Feb. 8, 1927. 1,616,682

V. E. CLARK

WING OR SIMILAR MEMBER FOR AIRPLANES

Filed Sept. 29, 1922 3 Sheets-Sheet 1

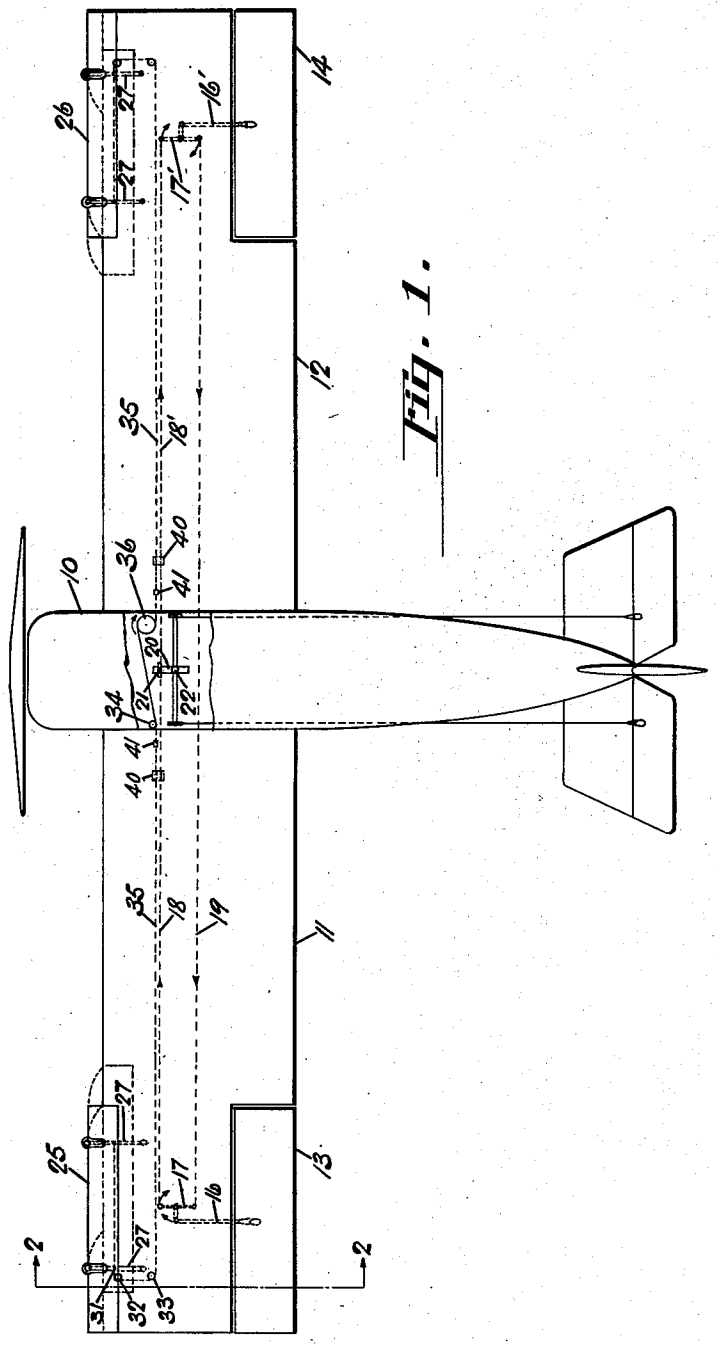



Fig. 1.

Witness.
Elmer E. Freed
Wm. F. Pasco

By

Inventor.
Virginius E. Clark
Ralph H. Chilton
Attorney.

Feb. 8, 1927. 1,616,682

V. E. CLARK

WING OR SIMILAR MEMBER FOR AIRPLANES

Filed Sept. 29, 1922 3 Sheets-Sheet 2

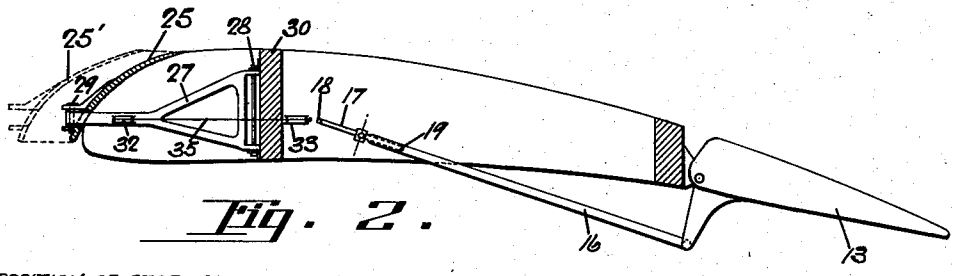



Fig. 2.

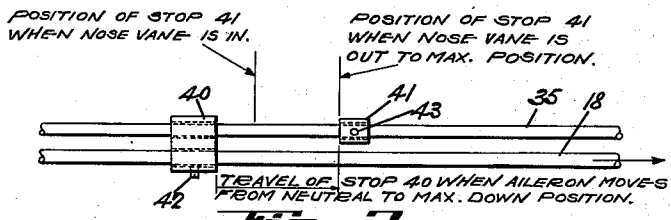



Fig. 3.

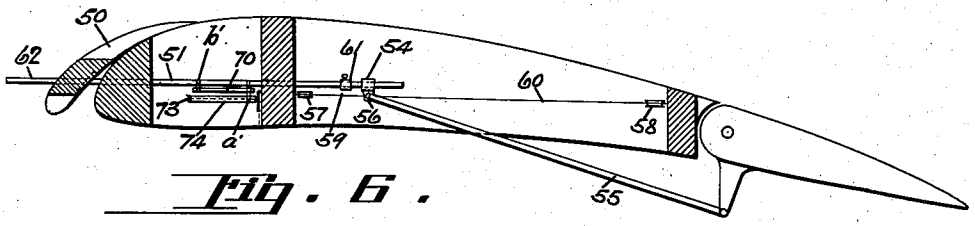



Fig. 6.

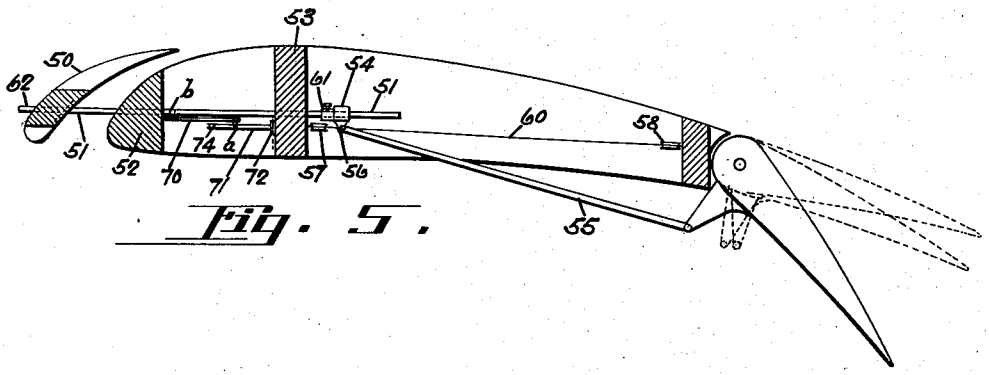



Fig. 5.

Witness.
Elmer E. Breed By
Wm. P. Pasco.

Inventor.
Virginius E. Clark
Ralph N. Chilton
Attorney.

Feb. 8, 1927. 1,616,682

V. E. CLARK

WING OR SIMILAR MEMBER FOR AIRPLANES

Filed Sept. 29, 1922 3 Sheets-Sheet 3

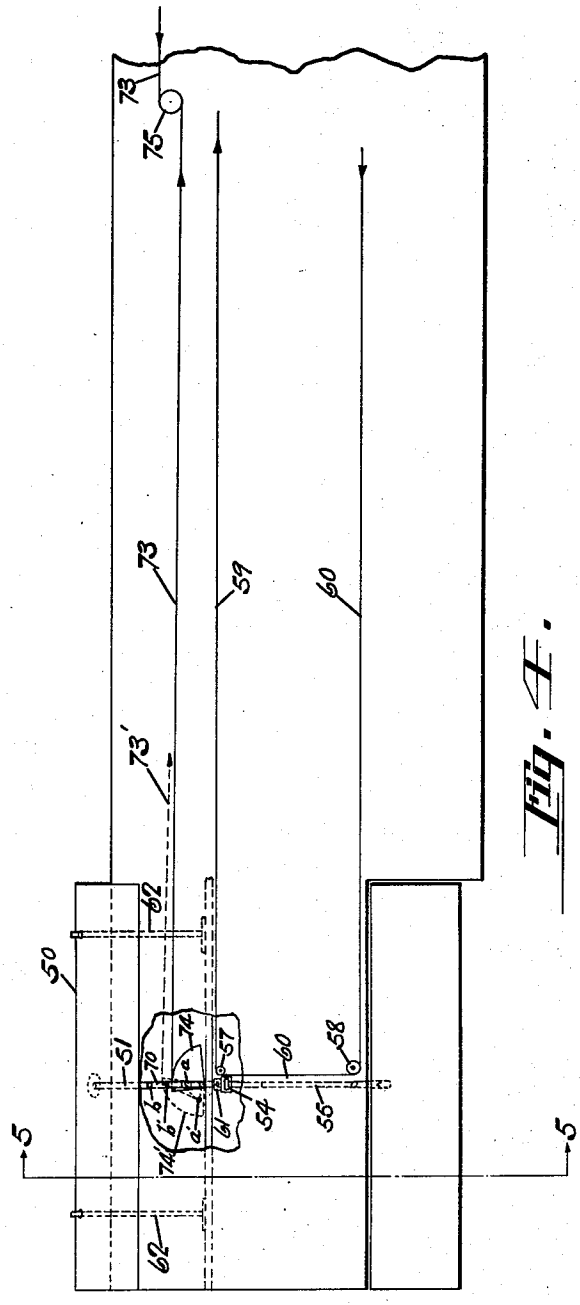



Fig. 4.

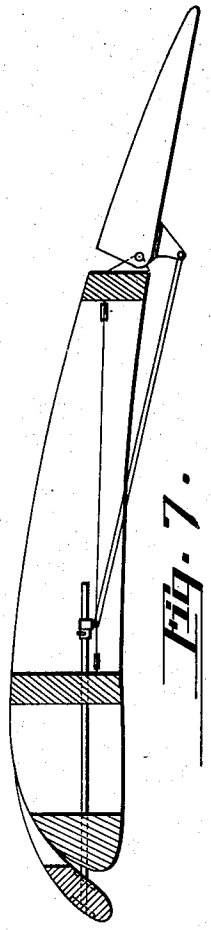


Fig. 7.

Witness.
Elmer E. Reed
Wm. F. Casco

By

Inventor.
Virginius E. Clark
Ralph W. Chilton
Attorney.

Patented Feb. 8, 1927. 1,616,682

# UNITED STATES PATENT OFFICE.

VIRGINIUS E. CLARK, OF DAYTON, OHIO, ASSIGNOR TO DAYTON-WRIGHT COMPANY, OF DAYTON, OHIO, A CORPORATION OF DELAWARE.

## WING OR SIMILAR MEMBER FOR AIRPLANES.

Application filed September 29, 1922. Serial No. 591,376.

This invention relates to aerofoils especially such as are used in aircraft, and has as a general object to provide means for varying the lift of an aerofoil by a movable auxiliary vane positioned in close proximity to the entering edge of the aerofoil. A more specific object is to provide means for operating the auxiliary nose vane simultaneously with the operation of a rear wing flap or aileron whereby the lift of the aerofoil is greatly increased when the rear wing flap is pulled down.

Another object is to give a quicker aileron action for controlling airplanes and to greatly decrease the tendency to spin, especially when the airplane is flying with the wings at a large angle of attack. Ordinarily, when flying at a large angle of attack if an aileron is pulled down beyond a slight angle there is danger of the lift curve going beyond the "burble point" and hence giving a decreased lift on that side of the machine instead of an increased lift which is desired in such cases. By means of this invention an auxiliary nose vane is extended when the aileron is pulled down, the effect of the extension of the nose vane being to permit the angle of attack of the wing to be greatly increased without passing the "burble point" or maximum lift of the wing. Of course this feature of the invention also prevents or decreases the tendency to spin. When an airplane becomes laterally unbalanced for any reason and one wing begins to fall, the downward motion of that wing causes the air to strike it at an increased angle of attack. If such angle of attack exceeds the angle for maximum lift the wing will continue to fall and consequently the airplane will spin. If an attempt is made to raise the falling wing by pulling down the aileron on that side, the effective angle of attack is increased by such attempt and hence the lift on that side will be still further decreased. If, however the wing has auxiliary nose vanes according to this invention, the pulling down of the aileron will extend the nose vane and give the wing a high lift instead of a decreased lift, due to the characteristic late burble point on aerofoils having such nose vanes.

Another feature of this invention is the means for extending the nose vanes on both sides of the airplane at once but only on the outer portions of the wings. When an airplane equipped with such extended nose vanes on both sides is flying at a large angle of attack and for any reason one wing begins to fall, the increased angle of attack caused by such falling will cause a high lift over the outer portion of the wing which will have a large moment to again right the plane. Thus it is seen that this construction will greatly increase lateral stability without the aid of ailerons although, as explained above, this invention also renders the ailerons much more effective.

Other objects of the invention relating to means for operating the auxiliary nose vanes and the various adjustments of such means will appear hereinafter from the following more detailed description, reference being had to the accompanying drawings, wherein preferred forms of embodiment of the present invention are clearly shown.

Fig. 1 is a diagrammatic plan view of an airplane equipped with this invention, with both the auxiliary nose vanes extended.

Fig. 2 is a section on line 2—2 of Fig. 1, but with the nose vane retracted against the nose of, the wing.

Fig. 3 is an enlarged view of the interconnecting operating means for the nose vanes and ailerons.

Fig. 4 is a diagrammatic view of another form of the invention, the nose vane being shown extended and the aileron pulled down to its lowest position.

Fig. 5 is a section on line 5—5 of Fig. 4.

Fig. 6 is a view similar to Fig. 5 but with the nose vane retracted and with the aileron in neutral position.

Fig. 7 shows a modification wherein there are no means independent of the ailerons for extending the nose vanes.

In the drawings, like or similar reference characters refer to like or similar parts throughout the several views.

In Fig. 1 numeral 10 designates the body of an airplane having the left wing 11 and right wing 12. The outer portions of these wings are provided with the usual ailerons 13 and 14 at the trailing edge for giving lateral stability. These ailerons may be operated in various ways, but I have shown them in Fig. 1 to be operated by the rigid link 16 which has a universal pivot to one arm of the three-armed lever 17. Another arm of lever 17 is connected by the flexible cable 18 to the upstanding arm 21 on the

torque tube 20, which in turn is operated in the usual manner by the operator's stick 22. The operating linkage for aileron 14 is similar to that for aileron 13 as shown, and the third arms of the levers 17 and 17′ are interconnected by the flexible cable 19 as shown. Thus it is obvious that when the operator's control stick 22 is moved to the right cable 18 will be drawn to the right to rotate lever 17 in the direction of the arrows and cause aileron 13 to be pulled down. Cable 18′ will be loosened by the movement of control stick 22 and the cable 19 will rotate the lever 17′ in the direction of the arrows shown to cause aileron 14 to be moved up. Of course the reverse movement of the stick 22 will cause the two ailerons to move in the reverse directions to that described.

The wings 11 and 12 are also provided with the movable auxiliary vanes 25 and 26 located at the entering edge and arranged so they can either be drawn up snugly against the entering edge when they will have practically no effect on the aerodynamic properties of the wing, or be extended as shown by the dotted lines 25′ in Fig. 2 where they greatly increase the lift on that portion of the wing, especially when the wing is flying at the larger angles of attack. In other words, these auxiliary nose vanes permit the wing to be flown at large angles of attack without going beyond the burble point of the lift curve, that is, they give a characteristic late burble point. These nose vanes 25 and 26 may be moved outward or retracted by any suitable operating means but the particular means shown in Figs. 1 and 2 will now be described in more detail.

The vanes are connected to the wings by a plurality of parallel links 27 which are pivoted at 28 to the front spar and at 29 to the vane by means of a small bracket carrying the pivot pin. When the links 27 extend straight out in the direction of line of flight the vanes are extended and when they swing towards the fuselage the vanes (see Fig. 1) move with a parallel motion snugly up against the entering edge to the positions shown in dotted lines in Fig. 1 and as shown in full in Fig. 2. A flexible cable 35 is attached to the outermost link 27 at the point 31 and passes first around the guide pulley 32 located toward the wing tip, then around pulley 33 located so that the cable 35 will pass parallel and close to the aileron cable 18, then around another guide pulley 34, to the winding drum 36. The cable 35′ for the right wing is similarly arranged, both cables being arranged to be wound up or unwound together when the winding drum 36 is rotated. No means for operating this drum 36 has been illustrated, but it will be readily understood that any suitable and well known cranking means may be used, the idea being that the operator may extend or retract the nose vanes 25 and 26 at will by a simple cranking operation. In the means shown in the drawings the air pressure will retract the nose vanes when cables 35 are unwound from drum 36, however if desired positive means for retracting the nose vanes may also be provided.

In addition to the drum 36 I have provided independent means for extending the nose vanes one at a time and simultaneously with the pulling down of the aileron on that side, the opposite nose vane being unaffected. This is accomplished by means of the stop 40 securely fastened to the aileron control cable 18 and through which the nose vane control cable 35 passes, (see Fig. 3) and the stop 41 securely fastened to cable 35. Preferably, the stops 40 and 41 are so relatively located along the cables 18 and 35 that when the nose vanes are in fully retracted position and the ailerons in neutral position the stop 41 does not abut stop 40 by an amount which permits the ailerons to be moved through small angles without engaging the stops 40 and 41. If, however, either aileron is pulled down to such an angle that there is danger of reaching the burble point for that portion of the wing, the stop 40 will engage the stop 41 and move the nose vane outwardly to give a high lift on that portion of the wing as hereinbefore described. An important feature is that the nose vane is moved outwardly an amount according to the distance the aileron is pulled down, thus opening up a bigger slot at the entering edge when the aileron is pulled far down, which has been found to be advantageous. Preferably, the stops 40 and 41 are made adjustable along the control cables by any suitable means such as gripping means operated by the set screws 42 and 43 (see Fig. 3). Thus the relative position of the stops 40 and 41 may be changed, if desired, to cause the nose vane to begin moving outward immediately upon pulling the aileron below its neutral position or at any other desired time. When the nose vanes are being operated by the aileron cables it is preferable to have a spring supported guide pulley similar to a belt tightener pulley to take up the slack in the nose vane cable between stop 41 and the winding drum 36, but such tightener pulley has not been shown in Fig. 1 for the sake of clearness.

It is obvious that with the construction above described, it is possible to extend the nose vanes on both wings by winding up the drum 36 in the direction of the arrow without interfering in any way with the ordinary operation of the ailerons 13 and 14. The extension of these nose vanes great-

ly increases the lateral stability of the plane, as hereinbefore described, as well as renders the ailerons more effective when the same are used. An advantage in having the nose vanes extend over only the outer portions of the wing instead of over its entire length is to greatly reduce complication, weight, air resistance, etc., and yet at the same time to obtain almost as much stabilizing effect as if the vanes did extend the entire wing length.

When it is desired to extend the nose vane only when the corresponding aileron is pulled down, both nose vanes are retracted against the wing by the drum 36, and the operation of the ailerons by the stick 22 in the ordinary manner will automatically operate the corresponding nose vane as described above.

In the modification shown in Figs. 4, 5, and 6, the nose vane 50 is operated in a somewhat different manner. Rigidly secured to the vane 50 at its center is the operating rod 51. This rod 51 extends through suitable guide bearings in the nose brace member 52 and front wing spar 53, and beyond the spar 53 itself serves as a guide for the sliding member 54 to which the aileron operating link 55 is pivoted at 56. The aileron operating cable 59 for pulling the aileron down is attached to the member 54, preferably close to the pin 56, and passes forwardly around guide pulley 57, while the cable 60 for pulling the aileron up is attached at the same point and passes rearwardly around guide pulley 58. The control cables 59 and 60 may be operated by an operators' control stick in the manner illustrated in Fig. 1, or by any other well known means, and is considered unnecessary herein to illustrate and describe in detail such means. When cable 59 is pulled in the direction shown by the arrow in Fig. 4, member 54 will slide upon its guide rod 51 until it abuts the stop 61 secured to rod 51. Any further movement of member 54 will then cause the entire rod 51 to move forward and carry with it the nose vane 50 rigidly secured thereto. The nose vane 50 is provided with additional guide rods 62 which are rigidly supported in any suitable manner on the wing and project forwardly through the vane 50 in suitable slots provided therein. In its extended position the nose vane 50 is practically at the end of the guide rods 62, but in its retracted position the rods 62 project a few inches beyond (see Figs. 5 and 6). The stop 61 is preferably adjustable to any desired position along rod 51 so that if desired the aileron may be pulled down a small angle without extending the nose vane 50, but when it is pulled down to a large angle as shown in full lines in Fig. 5, the nose vane will be extended to prevent a break in the air stream above the wing surface. When the aileron is pulled up by tension on cable 60, member 54 will slide rearwardly along rod 51 as will be obvious from the drawings.

In this modification also I have shown means for extending the nose vanes on both sides simultaneously and independently of the operation of the ailerons. A toggle lever system is shown comprising the lever 70 pivoted to rod 51 at point $b$ and lever 71 pivoted to the front spar at 72, the levers 70 and 71 being pivoted together at point $a$. When the toggle levers 70 and 71 are straightened out so that pivots 72, $a$ and $b$ lie in a straight line, as shown in Fig. 5 and in full lines in Fig. 4, the nose vane 50 will be in extended position. However, when the toggle joint is broken so that pivot $a$ swings to position $a'$ and pivot $b$ moves to position $b'$, as shown in Fig. 6 and in dotted lines in Fig. 4, the vane 50 will be in retracted position. The toggle is operated by a cable 73 which is attached to a projecting quadrant 74 on the lever 71. I have shown the quadrant 74 containing a groove in its periphery for the cable 73 and the quadrant so shaped that the leverage of cable 73 is greatest at the initial movement of straightening out the toggle, and gradually reduces until the nose vane 50 is completely extended. The position of quadrant 74 when the vane 50 is completely retracted is shown in dotted lines at 74′ and cable 73 at 73′ in Fig. 4. The cables 73 on both the right and left wings are retracted at the same time by being wound up on the winding drum 75. The drum 75 is cranked by the operator in any suitable manner, such as by a hand crank and provided with ratchet means to hold in any desired position. The wind pressure may be relied upon to press the nose vane 50 inwardly when the drum 75 is unwound due to toggle levers $a$ and $b$ being at a slight angle when the nose vane is extended, but if desired positive means for operating the quadrant 74 in either direction may be provided.

If desired, instead of having one set of toggle levers in the central part of the nose vane, two or more sets of toggle levers may be provided to cause the nose vane to operate more smoothly.

The modification shown in Fig. 7 is substantially the same as that shown in Figs. 4 and 5 with the exception that the independent means for extending the nose vanes are omitted, thus greatly reducing complication. In this modification, the nose vanes are extended only when the corresponding aileron is pulled down.

In any of the modifications shown, if the force necessary to pull the aileron down and simultaneously extend the nose vane is excessively large the ailerons may be balanced in the well known manner to any desired

extent in order to suitably reduce the force on the controls.

While the forms of mechanism herein shown and described constitutes preferred forms of embodiment of the invention, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What I claim is as follows:

1. In an airplane having a main wing, a wing flap pivoted thereto at its trailing edge, a movable nose vane positioned in close relation to the entering edge, and common means to lower the wing flap and extend the nose vane.

2. In an airplane having a main wing, a wing flap pivoted thereto at its trailing edge, a movable nose vane positioned in close relation to the entering edge, and common means to lower the wing flap and extend the nose vane, the amount of extension of the nose vane varying with the degree of lowering of the flap.

3. In an airplane having a main wing, a wing flap pivoted thereto at its trailing edge, a movable nose vane positioned in close relation to the entering edge, means to lower the flap small angles independently of the nose vane, and means to extend the nose vane simultaneously with the lowering of the flap to large angles.

4. In an airplane having a supporting wing and an aileron, a movable nose vane located in the proximity of the entering edge of said wing, means to vary the angle of incidence of said aileron relatively small angles independently of the nose vane, and means to extend the nose vane simultaneously with the varying of the angle of incidence of the aileron through large angles.

5. In an airplane having a main wing, a wing flap pivoted thereto at its trailing edge, a movable nose vane positioned in close relation to the entering edge, and means to lower the wing flap and extend the nose vane simultaneously, and additional means to extend the nose vane independently of the operation of the wing flaps.

6. In an airplane having a supporting wing and an aileron, a movable nose vane located in the proximity of the entering edge of said wing, means to vary the angle of incidence of said aileron relatively small angles independently of the nose vane, and means to extend the nose vane simultaneously with the varying of the angle of incidence of the aileron through large angles, and additional means to extend the nose vane independently of the operation of the aileron.

7. In an airplane having right and left supporting wings, movable nose vanes located in the proximity of the entering edges of said right and left wings, and means to extend the nose vane on the right wing without moving the nose vane on the left wing, and vice versa, and additional means to extend the nose vanes on both right and left sides simultaneously when desired.

8. In an airplane having right and left supporting wings, each wing having a wing flap at the trailing edge and a nose vane located in the proximity of the entering edge, and common means for extending the nose vane and lowering the wing flap together on only one side at a time.

9. In an airplane having right and left supporting wings, each wing having a wing flap at the trailing edge and a nose vane located in the proximity of the entering edge, and common means for extending the nose vane and lowering the wing flap together on only one side at a time, the degree of extension of the nose vane varying with the degree of lowering of the flap.

10. In an airplane having right and left supporting wings, each wing having a wing flap at the trailing edge, and a nose vane located in the proximity of the entering edge, and means for independently operating the flaps through small angles and means to extend the corresponding nose vane simultaneously with the lowering of either flap to a large angle.

11. In an airplane having right and left supporting wings, each wing having a wing flap at the trailing edge and a nose vane located in the proximity of the entering edge, and common means for extending the nose vane and lowering the wing flap together on only one side at a time, and independent means to extend the nose vanes on both sides together.

In testimony whereof I hereto affix my signature.

VIRGINIUS E. CLARK.