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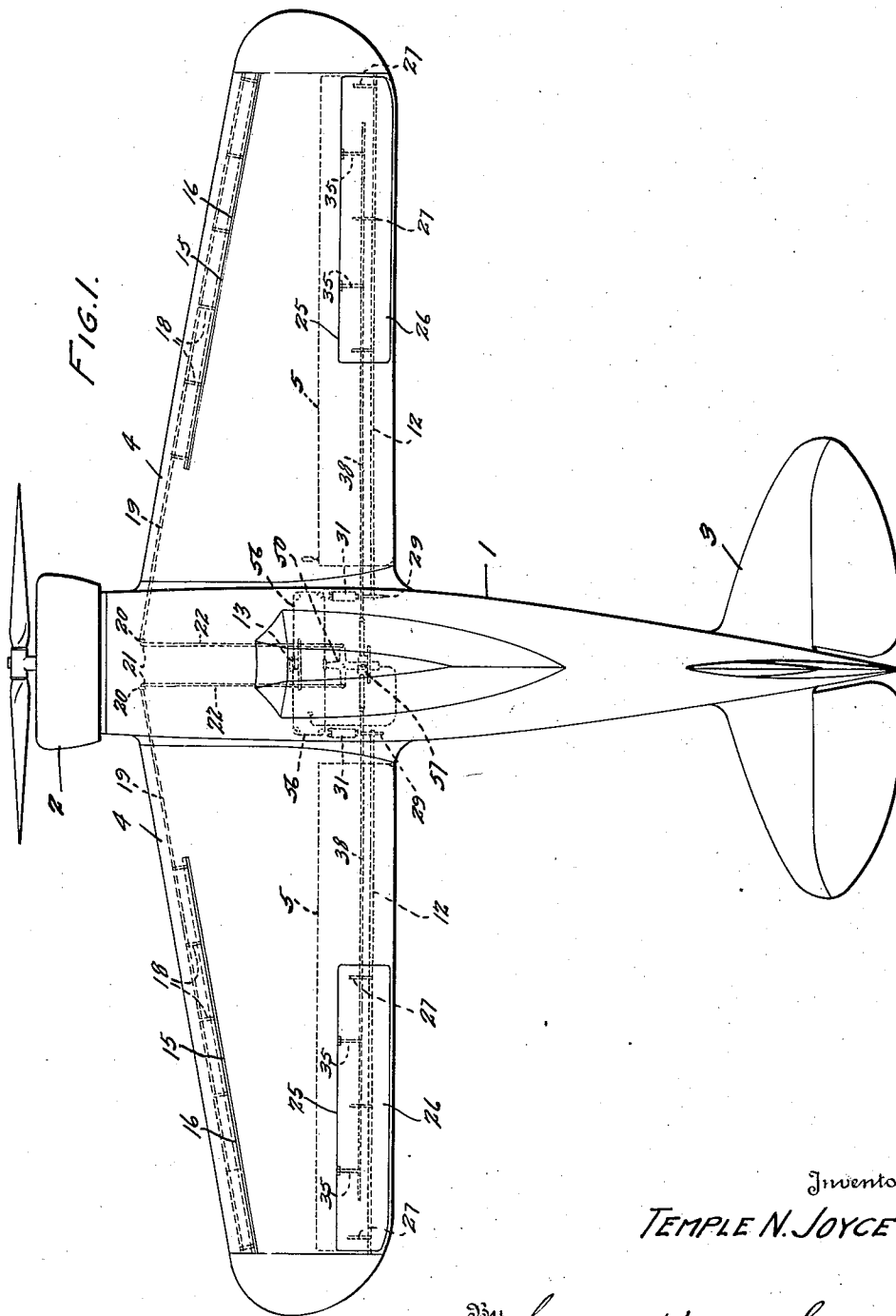
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2,263,992

CONTROL SYSTEM FOR AIRPLANES

Filed March 16, 1939

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

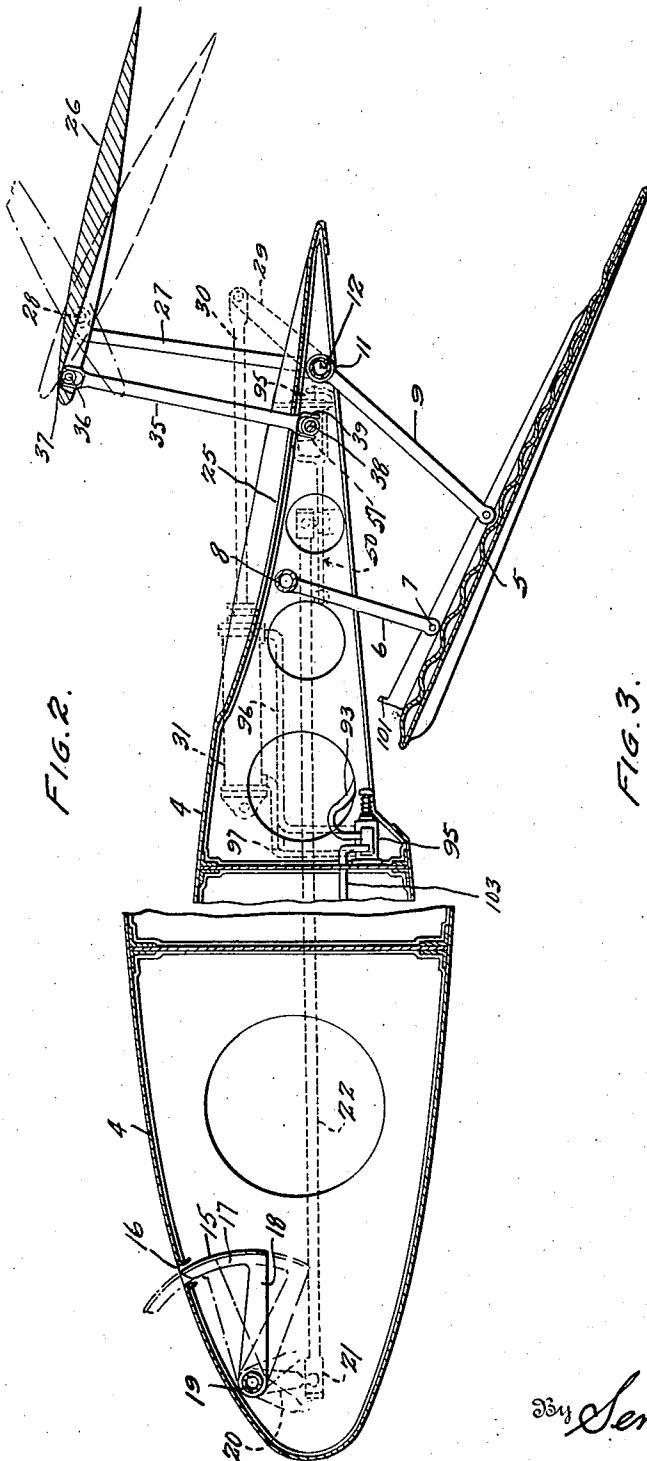
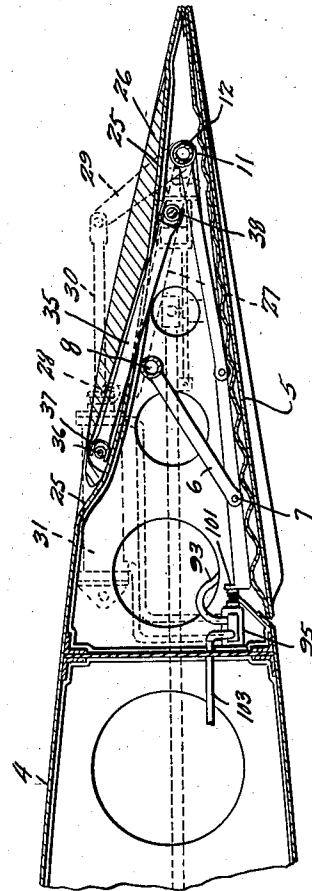


FIG. 3.



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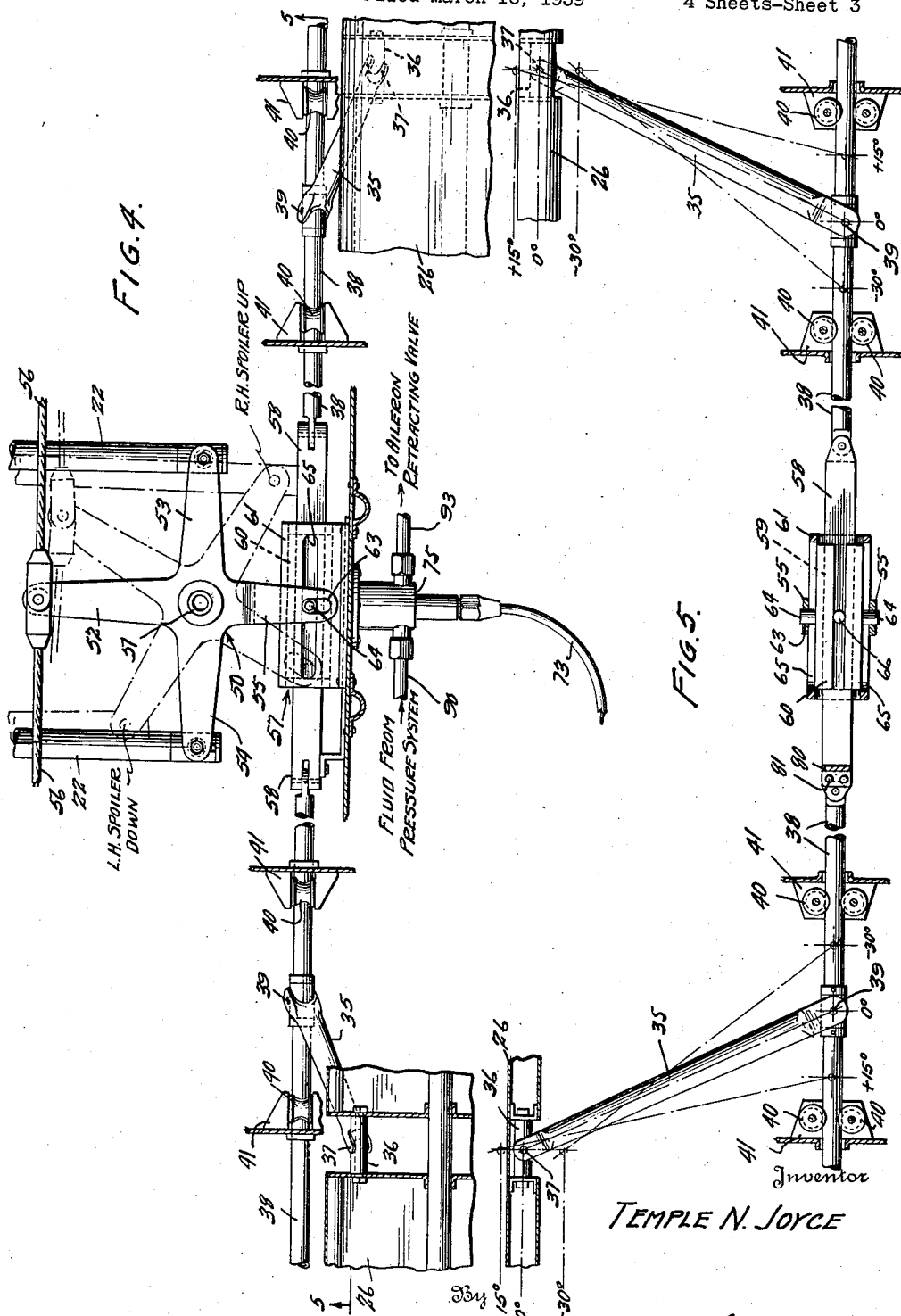
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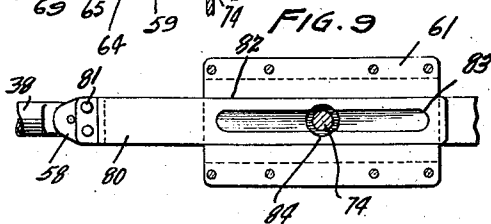
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UNITED STATES PATENT OFFICE

2,263,992

CONTROL SYSTEM FOR AIRPLANES

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Application March 16, 1939, Serial No. 262,264

8 Claims. (Cl. 244—90)

The present invention relates to airplanes and more particularly to a control system for airplanes. This invention is generally similar to that disclosed in my co-pending application, Serial No. 220,359, filed July 20, 1938, but constitutes an improvement thereover.

It is of course well known that it is advisable to employ wings in which the ratio of maximum lift to minimum drag that can be obtained is relatively large. At the present time wing flaps are being used to increase that ratio of a wing by increasing the maximum lift obtainable without the necessity of increasing the minimum drag any appreciable amount. Moreover, wings of variable camber and variable area are also resorted to in an endeavor to secure an increase in this ratio.

The constructions above set forth are not particularly desirable in view of the fact that they are somewhat complex in structural detail and the cost of manufacture of such constructions is so high as to render their use prohibitive. In addition, another undesirable factor is that the flaps conflict with the ailerons and thereby hinder the efficiency of either or both of these control surfaces.

An object of the present invention is to provide means to increase the efficiency of the lifting and lateral control surfaces of an airplane.

Another object of the present invention is to provide an airplane with proper lateral control at both high and low speeds.

Yet another object of the present invention is to provide a flap and aileron combination which will permit the use of full-span flaps.

And still a further object of the present invention is to provide a wing having spoiler, flap and aileron surfaces in which the aileron cannot be operated so long as the flap is in its nested or inoperative position.

Yet a further object of the present invention is to provide an aileron which is under positive control at all times.

A still further object of the present invention is to provide a wing having an aileron that is adapted to be moved into the slip stream about the wing which is provided with means to prevent fluttering of the aileron during its movement into and out of the slip stream.

And yet a still further object of the present invention is to provide a wing having an aileron that is adapted to be moved into the slip stream with means which will prevent the aileron from being moved from the slip stream into its in-

operative position except when the aileron is in its neutral position.

To accomplish the above and other important objects, my invention in general embraces the idea of providing a wing with spoiler, flap and aileron surfaces that are suitably associated with each other.

When the airplane is flying at high speeds the flap and aileron are in their nested or inoperative positions, and it is impossible to move the aileron to its operative position so long as the flap is in its inoperative position. However, at the same time the spoilers can be actuated by the pilot of the plane to give the necessary lateral control to the ship. This arrangement is highly desirable since it will prevent the ailerons being ripped off or otherwise damaged or adversely affected by ice.

On the other hand, however, when the ship is flying at low speeds and the flap is lowered the aileron is moved into the slip stream and can then be actuated to give the necessary lateral control. The type aileron used (an aileron adapted to be moved into the slip stream above the upper contour of the wing surface) is highly effective at low speeds due to the fact that it lies in a stimulated flow of air over the top surface of the wing that is caused by the lowering of the flap. Therefore, any movement of the aileron surface has an increased effect on the lateral movement of the wing. In addition, in the present invention there is provided an arrangement whereby the aileron is under positive control at all times and fluttering of the ailerons is prevented during its extension into the slip stream or its retraction into its nest within the wing.

Moreover, the aileron cannot be retracted except when it is in its neutral position.

In order to make my invention more clearly understood there is depicted in the accompanying drawings means for carrying the same into practical effect without limiting the improvements in their useful applications to the particular constructions which, for the purpose of explanation, have been made the subject of illustration.

In the drawings in which like numerals designate similar parts:

Figure 1 is a top plan view of an airplane embodying my invention.

Figure 2 is a fragmental transverse sectional view of a wing showing the aileron and flap in their extended or operative positions.

Figure 3 is a fragmental transverse sectional

view showing the aileron and flap in their retracted or nested positions.

Figure 4 is a fragmental plan view illustrating the control mechanism for the spoiler and aileron surfaces.

Figure 5 is a sectional view taken along the line 5-5 of Figure 4.

Figure 6 is a sectional view taken along the line 6-6 of Figure 5 looking in the direction of the arrows showing the position of the parts when the aileron surfaces are in connection with the pilot's control column.

Figure 7 is a sectional view similar to Figure 6 showing the position of the parts when the aileron control surfaces are disconnected from the pilot's control column.

Figure 8 is a sectional view taken along the line 8-8 of Figure 6 looking in the direction of the arrows.

Figure 9 is a sectional view taken along the line 9-9 of Figure 7.

Referring to the drawings and more particularly to Figure 1, there is illustrated an airplane having a fuselage 1, power plant 2, empennage structure 3, and wings 4.

A wing flap 5 of the Zap type of suitable construction as described in my co-pending application, Serial No. 220,359, is connected to the lower surface of the wings 4 by a double link mechanism to provide a downward and rearward movement of the flap. The flap moving means comprises forward links 6 pivotally attached at their lower end to the flap as at 7, and rigidly attached at their upper end to a torque tube 8 and adapted to be rotated by suitable mechanism under control of the pilot. Rear links 9 are pivotally secured to the flap and movably suspended at 11 to a transverse torque tube 12 suitably journaled in the wing structure.

The wings 4 are provided with spoiler surfaces 15 that are adapted to be moved through lateral slots 16 provided in the upper leading surfaces of the wing 4. As shown in Figure 2, each spoiler 15 comprises a segment 17 that is provided at its lower end with arms 18. The arms 18 are attached to a torque tube 19 that is suitably supported within the inner structure of the wing. The upper end of a short arm 20 is affixed to each torque tube 19 and the lower end is attached to a connection 21. Each connection 21 is associated with a push rod 22 which extends longitudinally of the fuselage and is of such length as to terminate in proximity to a control mechanism for operation of the spoilers and ailerons which may be operated by the control column 13 of the plane which is located within the pilot's compartment.

As best shown in Figure 3, the upper trailing edge of each wing 4 is formed with a depressed area or nest 25 in which an aileron 26 is adapted to be positioned when it is in its inoperative position. Aileron supporting arms 27 are pivoted at their upper ends to the aileron 26 at 28, and the lower ends of the arms are attached to a torque tube 12 supported within the wing. A crank 29 is affixed to the torque tube and a piston rod 30, that is moved by a cylinder 31, is pivotally connected to the upper end of the crank. As will later be more fully discussed, the piston rod 30, crank 29, torque tube 12, and arm 27 provide means whereby the aileron may be moved from its nested to its operative position or retracted again to its nested position.

Links 35 are universally connected to pins 36 carried by the leading edge of the aileron as de-

picted at 37. The lower ends of the arms 35 are also universally connected to a push rod 38 as shown at 39. The push rod 38 is suitably journaled in the internal structure of the wing and is adapted to move in roller bearings which I have designated 40. The bearings 40 are carried by support members 41 that can be attached in any desirable manner to the internal wing structure. Due to the angular relation of the links 35 on the right and left ailerons, as shown diagrammatically in Figure 5, equal horizontal movement of the lower end of the links will give unequal vertical movement to the upper end of the links, and, therefore, unequal angular or differential movement will be imparted to the right and left ailerons.

To provide means for operating the spoilers 15 and the ailerons 26 by the single control column 13, there is provided the following mechanism. A lever 50 pivoted at 51 to the fuselage structure comprises four right angularly disposed arms 52, 53, 54 and 55. The arm 52 has attached thereto cables 56 which are in turn connected to the control column 13. To each of the arms 53 and 54, the rearward ends of the push rods 22 are universally connected. The arm 55 is bifurcated and adapted to actuate an aileron operating mechanism designated generally 57.

The mechanism 57 comprises a slide 58, to the opposite ends of which are pivotally attached the inner ends of the push rods 38. The slide 58 is carried in rectangularly broached aperture 59 formed in a sleeve 60 which in turn is slidably carried by a guide block 61. The guide is rigidly attached to a suitable web member 62 of the fuselage.

Slots 63 in the bifurcated end of the arm 55 engage anti-friction trunnion pins 64 which are attached to the sleeve 60. The pins 64 are also adapted to ride in slots 65 in the upper and lower faces of the guide block 61. As shown in Figure 4, rotary movement of the lever 50 will impart linear movement to the sleeve 60.

A pin 66 mounted to move transversely in the slide 58 is provided to alternately engage the slide 58 with either the sleeve 60 or the guide block 61. This is accomplished by the pin 66 either being forced into an aperture 67 in the sleeve or an aperture 68 in the guide 61. A helical spring 69 is provided to normally force the pin into the aperture 68.

As depicted in Figure 6, when the pin 66 locks the slide 58 to the sleeve 60, movement of the sleeve caused by rotation of the lever 50 will also cause movement of slide 58 and the push rods 28 to impart angular movement to the ailerons. At the same time, the spoilers 15 will also be operated through the rods 22. Referring to Figure 7, it will be seen that when the pin 66 locks the slide 58 to the guide 61, movement will only be imparted to the sleeve 60, and this movement of the sleeve relative to the slide 58 and the pin 66 is effected by allowing the pin 66 to travel in a slot in the rear face of the sleeve 60, thereby permitting only the spoilers to operate.

In order to manipulate the locking pin 66, there is provided a pivoted lever 70 located at a position convenient to the pilot. This lever is formed with a notched segment 71 and detent 72 and has attached to one end thereof a flexible cable 73. The opposite end of the cable 73 is fixed to a rod 74 slidably carried in a valve casing 75, which casing is attached to the guide 60 as at 76 (see Figure 8). A helical spring 78 surrounds the rod 74 and is adapted to force

the rod into engagement with the pin 66 and move it against the tension of spring 69 into the aperture 67. Exerting tension on the cable 73 by the lever 70 will cause the rod 74 to move away from the pin 66 and allow the spring 69 to force the pin 66 into the aperture 68.

In order that the slide 58 may be engaged with or disengaged from the sleeve 60 only when the aileron is in proper position for extension or retraction, there is provided a plate 80 attached at 81 to the slide 58. This plate travels in a groove 82 formed in the guide 61 adjacent the valve casing 75. An elongated aperture 83 is formed in the plate 80 which is enlarged at 84. The enlarged portion 84 is so located that when the slide 58 is centrally positioned in the sleeve 60, it will be concentric with the end of the rod 74. The rod 74 is provided with an enlarged collar 85 that will only pass through the portion 84 of the slot 82, thus the rod only moves the locking pin 66 when the slide 58 is centrally located in the sleeve 60 or, in other words, when the aileron is in proper position for retraction (zero angle position).

To manipulate the lever 70, regardless of the position of the lever 50, which controls the spoilers and the ailerons, a spring loaded lost motion connector 88 is disposed in the flexible cable 73. The spring 89 of the connector overrides the spring 78 while the spring 78 overbalances the spring 69.

To move the aileron 26 to its operative and inoperative positions, fluid under pressure is admitted to the cylinder 31 through a line 90 connected to the valve casing 75. The casing 75 is provided with a transverse passage 91 adapted to register with a bore 92 in the rod 74. A line 93 connects with the inlet passage 94 of a piston valve 95. The piston valve 95 is in communication with the lines 96 and 97, which lines respectively connect with opposite ends of the cylinder 31. The piston 98 of the valve 95 is provided with a head 99 between which head and the valve casing is disposed a spring 100 to hold normally the valve in the position shown in Figure 6. The valve is adapted to be moved into the position shown in Figure 7 by the leading edge 101 of the flap 5 when the flap is in its retracted position as illustrated in Figure 3.

The exhaust ports 102 of the valve 95 are connected with a line 103 which returns the fluid to the source of supply.

In operation, consider the airplane flying at high speed under lateral control by the spoilers 15. When under control of the spoilers, the operating unit 57 and its associated parts will be in the position shown in Figure 7, where the slide 58 is in locked engagement with guide 61 by means of the pin 66. The valve 75 will be held in open position by the lever 70 and the flexible cable 73, and the valve 95 will be held by the flap 5 in position to admit fluid to the aileron retracting end of the cylinder 31.

Should the pilot desire to reduce the speed of the airplane so that the spoilers will no longer be effective for lateral control, he lowers the flap. As the leading edge of the flap moves away from the valve head 99, the position of the valve piston 98 will change to admit fluid through the line 97 to the aileron extending end of the cylinder 31, thus moving the aileron 26 to its operative position.

The ailerons are still locked in their zero angle position, as the airplane is still under spoiler con-

trol. The lever 70 is then moved to the position shown in Figure 6 allowing the spring 78 to force the rod 74 into engagement with the pin 66 to lock the slide 58 to the sleeve 60. As above set forth, when the slide 58 and the sleeve 60 are connected, movement of the lever 50 by means of the control column 13 will impart differential angular movement to the aileron. Obviously, when the airplane is under lateral control by means of the ailerons, it is not necessary to disconnect the operating means to the spoiler surfaces by reason of the fact that on the wing where the aileron is at a position angle of attack, the spoiler on this wing is moved out of the airstream over the wing. On the opposite wing, where the aileron is at a negative angle of attack, the spoiler is extended into the airstream, but as the airstream over this wing is already spoiled by the negative angle of the aileron, the spoiler will serve to produce additional beneficial yaw to this wing.

When the pilot retracts the flaps to increase speed, the flap 5 again engages the head 99 of the valve 95 to move the same to its retracting position as shown in Figure 7. The pilot then moves the lever 70 to withdraw the rod 74 and open the valve 75 for passage of fluid to the retracting cylinder. If the slide 58 is centrally located in the sleeve 60, and the ailerons are in the zero angle position, the enlarged collar 85 on the rod 74 will pass through the portion 84 of the slot 83 in the plate 80 and allow the parts to assume the position shown in Figure 7. However, should the ailerons be in other than zero angle position, the lever 70 may be moved to place tension in the connector 88 and when the ailerons are moved to their zero angle position, the position of the parts shown in Figure 7 may be automatically assumed.

By the above construction, the ailerons may only be nested when they are in their zero angle position thereby permitting proper retraction and preventing damage to the ailerons. This construction also assures that the ailerons will be locked in their zero angle position when being extended and retracted.

While I have shown and described the preferred embodiment of my invention, I wish it to be understood that I do not confine myself to the precise details of construction herein set forth by way of illustration, as it is apparent that many changes and variations may be made therein, by those skilled in the art, without departing from the spirit of the invention, or exceeding the scope of the appended claims.

I claim:

1. In an airplane assembly, a wing, spoiler, flap and aileron surfaces for the wing adapted to be variably positioned with respect thereto, a single control operable for variably positioning said spoiler and aileron surfaces relative to said wing and each other, said aileron normally resting in a recess in the wing and being adapted to be bodily extended to an operative position above the upper surface of the wing and tiltable relative to the latter by said single control, the flap and aileron being so connected that the aileron cannot be extended unless the flap is lowered, and means associated with the spoiler and aileron control positively retaining the aileron against tilting in response to operation of said control while the aileron is being moved to its location above the wing.

2. In an airplane assembly, a wing, spoiler, flap and aileron surfaces for the wing, a single

control member operable for pivotally moving the spoiler and aileron surfaces, said aileron normally resting in a recess formed in the upper trailing edge of the wing and being adapted to be bodily moved to a position above the trailing edge of the wing to afford lateral control, and means to so move the aileron surfaces, said flap and aileron being so connected that the aileron cannot be extended unless the flap is lowered, and means associated with the spoiler and aileron control to retain the aileron against pivotal movement in response to operation of said control member while the latter is being moved to its location above the wing.

3. In an airplane construction including a wing structure, pivotally movable ailerons for said structure adapted to be bodily projected thereabove to an operating position, and means for so projecting said ailerons, a control operably connectible with said ailerons and operable to effect pivotal movement thereof, and means retaining said control against operable connection with said ailerons during projection of the latter to said operating position.

4. In an airplane construction including a wing structure, pivotally movable ailerons for said structure adapted to be bodily projected thereabove to an operating position, and means for so projecting said ailerons, means operable to effect pivotal movement of said ailerons, and means rendering said means inoperative to effect said pivotal movement during projection of said ailerons to said operating position.

5. In an airplane construction, a wing structure, ailerons for said structure bodily movable to and from projected and retracted positions respectively relative to said wing structure, means for so moving said ailerons, means operable to control said movement of said ailerons, said ailerons having a normal position with respect to said wing structure when in said projected position and being tiltable therefrom, means operably connectible with said ailerons for effecting tilting of the latter, and means operable in response to operation of said control means for effecting said operating connection when said ailerons are in said normal position only.

6. In an airplane construction, a wing structure, ailerons for said structure bodily movable from a nested position to an operating position with respect thereto, means for so moving said ailerons, said ailerons having a normal position with respect to said wing structure and being tiltable therefrom, relatively movable parts adapted to be operably connected for effecting said tilting of said ailerons, and means accommodating establishment of said operable connection of said parts when said ailerons are in said normal position only.

7. In an airplane construction, a wing structure, ailerons for said structure adapted to be bodily projected thereabove, means operable to effect said projection, said ailerons having a normal position with respect to said wing structure when projected and being tiltable from said position to vary the angular relationship with respect thereto, deflector means at the leading edge of said wing structure adjustable with respect thereto, common means operable to simultaneously effect adjustment of said deflector means and tilting of said ailerons from said normal position, and means operable to render said common operating means inoperative to effect tilting of said ailerons when said ailerons are being projected.

8. In an airplane construction, a wing structure, ailerons for said structure adapted to be bodily projected thereabove, means operable to effect said projection, said ailerons having a normal position with respect to said wing structure when projected and being tiltable from said position to vary the angular relationship with respect thereto, means movable to effect tilting of said ailerons, deflector elements carried at the leading edge of said wing structure and adjustable with respect thereto, means operable to effect adjustment of said deflector elements, and means operable to connect said last mentioned means with said movable means when said ailerons are in said normal position only whereby said deflector elements and said ailerons are simultaneously operated.

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