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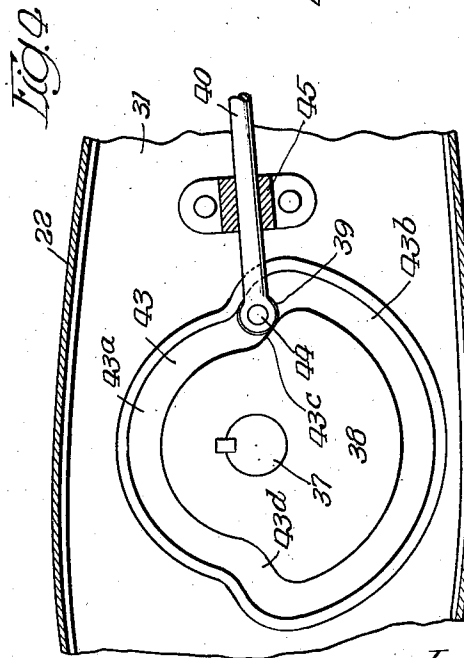
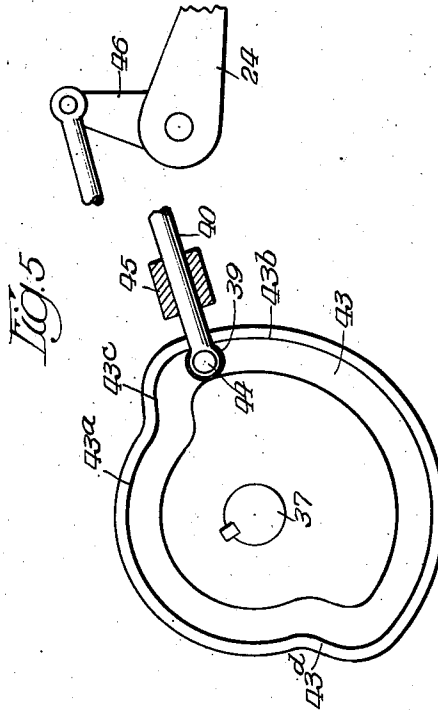
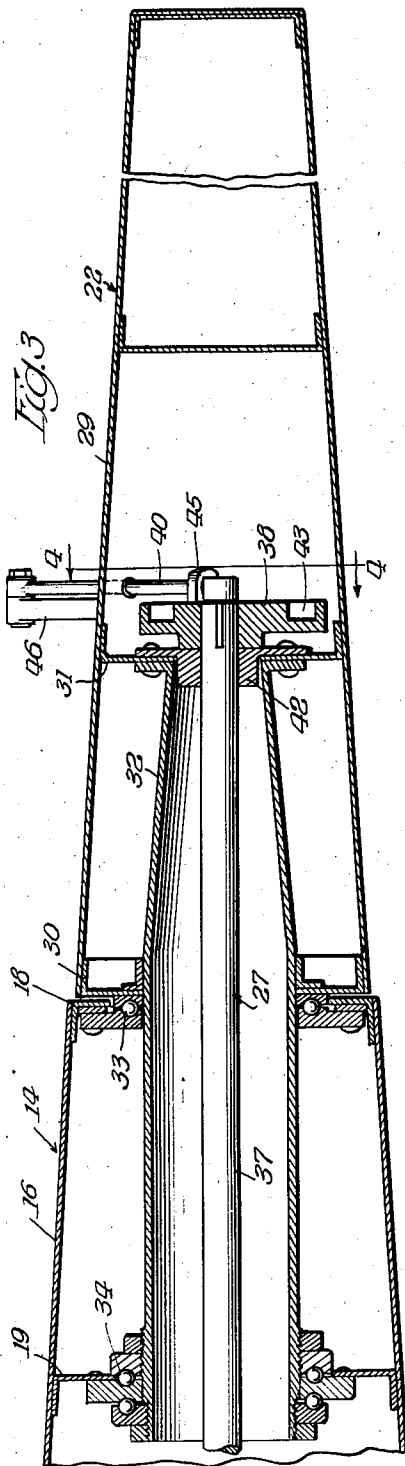
A. J. KLOSE

2,369,832

AIRPLANE AILERON SYSTEM

Filed Dec. 14, 1942

3 Sheets-Sheet 2



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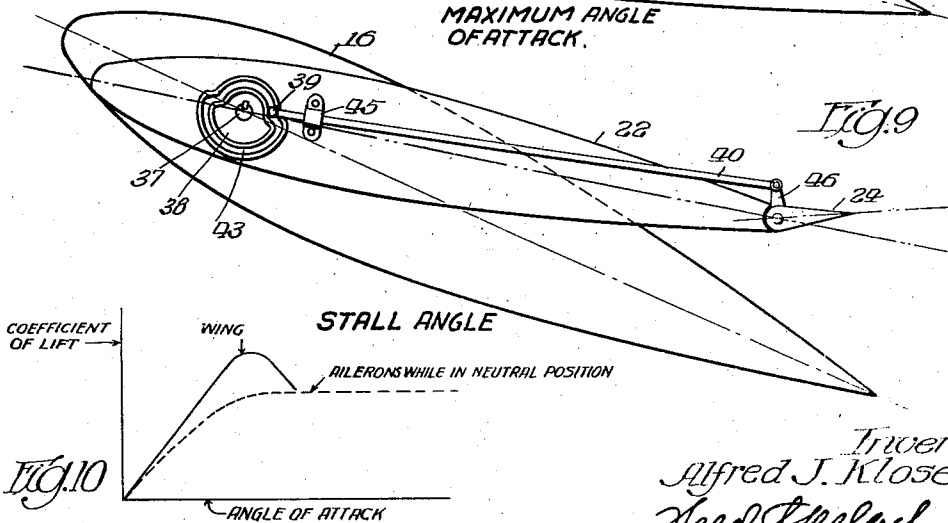
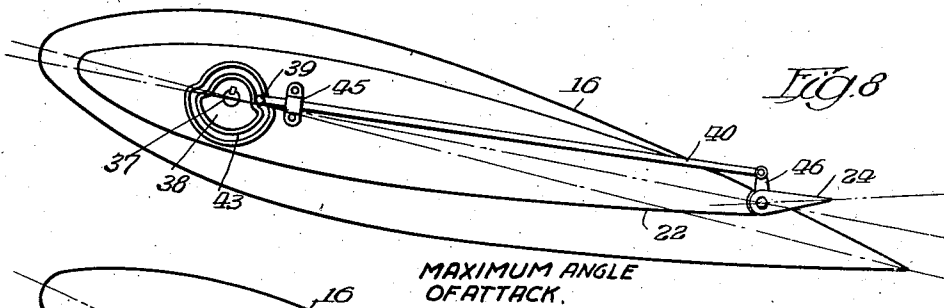
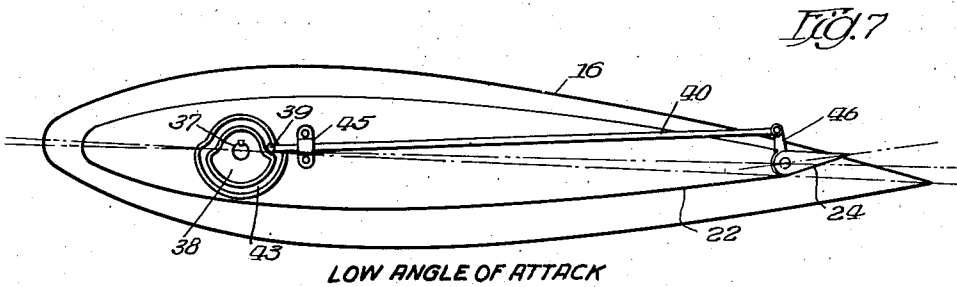
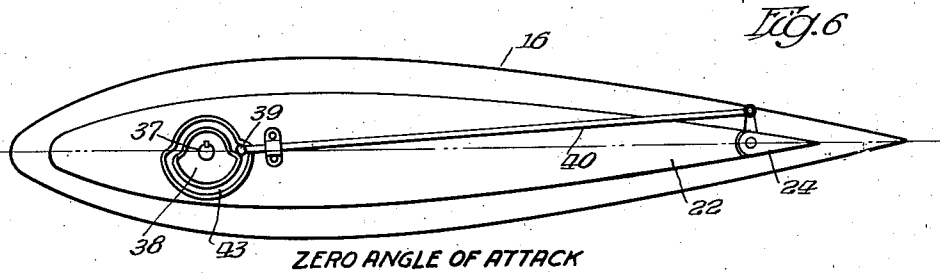
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AIRPLANE AILERON SYSTEM

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,369,832

AIRPLANE AILERON SYSTEM

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craft Corporation, a corporation of Delaware

Application December 14, 1942, Serial No. 468,908

10 Claims. (Cl. 244—90)

The present invention relates generally to aileron systems for airplanes. More particularly the invention relates to that type of system which serves as a medium for controlling lateral stability of the airplane with which it is employed and comprises a pair of freely floating or pivoted ailerons on the tips of the airplane wing, a pair of hinged control tabs in associated relation with the ailerons, a control element in the pilot's compartment, and a pair of operating linkages extending between the control element and the tabs, respectively, and serving when the control element is shifted sidewise in one direction, to tilt one of the tabs upwards and the other downwards and thus cause the aileron to which the one tab is connected to swing downwards and the other aileron to swing upwards and when the control element is shifted by the pilot sidewise in the opposite direction, to shift the one tab downwards and the other upwards and thus effect reverse swinging of the ailerons around their pivot or hinge axes.

One object of the present invention is to provide an airplane aileron system of this type which is an improvement upon, and is more efficient than, previously designed systems of the same general character and, due to its construction and design, affords ready and efficient control for the airplane with which it is employed while at the same time it gives the airplane certain inherent and desirable flying characteristics.

Another object of the invention is to provide an airplane aileron system of the type under consideration in which the operating linkages between the control element and the tabs include cams which are independent of the ailerons and are so designed and arranged that while the control element in the pilot's compartment is in its neutral position in connection with upward flight of the airplane they automatically control the tabs so that the latter in turn cause the ailerons to float at approximately the same angle of attack as the wing, between zero attack angle and the stall angle, and thus contribute materially to the lift of the wing as a whole.

A further object of the invention is to provide an airplane aileron system of the last mentioned character in which the cams that form parts of the operating linkages between the control element and the tabs are so designed that they hold the tabs in fixed angular relation with the ailerons when the angle of attack of the wing is above the stall angle and hence permit the ailerons to assume trim angles relatively to the air

stream in connection with stall flight conditions of the airplane.

A still further object of the invention is to provide an airplane aileron system which is generally of new and improved construction, may be operated with a minimum amount of effort and is characterized by simplicity of design and high efficiency.

Other objects of the invention and the various advantages and characteristics of the present airplane aileron system will be apparent from a consideration of the following detailed description.

The invention consists in the several novel features which are hereinafter set forth and are more particularly defined by claims at the conclusion hereof.

In the drawings which accompany and form a part of this specification or disclosure and in which like numerals of reference denote corresponding parts throughout the several views:

Figure 1 is a perspective of an airplane with an aileron system embodying the invention;

Figure 2 is an enlarged perspective of the left hand aileron showing the manner in which it is pivoted for free floating relatively to the adjacent wing tip and illustrating the design and arrangement of the control tab therefor;

Figure 3 is an enlarged longitudinal section taken on the line 3—3 of Figure 2 and illustrating in detail certain parts of the linkage between the control element in the cockpit of the airplane and the control tab for the left hand aileron;

Figure 4 is an enlarged vertical transverse section taken on the line 4—4 of Figure 3 and illustrating the design and construction of the cam for controlling the tab of the left hand aileron;

Figure 5 is a similar vertical transverse section showing the cam of Figure 4 after it has been rocked by manipulation of the control element so as to cause the control tab to tilt downwards and effect upward swinging of the left hand aileron;

Figure 6 is a diagrammatic view showing the left hand aileron and control tab therefor in the position they assume when the control element in the pilot's compartment is in neutral position and the wing is at its zero angle of attack;

Figure 7 is a diagrammatic section showing the left hand aileron and its control tab in the position they assume when the wing of the airplane is disposed at a low angle of attack;

Figure 8 is a diagrammatic section showing the left hand aileron and its control tab in the position they assume when the airplane wing is

disposed at its maximum attack angle while the control element in the pilot's compartment is in its neutral position;

Figure 9 is a diagrammatic section showing the left hand aileron and its control tab in the position they assume when the airplane wing is disposed at its stall angle; and

Figure 10 is a view showing the coefficient of lift-angle of attack curve for the wing, and the coefficient of lift-angle of attack curve for the ailerons while in their neutral position.

The aileron system which is shown in the drawings constitutes the preferred form or embodiment of the invention. It is illustrated in connection with, and as forming a part of, an airplane 10 and serves as a medium for controlling lateral stability of the airplane. The airplane 10 is of conventional or standard design and illustrates one type of airplane with which the system may be employed. It is of the low wing monoplane type and comprises a fuselage 11, an empennage 12 at the rear end of the fuselage, an engine driven propeller 13 at the front end of the fuselage, and a cantilever type wing 14. The fuselage 11 includes an enclosed pilot's compartment 15 behind the propeller driving engine. The empennage 12 is of conventional construction and includes a pair of elevators for controlling longitudinal stability, and a rudder for turning purposes. The wing 14 constitutes the main sustaining surface for the airplane and consists of a pair of complementary oppositely extending side sections 16 and 17. The side section 16 of the wing projects outwards from the left hand lower central portion of the fuselage and embodies adjacent its outer end a pair of laterally spaced cross ribs 18 and 19. It is of any suitable design or construction and includes one or more longitudinally extending spars (not shown) and a skin around the spar or spars and the cross ribs. The other side section, i. e., the section 17, is connected to, and projects outwards from, the central lower right hand portion of the fuselage 11 and embodies at its outer end a pair of laterally extending cross ribs 20 and 21. It is the same in size as the left hand side section 16 of the wing and also includes one or more longitudinally extending spars and a covering or skin over and around the spar or spars and the cross ribs. The ribs 18 and 20 of the two side sections have flat, vertically extending, outer faces and constitute the outer extremities or tips of the wing 14.

As its component parts the improved aileron system comprises a pair of floating ailerons 22 and 23 outwards of the tips of the two wing sections, a pair of aileron controlling tabs 24 and 25, a tab control element 26 in the pilot's compartment 15, and a pair of linkages 27 and 28 between the control element and the tabs, respectively, for operating or actuating the tabs in response to shift of the control element. The aileron 22 is disposed outwards of the left hand side section 16 of the wing 14 and is in the nature of a continuation thereof. It is adapted, when swung upwards in connection with conjoint downward swing of the other aileron, to cause right hand tilting or clockwise rotation of the airplane and operates, when swung upwards in connection with downward swing of the aileron 23, to effect opposite or left hand tilting of the airplane. The tab 24 is associated with, and serves as the controlling medium for, the aileron 22. The aileron 23 is in the nature of a continuation of the right hand side section 17 of

the wing 14 and is controlled by the tab 25, as hereinafter described. The two ailerons are adapted to swing in opposite directions in response to control movements of the control element 26 and when the control element is in its neutral position in connection with ascension or descension of the airplane 10 move conjointly in the same direction under control of their respective tabs as hereinafter described.

The aileron 22 is of airfoil cross section and comprises a longitudinal series of laterally spaced cross ribs and a surrounding skin 29. The innermost cross rib of the aileron 22 has the reference numeral 30 applied to it and is disposed immediately adjacent the cross rib 18 of the side section 16 of the wing 14. The next innermost cross rib is designated by the reference numeral 31 and is disposed in parallel relation with the rib 30. The aileron 22 is mounted for floating or free pivotal movement relatively to the side section 16 of the wing 14 by way of a tubular member 32. This member extends longitudinally of the wing and enables the aileron 22 to swing upwards and downwards. The outer end of the member 32 extends through holes in, and is fixedly secured to, the front central portions of the cross ribs 30 and 31. The inner end of the member projects into the outer end of the side section 16 of the wing 14 and is journaled in a pair of roller bearings 33 and 34. These two bearings are carried respectively by the cross ribs 18 and 19, as shown in Figure 3. The tubular member 32 is so positioned that the aileron 22 is statically and dynamically stable. It is, however, disposed forwards or ahead of the aerodynamic center of the aileron 22 with the result that when the airplane is travelling in such manner that the angle of attack of the wing 14 is zero the aileron 22 is maintained by the air strain coplanar or in alignment with the wing side section 16. The control tab 24 extends along, and is preferably coextensive with, the trailing edge of the aileron 22. It is suitably hinged to the aileron 22 so that it is capable of being tilted upwards and downwards relatively thereto. During normal flying conditions when the aileron 22 is in alignment with the side section 16 of the wing the control tab 24 is in centered relation with the aileron 22 and its trailing edge is aligned with the trailing edge of the wing side section 16. The aileron 22 is supported wholly by the tubular member 32 and the roller bearings therefore and is controlled solely by tilting of the tab 24. It is essentially floating or freely pivoted and is not capable of any direct control from the pilot's compartment 15 or any other station within or on the airplane. When the control element 24 is tilted downwards relatively to the aileron 22 the aileron swings upwards relatively to the wing side section 16, as shown in Figure 2. When the tab 24 is tilted upwards, as hereinafter described, the aileron 22 is depressed, i. e., it is caused to swing downwards relatively to the wing side section 16.

The aileron 23 is the same in design and construction as the aileron 22 except that it is the complement of the latter. It is in the nature of a continuation of the right hand section 17 of the wing 14 and is mounted for free floating or pivotal movement relatively to said side section 17 by way of a tubular element 35. The latter is longitudinally or axially aligned with the aileron supporting member 32 and has the inner end thereof journaled in roller bearings on the two outermost cross ribs of the wing side

section 17. The outer end of the member 35 extends through holes in, and is fixedly secured to, the two innermost ribs of the aileron 23. Said member 35 serves to make the aileron 23 statically and dynamically stable about its pivot axis and is located ahead of the dynamic center of the aileron 23 so that the latter functions or floats similarly to the aileron 22. The tab 25 extends along, and is hinged to, the trailing edge of the aileron 23 and is adapted to tilt upwards and downwards relatively to such aileron. When the tab 25 is tilted upwards relatively to the aileron 23 such aileron swings downwards and when the tab 25 is tilted downwards the air stream impinges against it and causes the aileron 23 to swing upwards.

The control element 26 is shown in Figure 1 of the drawings as being of the "joystick" variety. It is located in the front portion of the pilot's compartment 15 and has a cross arm 36 at its lower end. It, together with the linkages 27 and 28, serves as a medium for tilting the two tabs 24 and 25 in opposite directions. The cross arm 36 extends transversely of the fuselage. The element 26 is pivotally supported in any suitable manner so that it is permitted to swing or rock laterally. The linkages 27 and 28, as hereinafter described, are so designed that when the control element 26 is shifted to the left the tab 24 is tilted downwards relatively to the aileron 22 and the tab 25 is tilted upwards relatively to the aileron 23. When the control element 26 is shifted to the right the tab 24 is tilted upwards relatively to the aileron 22 and the tab 25 is tilted downwards relatively to the aileron 23. Downward tilt of the tab 24 and upward tilt of the tab 25 result in upward swinging of the aileron 22 and downward swinging of the aileron 23 and cause the airplane to tilt to the left. Reverse tilting of the two tabs causes the aileron 22 to swing downwards and the aileron 23 to swing upwards and results in the airplane 10 tilting or rolling on its longitudinal axis to the right.

The linkage 27 serves operatively to connect the control element 26 to the control tab 24 for the left hand aileron 22 and comprises as its principal parts a rock shaft 37, a cam 38, a cam follower 39, and a link 40. The rock shaft 37 extends through and longitudinally of the left hand side section of the wing 14 and has a depending, radially extending arm 41 at its inner end. The outer end of the rock shaft extends through the tubular member 32 and is journaled in a bearing 42 at the outer end of said member. The outer extremity of the rock shaft 37 projects beyond the bearing 42 and has the cam 38 keyed or otherwise fixedly secured thereto, as shown in Figure 3. The cam is of the plate variety. It extends transversely of the rock shaft 37 and has in the outer face thereof a continuous cam groove 43. The cam follower 39 is in the form of a roller and is adapted to travel in the cam groove 43. It is mounted on a laterally extending pivot pin 44 on one end of the link 40 and operates in connection with travel thereof in the cam groove positively to shift the link 40 lengthwise. The link extends rearwards from the outer end or extremity of the rock shaft 37 and is disposed outwards of the cross rib 31 of the aileron 22. It is mounted for longitudinal sliding movement in the bearing 45 and projects through a hole in the skin 29 of the aileron 22. The pivot pin 44 for the roller type cam follower 39 is fixed to the front end of the link 40. The rear end of the link is pivotally connected to the upper end

of a fixed upstanding horn 46 on the tab 24. The cam groove 43 consists of an upper substantially semi-circular portion 43^a of comparatively small radius, a lower substantially semi-circular portion 43^b of greater radius and with the same center as the portion 43^a, an oblique portion 43^c between the ends of the portions 43^a and 43^b at the rear portion of the groove, and an oblique portion 43^d between the other or front ends of the semi-circular or arcuate portions 43^a and 43^b. The common center of the arcuate portions 43^a and 43^b of the cam groove coincides with the pivot axis of the floating aileron 22. As shown in Fig. 5, the cam groove 43 is symmetrical. The rear ends of the semi-circular portions 43^a and 43^b and the oblique connecting portions 43^c only function or coact with the cam follower 39. The front ends of the portions 43^a and 43^b and the oblique portion 43^d between the front ends of such portions are non-functional. The link 40 is of such length that when the tab 24 is in its normal trailing position the roller type cam follower 39 is disposed in the central part of the oblique portion 43^c of the cam groove 43, as shown in Figure 6. When the cam 38 is turned relatively to the wing 14 in a clockwise direction as viewed in Figures 4 and 6 the cam follower 39 is urged or forced inwards towards the rear end of the portion 43^a of the cam groove and when the cam is reversely rotated, i. e., in a counterclockwise direction relatively to the wing, the roller type follower is urged rearwards or outwards towards the rear end of the portion 43^b of the cam groove 43. Forward or inward shift of the cam follower in response to clockwise rotation of the cam results in the link 40 tilting upwards the control tab 24, and rearward or outward movement of the cam follower causes the link 40 to shift rearwards and depress or tilt downwards the tab 24 relatively to the aileron 22. The rock shaft 37 of the linkage 27 is operatively connected to the control element 26 by way of the radially extending depending arm 41 and a cable 47. The ends of the cable are connected to the ends of the cross arm 36 at the lower end of the control element 26. As shown in Figure 1 of the drawings, the cable 47 extends downwards from the left hand end of the cross arm 36, then passes around a vertical sheave 48, then extends rearwards past and beneath the inner end of the rock shaft 39, then passes around a horizontal sheave 49, then extends transversely of the fuselage toward the right hand side thereof, then passes around a horizontal sheave 50, then extends forwards, then passes around a vertical sheave 51, and then extends upwards to the right hand end of the cross arm 36. The sheaves 48 and 50 are axially aligned and the sheaves 49 and 51 are horizontally and transversely aligned. The lower end of the depending radially extending arm 41 at the end of the rock shaft is anchored to the portion of the cable 47 that extends between the sheaves 48 and 49. When the control element is shifted to the left the arm 41 is caused to swing rearwards and results in the rock shaft and cam being rotated or turned in a counterclockwise direction as viewed in Figures 4 and 6. Counterclockwise rotation of the cam 39 operates to tilt the tab 24 downwards and causes upward swing of the aileron 22. Sidewise shift of the control element 26 to the right causes the arm 41 to swing forwards and this results in clockwise rotation or turning of the rock shaft and cam as viewed in Figures 4 and 6. As heretofore

pointed out, clockwise turning of the cam causes the tab 24 to tilt upwards and the aileron 22 to swing downwards. Downward swing of the aileron results from the impingement of air on the upwardly tilted tab 24 in connection with forward propulsion of the airplane, as well understood in the art.

When the control element 26 is in its neutral position the cam 39 remains stationary and if the floating aileron 22 is in a horizontal position the cam follower 39 is in the central part of the connecting portion 43^c of the cam groove 43 and the tab 24 is in its normal trailing position. Should the operator, by manipulation of the elevators of the empennage, cause the angle of attack of the wing 14 to increase from zero toward the stall angle, the resultant tilting of the wing relatively to the aileron 22 causes clockwise displacement of the cam 29 and results in the tab 24 being tilted upwards (see Figures 7, 8 and 9). Upward tilting of the tab results in the floating aileron 22 swinging downwards and assuming an angle of attack corresponding substantially to the angle of attack of the wing. The inner part of the oblique portion 43^c of the cam groove is so canted or angled that the tab 24 is caused progressively to tilt upwards in conformity with progressive increase in the angle of attack of the wing up to the stall point with the result that the aileron 22 automatically follows, and assumes substantially the same position as the wing between zero angle and the stall angle. When the wing reaches or goes beyond its stall angle (see Figure 9) the cam follower 39 moves into the rear end of the semicircular portion 43^a of the cam groove. Since this particular portion is in concentric relation with the pivot axis of the aileron 22 there is no further movement of the tab with respect to the aileron 22 and the latter floats freely in a so-called trim position even though the wing 14 assumes a much greater angle than its stall angle. In connection with dive of the airplane the wing 14 tilts downwards, i. e., it assumes a negative attack angle. As the wing tilts downwards the cam 39 is caused to rotate in a counterclockwise direction as viewed in Figures 4 and 6 and this results in the tab 24 tilting downwards and causing upward swing of the aileron. The shape or design of the rear or outer part of the oblique portion 43^c of the cam groove 43 is such that the tab 24 is caused progressively to tilt downwards in response to downward tipping or tilting of the main wing. This results in the aileron 22 following, or assuming approximately the same angular position as, the wing during dive of the airplane up to a predetermined point. When the airplane is caused to dive at a sharp downward angle the cam follower 39 enters the rear end of the semicircular portion 43^b of the cam groove 43 and since such portion is concentric with the pivot axis of the aileron 22 there is no further downward tilting of the tab after the wing is tilted downwardly to a predetermined angle and any further downward tilting of the wing in connection with a dive results in the aileron assuming what may be termed a negative trim angle. The cam 39, when rocked relatively to the wing in one direction, results in swinging of the aileron 22 in one direction and when rocked in the reverse direction results in reverse swinging of the aileron 22, as hereinbefore described. When the cam is in fixed relation with the wing 14 due to the control element 26 being maintained in its neutral position the cam operates automatically to cause the aileron 22 to fol-

low, and assume substantially the same angular position as, the wing during upward or downward tilting of the wing up to predetermined positive or negative angles of attack. When the wing reaches or goes beyond its stall angle or reaches or goes beyond a maximum dive angle the cam has no effect on the aileron 22 and the latter, instead of continuing to follow the angular position of the wing, remains in a trim or fixed position with respect to the air stream.

The linkage 28 for controlling the tab 25 in response to control movements of the control element 26 in the pilot's compartment of the airplane is the same as the linkage 27 and functions or operates in a corresponding manner. It is positioned in opposed relation with the linkage 27 and comprises a rock shaft 52, a cam 53, a cam follower 54, and a link 55. The rock shaft 52 is disposed within, and extends longitudinally through, the right hand side section 17 of the wing 14 and is axially aligned with the rock shaft 37 of the linkage 27. The inner end of the rock shaft 52 is provided with a depending, radially extending arm 56 and this has the lower end thereof connected to the portion of the cable 47 that extends between the sheaves 50 and 51, as shown in Figure 1. The outer end of the rock shaft 52 extends through and is centrally positioned with respect to the tubular element 35 constituting the pivot medium for the right hand aileron 23. The extremity or extreme outer portion of the rock shaft 52 has connected or otherwise fixedly secured thereto the cam 53. The latter has a cam groove like cam groove 43 of the cam 38. Because the cams 38 and 53 are the same in design and construction they are interchangeable. The cam follower 54 is disposed in the cam groove and is carried by the front end of the link 55. The latter extends rearwards and has its rear end pivotally connected to an upstanding horn 57 on the control tab 25. The cam 53 functions in precisely the same manner as the cam 38 and operates when turned in one direction to tilt the tab associated therewith upwards and when turned in the opposite direction to tilt the tab downwards. Since the groove in the cam 53 is exactly the same as the cam groove 43 the tab 25 is automatically controlled so as to cause the aileron 23 to follow, and assume approximately the same angular position as the wing 14 during movement of the latter between zero angle of attack and is stall angle. The tab 25 also is controlled automatically by the cam so that it causes the aileron 23 to assume approximately the same angular position as the wing 14 during downward tilting thereof to a predetermined point in connection with dive of the airplane 10. By reason of the fact that the depending arm 41 on the inner end of the rock shaft 37 of the linkage 27 is connected to the portion of the cable 47 that is between the sheaves 48 and 49 and the arm 56 at the inner end of the rock shaft 42 of the linkage 28 is connected to the portion of the cable that is between the sheaves 50 and 51 and such portions of the cable move in opposite directions in connection with lateral shift of the control element 26 the two rock shafts are caused reversely to rock in connection with sidewise shift of the control element.

When it is desired to roll the airplane to the left in connection with flight thereof the pilot swings the control element 26 to the left. This results in counterclockwise turning of the rock shaft 37, as viewed in Figure 1, and clock-

wise turning of the rock shaft 52. In response to counterclockwise turning of the rock shaft 37 the tab 24 is tilted downwards and results in the aileron 22 swinging upwards. In connection with clockwise turning of the rock shaft 52 the tab 25 is caused to tilt upwards relatively to the aileron 23 and the air stream impinging thereagainst results in such aileron swinging downwards. Banking or rolling of the airplane to the right is effected by swinging or shifting the control element 26 to the right. Such swinging of the control element results in the tab 24 tilting upwards and causing the aileron 22 to swing downwards and the tab 25 tilting downwards and causing the aileron 23 to swing upwards. When the airplane 10 is laterally stable, i. e., in lateral equilibrium and is flying horizontally the two ailerons are horizontally disposed and assume substantially the same angular position as the wing. Should the airplane be caused to climb the ailerons 22 and 23 follow the wing and assume approximately the same angular position between zero angle of attack and the stall angle. This is due to the fact that upward tilting or swinging of the wing 14 relatively to the two ailerons turns both cams in a clockwise direction as viewed in Figures 7 to 9, inclusive, and such turning of the cams effects upward tilting of the two tabs and resultant downward swinging of the ailerons. The two ailerons follow the wing up to the stall angle. When such angle is reached or exceeded the cam followers of the linkages travel into the upper semi-circular portions of the cam grooves and hence result in no further upward tilting of the tabs. When the cam followers are in such portions of the cam grooves the angular position of the tabs and ailerons is fixed and the ailerons hence remain in a fixed trim angle with respect to the air stream. When the airplane 10 is in lateral equilibrium and is caused to dive the two cams turn in a counterclockwise direction relatively to the ailerons and such turning of the cams results in downward tilting of the two tabs and the ailerons swinging upwards and assuming substantially the same negative angle of attack as the wing. The ailerons follow the wing during diving of the airplane until the cam followers ride or travel into the semi-circular bottom portions of the cam grooves. At such time the angular position of the tabs and the ailerons becomes fixed and the ailerons remain in a fixed negative trim angle with respect to the air stream, regardless of any further increase in the negative angle of attack of the wing. Because of the fact that the ailerons, while in neutral position, automatically follow, and assume substantially the same angle of attack as, the wing from zero angle to approximately the stall angle, they contribute materially to the lift of the wing as a whole. This is shown or illustrated by the curves constituting Figure 10. By referring to Figure 10 it is apparent that the lift of the wing increases in a normal manner to the maximum point after which the added increase of the angle of attack causes the wing to stall. As shown by the dotted line or curve in Figure 10, the lift of the ailerons, while the latter are in their neutral position, increases almost as rapidly as the lift of the wing as the angle of attack is increased; at a point somewhat below maximum lift the ailerons level off and maintain a constant lift coefficient.

The herein described aileron system is essentially simple in design and highly efficient. It may be operated or actuated with a minimum amount of effort on the part of the pilot and ef-

fectively fulfills its intended purpose by reason of the fact that it includes means for automatically causing the floating ailerons to assume substantially the same angle of attack as the wing up to predetermined positive and negative angles of attack. By reason of the fact that the floating ailerons are disposed outwards of the wing tips it is possible to employ in connection with the airplane, flaps or high lift surfaces of substantially the full wing span. Since the two cams are exactly the same they may be used interchangeably and it is not necessary to have special right and left hand cams for the two tab controlling linkages.

Whereas the system has been described as an aileron system it is to be understood that it may be used in connection with floating type control surfaces other than ailerons. It is also to be understood that the invention is not to be restricted to the details set forth since these may be modified within the scope of the appended claims without departing from the spirit and scope of the invention.

Having thus described the invention what I claim as new and desire to secure by Letters Patent is:

1. In combination with an airplane having a wing for sustaining purposes, an aileron pivotally supported adjacent the wing and adapted to float freely relatively thereto, and a tiltable tab carried by the aileron and adapted in response to tilting during flight of the airplane to control the angular position of said aileron with respect to the air stream, a system for controlling the tab comprising a movably mounted pilot actuated element, and a linkage between the element and tab, adapted to tilt the tab in response to movement of the element and including means whereby, when the element is in its neutral position and the wing is caused, in connection with flight, to change its angle of attack from zero to a predetermined positive or negative angle, the tab is automatically tilted so that it causes the aileron to follow, and assume substantially the same angle of attack as, the wing.

2. In combination with an airplane having a wing for sustaining purposes, an aileron pivotally supported adjacent the tip of the wing and between its leading and trailing edges and adapted to float freely relatively to the wing, and a tab hinged to the trailing edge of the aileron and adapted in response to tilting during flight of the airplane to control the angular position of said aileron with respect to the air stream, a system for controlling the tab comprising a movably mounted pilot actuated element, and a linkage between the element and tab, adapted to tilt the tab in response to movement of the element and including means whereby, when the element is in its neutral position and the wing is caused, in connection with flight, to change its angle of attack between zero and approximately stall, the tab is automatically tilted so that it causes the aileron to follow, and assume substantially the same angle of attack as, the wing.

3. In combination with an airplane having a wing for sustaining purposes, an aileron pivotally supported adjacent the wing so that it is free to float relatively thereto, and a hinged tab carried by the aileron and adapted in response to tilting thereof relatively to the aileron during flight of the airplane to control the angular position of the aileron with respect to the air stream, a control system for the tab comprising a movably mounted pilot actuated element, and a linkage between

the element and the tab, adapted to tilt the tab in response to movement of the element and including means whereby when the element is in its neutral position and the wing is at an angle of attack between zero and predetermined positive and negative angles of attack in connection with flight of the airplane the tab is automatically tilted so as to cause the aileron to assume substantially the same angle of attack as the wing, and when the element is in its said neutral position and said wing is positioned at a greater angle of attack than said predetermined positive and negative attack angles in connection with flight of the airplane the tab is automatically retained in a fixed angular or tilted position with respect to the aileron and retains the latter at a substantially fixed trim angle relatively to the air stream.

4. In combination with an airplane having a fixed wing for sustaining purposes, an aileron pivotally supported adjacent the tip of the wing and between its leading and trailing edges and adapted to float freely relatively to the wing, and a tab hinged to the trailing edge of the aileron and adapted in response to tilting during flight of the airplane to control the angular position of said aileron with respect to the air stream, a control system for the tab comprising a movably mounted pilot actuated element, and a linkage between the element and the tab, adapted to tilt the tab in response to movement of the element and including cam means whereby when the element is in its neutral position and the wing is at an angle of attack between zero and the stall angle in connection with flight of the airplane the tab is automatically tilted so as to cause the aileron to assume substantially the same angle of attack as the wing, and when the element is in its said neutral position and said wing is positioned at an angle of attack above the stall angle the tab is automatically retained in a fixed angular position with respect to the aileron and maintains the aileron at a trim angle with respect to the air stream.

5. In combination with an airplane having a substantially horizontal sustaining surface, an airfoil for airplane controlling purposes pivotally supported adjacent the surface and adapted to float freely relatively to said surface, and a tab carried by the airfoil to tilt relatively thereto and adapted in response to tilting during flight of the airplane to control the angular position of the airfoil, a tab control system comprising a movably mounted pilot actuated element, and a linkage between the element and the tab, adapted to tilt the tab in response to movement of the element and including means whereby when the element is in a neutral position and the sustaining surface is at an angle of attack between zero and the stall the tab is automatically tilted so as to cause the airfoil to assume substantially the same angle of attack as the sustaining surface, and when said element is in its said neutral position and said surface is positioned at an angle of attack above the stall angle the tab is retained in a fixed angular position with respect to the airfoil and maintains the airfoil at a fixed trim angle with respect to the air stream.

6. In combination with an airplane having a fixed wing for sustaining purposes, an aileron pivotally supported adjacent the tip of the wing and between its leading and trailing edges and adapted to float freely relatively to the wing, and a tab hinged to the trailing edge of the aileron and adapted in response to tilting relatively to the

aileron during flight of the airplane to control the angular position of said aileron with respect to the air stream, a control system for the tab comprising a movably mounted pilot actuated element, and an operating linkage between the element and the tab, adapted to tilt the tab in response to movement of the element and including a cam in concentric relation with, and rotatable about, the pivot axis for the aileron, said cam being adapted to remain stationary with respect to the wing when the element is in a neutral or non-tab-actuating position and being so designed and operatively connected to the tab that when the element is in its neutral position and the wing is caused, in connection with flight, to change its angle of attack from zero to approximately stall, it automatically effects such tilting of the tab as to cause the aileron to assume substantially the same angle of attack as the wing, and being further so designed that when the element is in its said neutral position and the wing is caused to increase its angle of attack above the stall angle it automatically retains the tab in a fixed angular position with respect to the aileron and hence maintains the aileron at a trim angle with respect to the air stream.

7. In combination with an airplane having a wing for sustaining purposes, an aileron pivotally supported adjacent the wing and between its leading and trailing edges and adapted to float freely, and a tab hinged to the trailing edge of the aileron and adapted in response to tilting relatively to the aileron during flight of the airplane to control the angular position of said aileron with respect to the air stream, a system for controlling the tab comprising a cam mounted to rotate about the pivot axis of the aileron, pilot actuated means for turning the cam relatively to the wing, a cam follower in operative engagement with the cam, and an operating connection between the cam follower and the tab and operative to tilt the tab relatively to the aileron in response either to turning of the cam relatively to the wing or relative turning of the cam and aileron, and said cam being so designed that when it is in a neutral stationary position with respect to the wing and said wing is caused to change its angle of attack to a predetermined extent in connection with flight of the airplane it causes the tab to tilt into a position wherein the aileron assumes substantially the same angle of attack as the wing.

8. In combination with an airplane having a wing for sustaining purposes, an aileron pivotally supported adjacent the wing and adapted to float freely, and a hinged tab associated with the aileron and adapted in response to tilting relatively to the aileron during flight of the airplane to control the angular position of said aileron with respect to the air stream, a system for controlling the tab comprising a cam mounted to rotate about the pivot axis of the aileron, pilot actuated means for turning the cam relatively to the wing, a cam follower in operative engagement with the cam, and an operating connection extending between the cam follower and the tab and operative to tilt the tab relatively to the aileron in response either to turning of the cam relatively to the wing or to relative turning of the cam and aileron, said cam being so designed that when it is in a neutral stationary position with respect to the wing and said wing is caused in connection with flight to change its angle of attack from zero to stall it effects tilting of the tab into a position wherein it causes the aileron to assume substantially the

same angle of attack as the wing and being also so designed that when it is in its said neutral stationary position with respect to the wing and such wing is caused to increase its angle of attack above the stall angle it positively maintains the tab in a fixed tilted position with respect to the aileron.

9. In combination with an airplane having a sustaining surface, an airfoil for airplane controlling purposes pivotally supported adjacent the surface and adapted to float freely relatively to said surface, and a tab carried by the airfoil to tilt relatively thereto and adapted in response to tilting during flight of the airplane to control the angular position of the airfoil with respect to the air stream, a control system for the tab comprising a cam in concentric relation with the pivot axis of the surface and having a concentric arcuate portion, a concentric arcuate portion of different radius than the first mentioned portion and an oblique connecting portion between certain ends of the two arcuate portions, a cam follower in operative engagement with the cam, and an operating connection between the cam follower and the tab, said cam follower being adapted in response to relative turning of the cam and airfoil to travel along said portions of the cam and in addition being arranged so that it is in engagement with the central part of the oblique portion of the cam when the tab is in its neutral or non-tilted position with respect to the airfoil.

10. In combination with an airplane having a fuselage with a pilot's compartment therein, a sustaining surface, an airfoil for airplane controlling purposes pivotally supported adjacent the surface and adapted to float freely relatively to said surface, and a tab carried by the airfoil to tilt relatively thereto and adapted in response to tilting during flight of the airplane to control the angular position of the airfoil with respect to the air stream, a control system for the tab comprising a cam mounted to turn or rotate about the pivot axis of the airfoil and having a concentric arcuate portion, a second concentric arcuate portion with a different radius than the first mentioned arcuate portion and an oblique portion between, and serving to connect, certain ends of the two arcuate portions, a cam follower in operative engagement with the cam, an operating connection between the cam follower and the tab, and means for turning the cam from the pilot's compartment, said cam follower being adapted in response to turning of the cam relatively to the airfoil to travel along said portions of the cam and effect tilting of the tab and in addition being arranged so that it is in engagement with the central part of the oblique portion of the cam when the tab is in its neutral or non-tilted position relatively to the airfoil.

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