10, the lower side of which is substantially tangent to the axis of the hinge pins. Strip 11 is coextensive with strip 9 between the hinges and is of a resilient material which contacts the bead forming a seal to prevent the flow of air between the lower surface of the wing and the upper surface of the wing and thus cause all of the air underneath the wing to flow along the under surface of the aileron. Due to its construction, the seal is practically frictionless and does not interfere with the hinge action of the aileron.

The primary purpose of this seal construction is to minimize friction so as to keep control forces exerted by the pilot to a minimum but permits the ready removal of the airfoil for service or repair without the extra operations required to break and replace a seal.

Slat 12 is secured to, but spaced from, the forward lower portion of aileron 2. This slat has a negative incidence with respect to the wing. When the aileron is in the neutral position shown in Figure 4, the top and bottom surfaces of the aileron are substantially at the top and bottom planes of the wing and slat 12 is entirely within the bottom plane of the wing.

For a large upward deflection of the aileron as shown in Figure 5, slat 12 projects into the airstream and due to its airfoil shape, rather than causing a spoiler effect, it bends the airstream from the lower portion of the wing over the lower surface of the aileron, thus eliminating the usual stalling effect on the aileron. Since the seal between the hinges effectively prevents the flow of air over the top surface of the airfoil, all of the air is caused to flow on the under surface of the aileron with substantially no turbulence. Slat 12 also has a slight negative lift and adds to the rolling moment of the airfoil as well as acting to balance the aileron. It will also be noted that for all positions of the aileron, the bottom surface of the aileron proper never extends beyond the lower plane of the wing into the airstream but rather remains substantially tangent to this plane.

A further advantage of the type of hinged construction described is that in this upper hinged construction, the brackets 6 and 7 are entirely outside of the ailerons, thus, avoiding the necessity for cutting the ailerons to attach hinges which reduces the strength of the structure, as is usual in the aileron construction. It can be seen from Figure 3 that with the internal hinge of the Frise type aileron it is necessary to have a cut or slot in the aileron to acommodate the mounting bracket 13.

From a consideration of the conventional aileron and applicant's improved airfoil, it will be seen that due to the increased efficiency of the improved structure, an aileron of the improved structure can be considerably shorter than the conventional aileron and accomplish the same rolling moment. Actual tests show that for the same wing, the new aileron will give the same rolling moment as the Frise type, with 35% to 45% less length along the span. This will result in a longer flap, thus increasing the lift efficiency of the airplane for take-off.

It is to be understood that certain changes, alterations, modifications and substitutions can be made without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. An aileron mounting for the trailing edge of an airplane wing, comprising hinge means movably securing said aileron to said wing, said hinge means comprising brackets secured to the upper leading edge of the aileron within the contour of the wing, the axis of said hinge being close to the inside of the upper contour of said wing and the lower leading portion of said aileron having a contour so that for maximum upward deflections of the aileron, the contour of said aileron remains approximately in the plane of the lower surface of said wing, strips secured to the top surface of said wing and said aileron extending the length of the aileron which engage each other and cover the space therebetween to prevent the flow of air therethrough, a slat secured in fixed-spaced relation to the lower leading edge of said aileron having a negative lift with respect to said wing when said slat is in its operative position, said slat moving with said aileron into an inoperatve position between the wing and the aileron when said aileron is in the neutral or down position and into an operative position extending into the airstream below said wing upon an upward movement of the aileron whereby all of the air flow on the under side of the wing is bent without turbulence around the lower surface of said aileron to effect an increase in rolling moment of said wing.

2. An aileron mounting for an aircraft wing, comprising a plurality of hinges for movably securing said aileron to said wing, the axis of said hinges lying approximately in the plane of the upper surface of said wing, a slat secured to the leading edge of said aileron, said slat being spaced from said aileron and having a negative lift with respect to said wing when in the operative position, said slat being retracted within the plane of the lower surface of said wing when said aileron is in the neutral or down position, and extending into the airstream below said wing upon an upward movement of the aileron whereby the airflow is bent around said aileron to minimize turbulence, and sealing means between said hinges to prevent airflow between said aileron and said wing, to cause all of the airstream on the under side of said wing to flow on the under side of said aileron.

3. An aileron assembly for an airplane wing, comprising a control airfoil movably secured to the trailing edge of said wing, a negative lift slat secured to the forward lower portion of said control airfoil extending into the airstream on the under side of said wing when the control surface is in the up position, said slat being movable with said airfoil within the contour of the lower surface of said wing when said control airfoil is in the neutral or down position, and hinge means within the contour of the airfoil close to the plane of the upper surface of said airfoil for movably securing said airfoil to said wing, and sealing means extending throughout the length of said airfoil to prevent the flow of air from the under side of the wing through the space between said airfoil and said wing.

4. An aileron assembly for the trailing edge of an airplane wing; comprising hinge means for movably securing said aileron to said wing, the axis of said hinge lying approximately in the plane of the upper surface of said wing, strips secured to the top surface of said wing and said aileron extending the length of the aileron which interengage and cover the space therebetween to prevent the flow of air therethrough, a slat secured in fixed spaced relation to the lower leading edge of said aileron having a negative lift with respect to said wing when in the operative position, said slat moving with said aileron to an inoperative position between the wing and the aileron when said aileron is in the neutral or down position, and into a position extending into the airstream below said wing upon an upward movement of said aileron, whereby all of the air flows with substantially no turbulence along the underside of the aileron to effect an increased rolling moment of said wing.

5. An aileron mounting for an aircraft wing,

comprising a control airfoil movably secured to the rear portion thereof, hinge means for securing said airfoil to said wing, the axis of said hinge being approximately in the plane of the upper surface of said wing, a separable sealing means comprising members secured adjacent the upper surfaces of said wing and said control airfoil, said members extending along the upper adjacent edges of said wing and said airfoil to form an airflow seal, a negative lift slat secured to the forward lower portion of said control airfoil extending into the airstream when said control airfoil is in the up position, said slat being movable with said airfoil within the plane of the lower surface of said wing when said control airfoil is in the neutral or down position.

6. An aileron mounting for an aircraft wing, means for hingedly securing said aileron to the trailing edge of said wing, comprising a plurality of complementary brackets mounted on said aileron and said wing to form hinges, the brackets on the aileron being mounted on the exterior thereof, hinge pins securing said brackets together, the axis of said hinge pins being adjacent the underside of the upper surface of said wing, so that the leading edge of the aileron is maintained approximately within the profile of the wing for all positions of the aileron, sealing means adjacent said hinges closing the space between said wing and said aileron, a slat mounted on the leading edge of said aileron, said slat being spaced from the lower side of the leading edge of said aileron and having a negative lift with respect to said wing when the slat is in its operative position, said slat being movable with said aileron to a position within the contour of the

lower surface of said wing when the aileron is in the neutral or down position and extending into the airstream below said wing upon an upward movement of said aileron whereby all of the air flow along the lower surface of the wing is bent around the lower surface of said aileron with substantially no turbulence.

7. Control airfoil mounting on an airplane wing comprising a plurality of hinges for movably securing said airfoil to said wing, the axis of said hinges lying approximately in the plane of the upper surface of said wing and strips extending between said hinges, one secured to said airfoil and one secured to said wing meeting with line contact substantially at the axis of said hinges for closing the passage between said airfoil and said wing against airflow therebetween.

8. Control airfoil mounting on an airplane wing comprising a plurality of hinges for movably securing said airfoil to said wing, the axis of said hinges lying approximately in the plane of the upper surface of said wing and strips extending between said hinges, one secured to said airfoil and one secured to said wing meeting with line contact substantially at the axis of said hinges for closing the passage between said airfoil and said wing against airflow therebetween, a negative lift slat secured to the forward lower portion of said airfoil, extending into the airstream on the under side of said wing when the control surface is in the up position, said slat being movable with said airfoil within the plane of the lower surface of said wing when said control is in the neutral or down position.

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