Oct. 25, 1960 D. S. LEWIS ET AL 2,957,656

MEANS FOR LATERAL CONTROL OF HIGH-SPEED AIRPLANES

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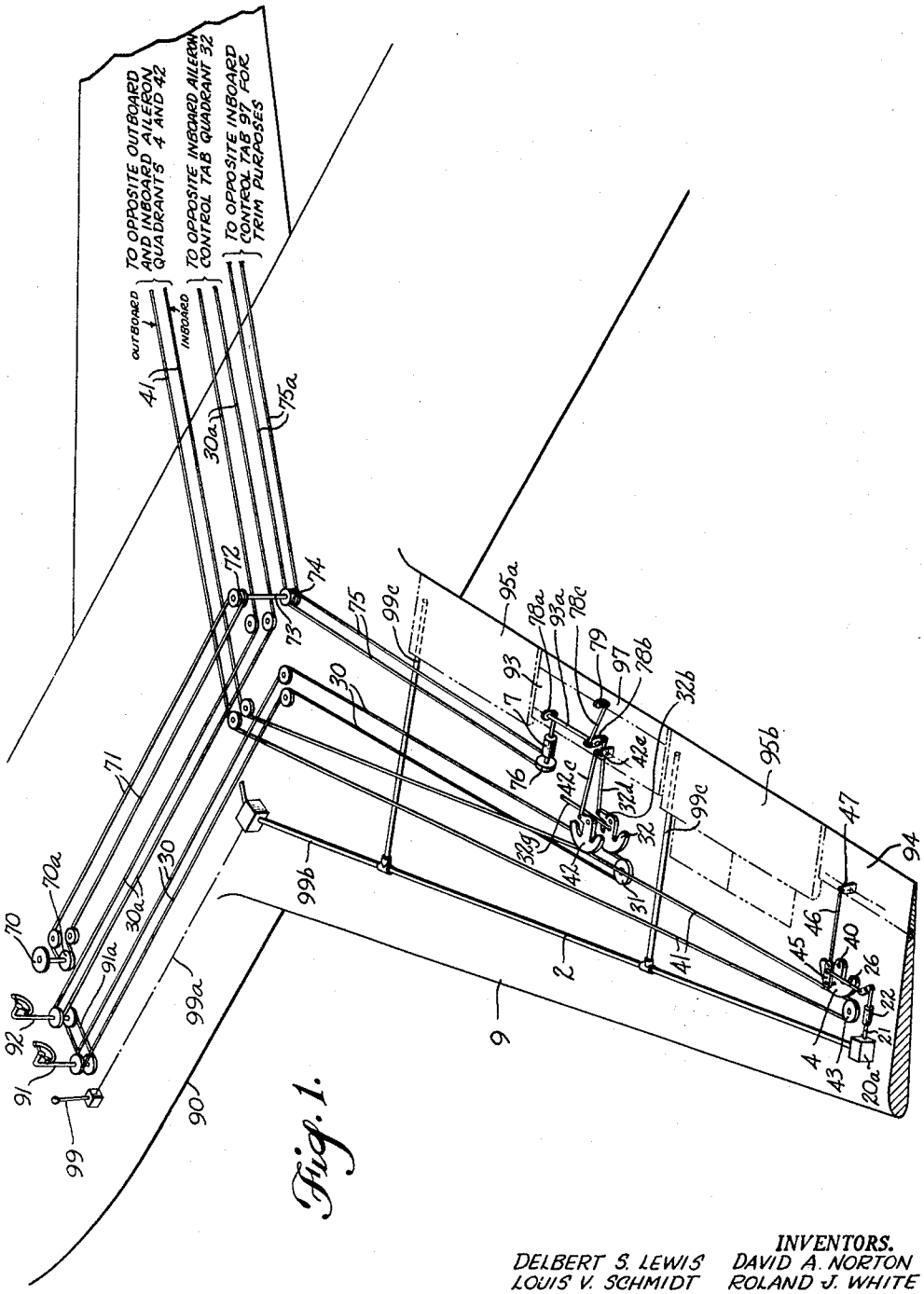


Fig. 1.

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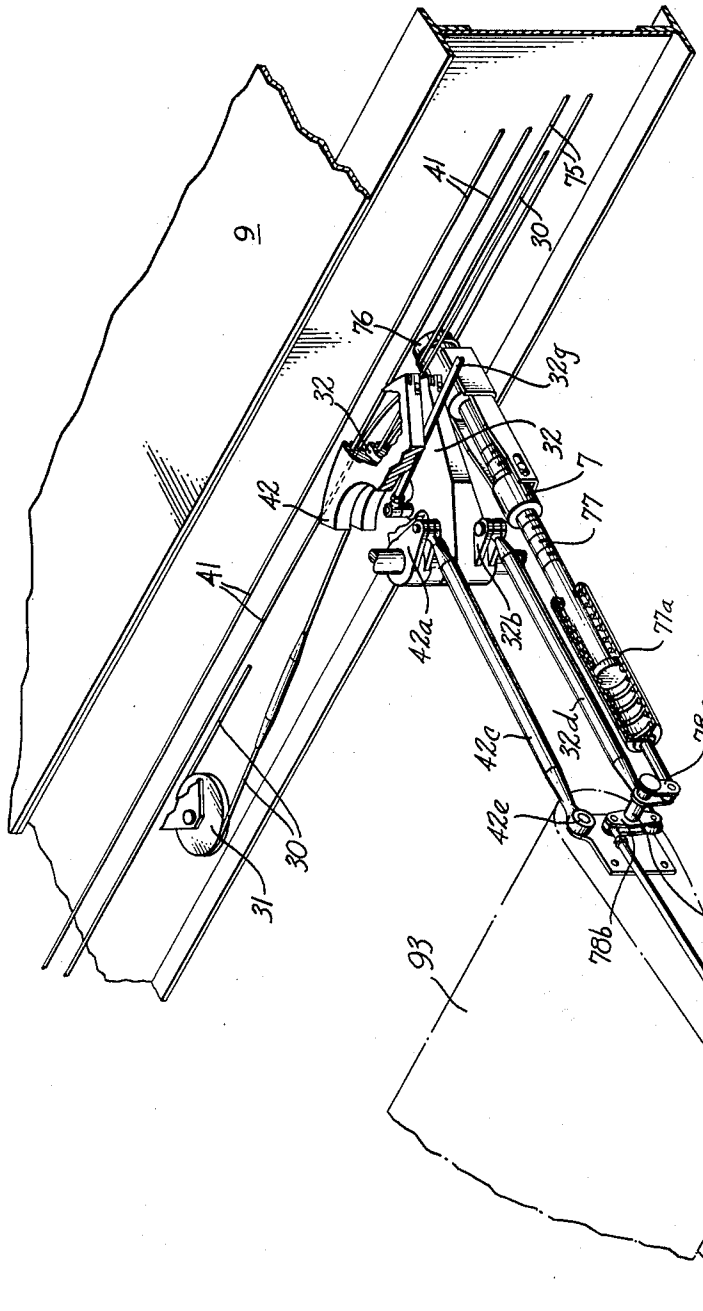


Fig. 2.

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Fig. 3.

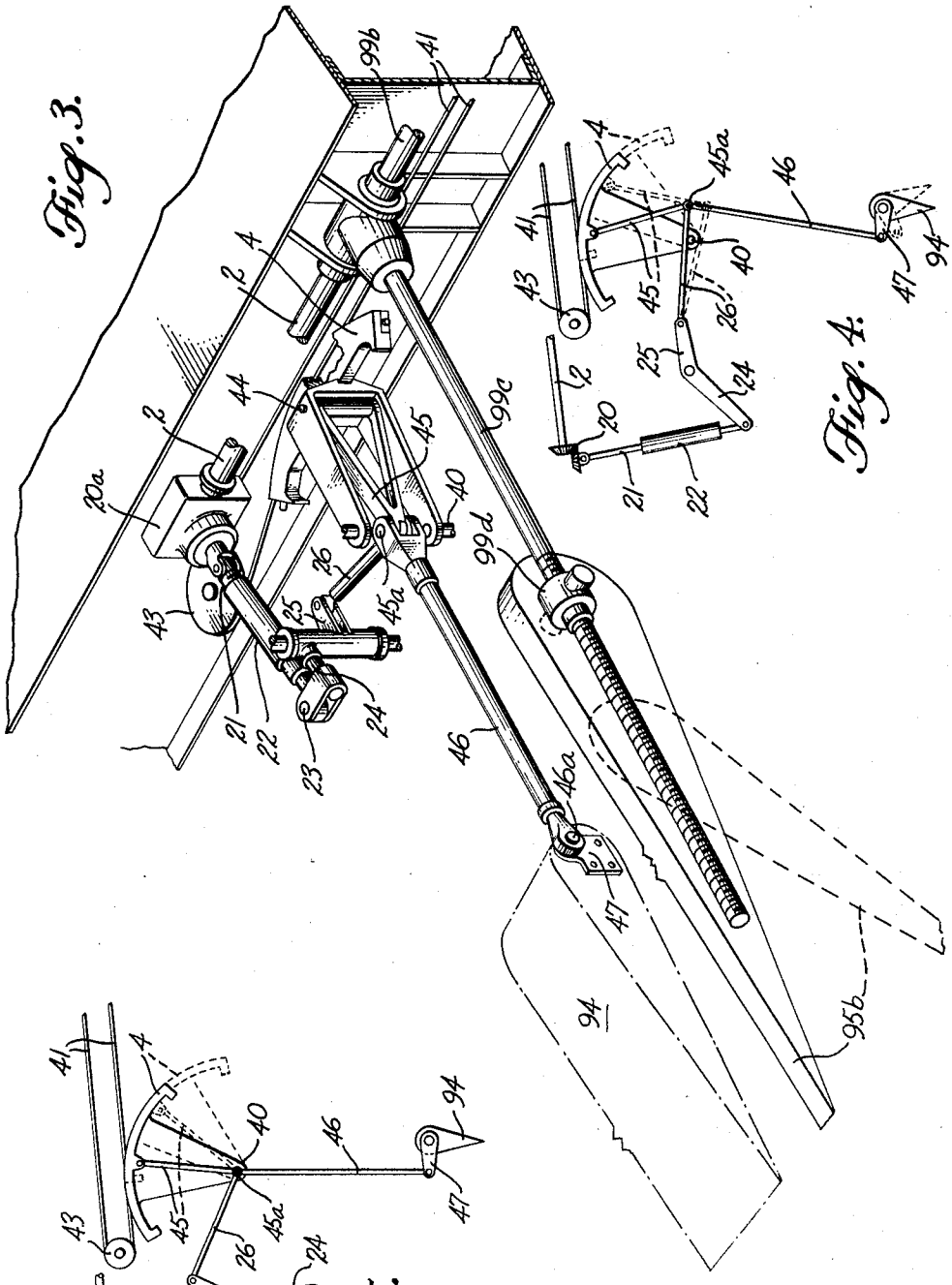


Fig. 4.

Fig. 5.

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MEANS FOR LATERAL CONTROL OF HIGH-SPEED AIRPLANES

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12 Claims. (Cl. 244—90)

It has been found that outboard ailerons on high-speed airplanes are ineffective at high speeds because of wing elasticity, and that good lateral control under such conditions is afforded by inboard ailerons alone; nevertheless, outboard ailerons are necessary to supplement the inboard ailerons at lower speeds, as in landing or making a landing approach. The ineffectiveness of the outboard ailerons for control at high speed, commonly referred to as "aileron reversal," arises from the twisting of the wing, deflecting its leading edge portions upwardly progressively towards the wing tip as the aileron's trailing edge is deflected upwardly, and vice versa. Whatever ailerons are used must be, naturally, in a sufficiently outboard location to afford an adequate lever arm for lateral control, but the loss of effectiveness due to twisting of the wing counteracts the increase in effectiveness due to the longer lever arm of outboard ailerons at a rate that makes the location of any aileron outboard of the usual location of inboard ailerons progressively less helpful and eventually detrimental rather than helpful, at high speed. The lower loading and the smaller tendency to twisting at low speeds, on the other hand, permits and requires a longer lever arm, hence requires both inboard and outboard ailerons for effective control, and makes the latter effective.

Primarily, the present invention is designed to afford the pilot lateral control through the inboard ailerons at all times, to eliminate any outboard aileron function automatically under high speed conditions, yet to afford outboard aileron function automatically supplementing the inboard ailerons under low speed conditions. More specifically, such a wing is provided with both inboard and outboard ailerons, interconnected for conjoint operation, but with means in the interconnection which can disable the outboard ailerons and retain them in a neutral or non-deflected position with respect to the wing (moving them into such neutral position if not already therein), without interfering with continued operation of the inboard ailerons. Preferably the disabling is performed automatically in conjunction with functioning of some instrumentality that is sensitive to airspeed conditions. Conversely, when airspeed drops to a given value, the instrumentality referred to causes automatic resumption of conjoint functioning of the inboard and outboard ailerons.

The automatic disabling and resumption of functioning is much to be preferred, although it is obvious that the lock-out of the outboard ailerons and their resumption might be effected either by providing separate controls for the inboard and the outboard ailerons, or by providing a disconnect and reconnect device that would be consciously operated by a crew member at proper times. Any such arrangement would require the crew member to perform some positive act, which he might forget to do, or which he might do too early or too late, and in any such case the results might be dangerous if not disastrous. Thus, although in its bare essence the present invention has to do with the fact of disabling the outboard ailerons when necessary, without interfering with continued effective operation of the inboard ailerons, and the restoration of conjoint operation with inboard ailerons, in each case under appropriate airspeed conditions, this invention is also closely concerned with automatic control of disablement and restoration, under control of an appropriately sensitive instrumentality.

This is accomplished, according to the present invention, by coupling to the outboard ailerons or to their operating mechanism, or to the interconnection between the inboard and outboard ailerons, some instrumentality which is necessarily shiftable between high-speed and low-speed positions in accordance with the speed of the airplane, or in order to permit the speed of the airplane to accelerate, or to cause it to decelerate. Such an instrumentality might be, for example, the retractable landing gear, which is normally retracted before the airplane has attained or can attain high-speed flight, but since it is sometimes lowered during high-speed flight to assist in decreasing the airplane's speed, it is preferred that the instrumentality referred to be of the lift-increasing flaps. These flaps are always lowered for landing, but not until the speed of the airplane has dropped to the low-speed range, and these flaps must always be raised into their inoperative position before the airplane can attain high-speed flight. Likewise, they are always lowered at take-off, but raised when safe flying speed has been attained.

Accordingly, it is a further object of this invention to provide such an interconnection between the flaps and the flap-operating means, on the one hand, and the outboard ailerons and their operating mechanism, on the other hand, that the outboard ailerons are disabled and retained in neutral or nondeflected position, without interfering with continuing deflection of the inboard aileron, whenever the flap is raised, and conversely, the outboard ailerons are freed from restrains so that they may deflect with the corresponding inboard aileron whenever the flap is lowered. Thus, the disablement and the reestablishment of the operative condition of the outboard aileron is automatic, and is controlled without thought on the part of the pilot, by an operation which is essential as the airplane moves from one speed range into another, or which is of such nature that the pilot will never perform it except while in the correct speed range.

Since the flaps are the preferred mechanism for effecting control over the outboard aileron, but since other regulating means might be chosen, for instance the landing gear and its retracting mechanism, already mentioned, it is to be understood that the term "instrumentality shiftable between high-speed and low-speed positions" as used in this specification is intended as a general term to refer to either such instrumentality or any other that may be found suitable.

In the accompanying drawings the invention is shown diagrammatically in some views, installed upon a typical high-speed swept-wing airplane, and operative mechanism from a practical installation has been shown in somewhat greater detail and in more nearly practical embodiments in other views.

Figure 1 is a general diagrammatic view in phantom of portions of the airplane, illustrating particularly the various operative connections and the interconnection between certain thereof.

Figure 2 is an isometric view illustrating the operating mechanisms for the inboard aileron, and the operative connection thence to the outboard aileron.

Figure 3 is a view similar to Figure 2, illustrating the operating mechanism for the outboard aileron, and illustrating the interconnection between the flap-operating mechanism and the mechanism for operating the outboard aileron.

Figure 4 is a diagram of certain mechanism illustrated in Figure 3, illustrating parts in the low-speed flight condition, and indicating by dash lines how operation of the inboard aileron will effect coincident and conjoint operation of the outboard aileron, and Figure 5 is a diagram similar to Figure 4, but showing the parts in the high-speed flight condition, in which continuing operation of the inboard aileron will not effect operation of the outboard aileron, but will retain the latter in a neutral position.

Portions of the airplane wing and fuselage are shown in phantom in Figure 1, and the system with which the present invention is concerned is shown in conjunction therewith, in digarammatic fashion however, and without any attempt to incorporate all the several components and details, nor with the intention of showing those which are illustrated in the best and most practical form, but rather in an attempt to show the entire system simplified so far as possible, to make understanding thereof easier.

Within the pilot's compartment of the fuselage **90** are a pilot's control element **91** and a co-pilot's control element **92** by which, among other things, the ailerons are deflected. These ailerons are mounted at the trailing edge of a wing **9**, and as shown include the inboard aileron **93** and the outboard aileron **94**, each hingedly mounted for deflection above and below the level or general contour of the wing **9**. In addition, flaps **95***a* and **95***b* are mounted and guided by any normal or preferred means (not shown) for downward movement from a neutral or inoperative position, wherein they lie in general conformity with the streamline contour of the wing, into the downwardly deflected operative position, and back to the neutral position. Figure 3 illustrates a lead screw **99***c* threaded within a nut **99***d* as a means to shift the flap between full-line and dash-line positions, under control of the pilot's flap-control element **99**. Control tab **97** for the inboard aileron is hingedly mounted upon the trailing edge of that aileron, and by its deflection oppositely to the desired deflection of the aileron serves to effect or assist the deflection of the inboard aileron. The control tab **97** can also be deflected as a trim tab, and mechanism to that end is also illustrated. A trim or balance tab (not shown) may be used in conjunction with the outboard aileron **94**, but has been omitted to avoid confusion with the control tab **97**. While only one wing panel is illustrated, it will be understood that the elements described are likewise carried by the opposite wing panel and are controlled by the same control elements **91**, **92** and **99**.

All such elements and the general combination are normal and conventional, and no claim to the same is made herein. The present invention, rather, is concerned with the operating mechanisms for these several elements and the interconnection of those operating mechanisms, or, in the broader sense, is concerned with the interconnection between such an instrumentality as the flap or flaps, such as is always shifted to a given position for low-speed flight and always shifted to a different position for high-speed flight, and the respective ailerons **93** and **94**, of which the inboard aileron **93** must always be effective and operable, but of which the outboard aileron **94** is, by the present invention, rendered inoperative during high-speed flight, and is rendered operable only during low-speed flight. As has been stated above, the controls and the operative connections which will be described hereinafter are illustrated diagrammatically, and the showing is not to be taken as an illustration of the best practical mode of construction except in the broad sense, and insofar as concerns the interconnection between the several elements.

The inboard ailerons **93** are employed for lateral control under all conditions, and primarily, the aileron is intended to be operated through tilting of its control tab **97**. It will be noted that the pilot's and co-pilot's aileron controls **91**, **92** are interconnected for conjoint operation, as indicated at **91***a*. Considering the pilot's control **91**, this is directly connected to the inboard aileron **93** by means of cables **30**, which extend about the terminal pulley **31** and about the quadrant **32**. Similar cables **30***a* extend from the co-pilot's control **92**, but since the pilot's and co-pilot's aileron control elements **91** and **92** are interconnected at **91***a*, the inboard ailerons **93** are, in effect, capable of direct control by either of the control elements **91** and **92**. The quadrant **32** (see also Figure 2) is connected through a push-pull link **32***d* to the control tab **97**, and the resultant deflection of the inboard aileron is reflected through the push-pull link **42***c* in angular movement of the quadrant **42**, which is wholly separate from the quadrant **32**. In detail, the quadrant **32** has an arm **32***b* to which one end of the link **32***d* is pivotally connected; the opposite end of link **32***d* is pivoted to one arm of lever **78***b*, fast to shaft **93***a* that is coaxial with but not connected to inboard aileron **93**; the other arm of lever **78***b* is connected by the push-pull link **78***c* to arm **79** rigid with the control tab **97**. A push on link **78***c*, originating in a pull on link **32***d*, deflects the control tab upwardly, thus deflecting the inboard aileron **93** downwardly, and the reverse is true. Such deflection of the inboard aileron **93** reflects back, through the connection at **42***e* and the link **42***c* to the arm **42***a* of quadrant **42**, to effect angular displacement of this quadrant **42**. Thus whenever the inboard aileron **93** is deflected by whatever agency, the quadrant **42** and all mechanism operatively connected to the latter are also moved correspondingly.

The control tab **97** can also be deflected by other means, typified by the rotative high lead screw **77** and non-rotative nut **7** threaded thereon. The connection includes a spring cartridge **77***a*, so that the tab **97** may be deflected, as by the link **32***d*, without rotation of the screw **77**, but when the screw **77** is rotated it reacts from the nut **7** to produce an endwise thrust in one sense or the other. This functions through lever **78***a* to effect rotary movement of shaft **93***a* and consequent deflection of tab **97**, as explained above, with like results on quadrant **42**. Rotation of the screw **77** is effected by means such as cables **75** or **75***a*, extending about a pulley such as **76** on the screw **77**, and connected by way of pulley **74** (see Figure 1), shaft **73**, pulley **72**, and cables **71** to a trim knob **70** and pulley **70***a* in the pilot's compartment. The control tab **97** can be deflected for trimming, or could be deflected for control in the event of failure in the system operated by the pilots' controls **91**, **92**. Deflection of the tab **97** by angular movement of the quadrant **32**, in the usual course of operation, will not be impeded by the actuator **77**, **7**, because of the presence of spring cartridge **77***a*.

In passing, it may be noted that the quadrant **32** is connected to a rod **32***g* by which can be effected movement of another component, which is not a part of the present invention.

As has been stated, deflection of the inboard aileron **93** is reflected, through the push-pull link **42***c*, in angular movement of the quadrant **42**, to an arm **42***a* whereof the link **42***c* connects; the other end of link **42***c* is connected at **42***e* directly to the inboard aileron. Whenever the quadrant **32** is deflected angularly, it effects deflection of the tab **97** and of the inboard aileron **93**, and movement of the latter is reflected in deflection of quadrant **42**. The two quadrants are not otherwise connected, and each moves independently of the other. The quadrant **32** is part of the operative connection from the pilot's control of the inboard aileron control tab **97**, whereas the quadrant **42** is part of the operative interconnection between the inboard and outboard ailerons themselves.

A cable **41** extends over the quadrant **42**, and thence extends spanwise on both wing panels, and about a pulley **43** at each end. This pulley is in the vicinity of the outboard aileron **94**. Intermediate the pulley **43** and the

quadrant 42 the cable 41 extends about a quadrant 4, pivoted to oscillate about its center 40. Pivoted to the quadrant 4, at a pivot axis designated 44 and located radially outwardly of the quadrant's center 40, is a link 45, which is one link of a pair of articulated links, the second link 46 of which is pivotally connected to the link 45 at the center 45*a*, and at its opposite end is pivotally connected at 46*a* to a lever arm 47, fast to the outboard aileron 94, so that the pivot connection at 46*a* is outwardly of that aileron's hinge axis. Any push in the linkage system 45, 46 tends to deflect the outboard aileron 94 downwardly and any pull in that linkage system tends to deflect the outboard aileron 94 upwardly. The manner in which such pushing or pulling is accomplished will be described shortly.

The link 45 is of such length that the common pivot 45*a* between the links 45 and 46 can be brought into coincidence with the pivot 40 of the quadrant 4, or the pivot 45*a* may be moved from coincidence with the pivot 40. Compare Figures 4 and 5. It will be evident from Figure 5 that so long as the pivots 40 and 45*a* are in coincidence the quadrant 4 may tilt in any degree without effecting any movement whatsoever of the link 46, nor in consequence, of the outboard aileron 94. Whenever the pivot 45*a* is moved out of coincidence with the pivot 40 and held out of such coincidence, as in Figure 4, oscillation of the quadrant 4 will effect movement in the direction of length of the linkage system 45, 46.

As has been indicated heretofore, the particular instrumentality that is shiftable between high-speed and low-speed positions, and the movement of which is employed to effect shifting of the pivot 45*a*, is immaterial, but it is convenient and simple to employ the flap-operating mechanism. It will, therefore, be in order to describe briefly the flap-operating mechanism as shown herein. The pilot's flap control element is shown at 99, and this is connected by a connection 99*a* and 99*b* to what may be taken as lead screws 99*c* threaded into a 99*d* (see Figure 3), whereby both flaps 95*a* and 95*b*, guided by suitable guide means that are not shown herein, may be deflected downwardly from their inoperative position, shown in full lines in Figure 3, into an operative position, somewhat as shown in that figure in dash lines. The details of the flap, its mounting, and its operating mechanism are immaterial. This system, however, constitutes a further operative connection, namely, one from the pilot's flap-operating control element 99 to the flaps.

This operative connection has an extension 2 to the vicinity of the quadrant 4. For instance, there may be gearing 20 (Figures 4 and 5), shown in Figure 3 within the gear box 20*a*, to rotate one element 21 within a second element 22, these two elements being threadedly interconnected or otherwise arranged so that relative rotation will effect elongation and contraction of the composite elements 21, 22. This extensible and contractible element or actuator is connected at 23 to one arm 24 of a rockable member, which is in the nature of a bell-crank lever, the opposite arm of which is connected by a link 26 to the common pivot 45*a* of the linkage system 45, 46, previously described. This constitutes a further operative connection, either from the flaps or the flap-operating mechanism to the outboard aileron or its operative mechanism.

This last-mentioned operative connection is so arranged that when the flaps are in their upraised neutral position, the pivot axis of the pin 45*a* will coincide with the pivot axis at 40. Movement of the flaps into that neutral position will accomplish movement of the outboard aileron from any deflected position into its own neutral position. As has been pointed out, while this relationship obtains, rocking of the quadrant 4, such as will continue to occur with rocking of the quadrant 32 for lateral control through the inboard aileron 93, will have no effect on the outboard aileron 94. The system is further arranged so that downward deflection of

the flap will operate, through the extension or operative connection 2, to move the pivot 45*a* from coincidence with the pivot 40, and the outboard aileron will thereupon assume a deflection consonant with the deflection of its inboard aileron. In any such position, as shown in Figure 4, rocking of the quadrant 4 will effect a pushing or pulling through the linkage 45, 46, to effect deflection of the outboard aileron 94. Since downward deflection of the flap into an operative position occurs only at low speed, and since control action of the outboard aileron is desired only at low speeds, it follows that the outboard aileron is automatically brought into condition for control action whenever that control action is wanted, and yet under all high-speed flight conditions, when control action of the outboard aileron is not desired, it is automatically withheld from operation.

There are a number of operative connections which have been described in detail, for purposes of clarity, but it is desired to make clear that the invention resides not so must in details of these operative connections as in the fact that there is an operative interconnection between them in a particular way and to the particular end in view. It will be helpful to identify these several operative connections, which are referred to in the claims.

One such operative connection connects the pilot's and co-pilot's aileron control elements 91, 92 with the inboard aileron 93. It incorporates the primary connection that includes the cables 30, 30*a*, the quadrant 32, and the connections thence to the aileron 93 or its control tab 97, and may be considered to incorporate also (unless the contrary is stated) the trim connection that includes the trim control knob 70, the cables 71, 75, and 75*a*, the actuator 7, 77, and the tab 97 and connections to the latter from the actuator 7, 77. Either such operative connection is always fully effective.

Another such operative connection connects the one just described with the outboard aileron 94, or might be considered an extension of the previously mentioned connection; in effect, this other operative connection extends between the pilot's and co-pilot's aileron control elements 91, 92 and the outboard aileron 94. While actually constituting a separate system, not part of the pilot's control system, yet for some purposes it, too, may be considered to extend to and include the aileron control elements 91, 92, the cables 30, and the quadrant 32, by way of the coaxial quadrant 42, the quadrant 4, the cables 41, and so much of the mechanism of Figure 3 (link system 45, 46, etc.) as is necessary to deflect the outboard aileron 94, and which is, properly speaking, the system referred to. It is this operative connection that is capable of disablement and of reestablishment.

Still another operative connection extends from the pilot's flap-operating element 99 to the flaps 95*a*, 95*b*. It is indicated at 99*a*, 99*b*, 99*c* and 99*d*. This connection is always fully operative, but is operated only at low speeds, in transition from low to high speed or the reverse.

The extension 2 from the last-mentioned operative connection is, properly speaking, part of a further operative connection, which interconnects the flaps and the flap-operating connection with the outboard aileron and its operative connection. This further operative connection includes, in addition to the extension 2, the actuator 21, 22, the bell-crank lever 24, 25, and the link or rod 26, which connects at 45*a* to the operative connection for the outboard aileron, to disable or to reestablish the latter. This last-mentioned connection is always operative, and is automatically operated in conjunction with operation of the flaps, either to raise or to lower the latter.

The operation, briefly, involves free and normal operation of the inboard aileron 93 at all times, regardless of the position of the flaps. When the flaps are raised, which occurs as a necessary prelude to high-speed flight,

automatically the outboard ailerons, or the operative connection thereto, is disabled by way of the operative connection thereto from the flaps or their operative connection. This places the outboard ailerons in neutral position and retains them therein, until the flaps are lowered. Lowering of the flaps, which can only occur successfully during low-speed flight, automatically reestablishes the operative connection to the outboard ailerons, and the latter assume a deflection corresponding to the deflection of the inboard aileron on the same wing panel, and thereafter continue to deflect with that inboard aileron, until the flap is raised again.

We claim as our invention:

1. Lateral control means for high-speed elastic wing airplanes, comprising, in combination with the sustaining wing, an inboard aileron and an outboard aileron each hingedly mounted upon said wing and deflectable relative thereto from a neutral position, for lateral control, a pilot's control element, a first operative connection from said control element to the inboard aileron only, for deflection of the latter at all times, a second operative connection from said inboard aileron to the outboard aileron, a disabling device included in said second operative connection, a flap mounted upon said wing for movement from an upraised inoperative position, suitable for high-speed flight, to a lowered operative position, suitable only for low-speed flight, a flap control element, a third operative connection from said flap control element to said flap, to move the latter between its operative and inoperative positions, and a fourth operative connection from the flap and its third operative connection, to the disabling means in the second operative connection, to actuate said disabling means for disablement of the second operative connection and retention of the outboard aileron in its neutral position upon movement of the flap to its upraised, inoperative position, and conversely, for reestablishment of the second operative connection upon movement of the flap to its lowered, operative position.

2. Lateral control means as defined in claim 1, wherein the second operative connection includes a quadrant mounted to rock about its center, means extending from the inboard aileron to said quadrant, to rock the latter in accordance with the deflection of the inboard aileron, the disabling means including a pair of articulated push-pull links, a first one of said links being of a length equal to the quadrant's radius, pivoted at one end to the quadrant's periphery, and extending towards the quadrant's center, the latter end being pivoted to the second link, an operative connection between the second link and the outboard aileron, to deflect the latter by rocking of the quadrant so long as the pivot common to the two links does not coincide with the quadrant's center, and means included in the fourth operative connection to shift the common pivot of the links from coincidence with the quadrant's center so long as the flap is in its lowered position, and into coincidence therewith by raising of the flap.

3. In combination with the opposite wings of a high-speed aircraft, each having sufficient elasticity to produce a reverse-lift effect at an outboard aileron upon normal aileron operation at higher speeds, an inboard and a separate outboard aileron mounted upon each wing for deflection relative to such wing; a pilot's control; a first operative connection extending from said pilot's control to each inboard aileron, and permanently connected to the latter to effect deflection thereof always in the same sense for each given control movement of the pilot's control, regardless of the speed of flight or elastic flexure of the wings; means constituting an outboard extension of and movable with each of said first operative connections; mechanism operatively interconnecting each outboard extension to the corresponding outboard aileron; an instrumentality shiftable between high-speed and low-speed positions; a second pilot's control operatively connected to said instrumentality to effect such shifting of the latter; a second operative connection between said instrumentality and its control, on the one hand, and said mechanism, on the other hand; said mechanism including means shiftable by said second operative connection between a high-speed and a low-speed position, in which high-speed position movement of the outboard extension, accompanying deflection of the inboard aileron, is ineffective to produce deflection of the corresponding outboard aileron, and such mechanism retains the outboard aileron in neutral, undeflected position; and in which low-speed position movement of the outboard extension, accompanying deflection of the corresponding inboard aileron, produces like deflection of the outboard aileron through said outboard extension.

4. The combination of claim 3, wherein the outboard extension of the first operative connection includes a lever oscillatable about its pivot to opposite sides of a neutral position such as corresponds to neutral position of the corresponding inboard aileron, and the mechanism connecting to the outboard aileron includes a first link of the same length as said lever, pivotally connected at one end to the outer end thereof, means to shift its free end into substantial registry with the lever's pivot, or from such registry, according to whether the instrumentality is in its high-speed or low-speed position, respectively, and a second link joined to and shiftable with the free end of the first link, and operatively connected to the outboard aileron, to retain the latter in its inoperative position so long as the free end of the first link registers with the pivot of said lever, regardless of deflection of the inboard aileron, or to effect deflection of the outboard aileron in correspondence with deflection of the inboard aileron, when the free end of the first link is out of registry with the lever's pivot.

5. In combination with the elastic wing of a high-speed airplane, an inboard aileron and a separate outboard aileron each hingedly mounted at the trailing edge of the wing for deflection upwardly and downwardly, a pilot's aileron control element, a first operative connection thence to the inboard aileron, for deflection thereof always in accordance with actuation of said aileron control element, a second operative connection from the inboard aileron and its first operative connection to the outboard aileron, including mechanism shiftable between a first and a second position, a flap mounted at the trailing edge of said wing for movement between an upraised, inoperative position suited for high-speed flight and a lowered, operative position suited for low-speed flight, a pilot's flap control element, a third operative connection between said latter element and the flap, to move the latter between its operative and inoperative positions, and a fourth operative connection between the third operative connection and said shiftable mechanism in the second operative connection, to shift said mechanism, by shifting of the flap into its inoperative position, into a first position wherein the second operative connection to the outboard aileron is disabled, or alternatively to shift said mechanism, by shifting of the flap into its operative position, into the second position wherein the second operative connection is restored, and the two ailerons deflect alike under control of the pilot's aileron control element.

6. In combination with the opposite wings of a high-speed aircraft, each having sufficient elasticity to produce a reverse-lift effect at an outboard aileron upon normal aileron operation at higher speeds, an inboard and a separate outboard aileron mounted upon each wing for deflection relative to such wing, a pilot's aileron control; a first operative connection extending from said pilot's control to each inboard aileron, and permanently connected to the latter to effect deflection thereof always in the same sense for each given control movement of the pilot's control, regardless of the speed of flight or elastic flexure of the wings; means constituting an outboard ex-

tension of and movable with each of said first operative connections; mechanism operatively interconnecting such outboard extension to the corresponding outboard aileron; a flap on each wing shiftable between high-speed and low-speed positions; a second pilot's control operatively connected to said flaps to effect such shifting of the latter; a second and permanent operative connection between each flap and its control, on the one hand, and said mechanism, on the other hand; said mechanism including means shiftable by said second operative connection between a high-speed and a low-speed position, in which high-speed position movement of the outboard extension, accompanying deflection of the inboard aileron, is ineffective to produce deflection of the corresponding outboard aileron, and such mechanism retains the outboard aileron in neutral, undeflected position; and in which low-speed position movement of the outboard extension, accompanying deflection of the corresponding inboard aileron, produces like deflection of the outboard aileron through said outboard extension.

7. Lateral control means for high-speed airplanes comprising, in combination with opposite elastic sustaining wings, an inboard aileron for each wing, an outboard aileron for each wing, a pilot's aileron control element, a first operative connection from said control element to the inboard ailerons, for deflection thereof to effect lateral control at all speeds, a second operative connection from each inboard aileron to the corresponding outboard aileron, for conjoint and like operation thereof, flaps on both wings shiftable between a high-speed inoperative position, coinciding with the wing, and a deflected low-speed operative position, non-coincident with the wing, a third operative connection to said flap and including an extension operatively connected to said second operative connection, and shiftable in conjunction with the movement of the flap into high-speed position to disable the second operative connection and thereby to retain the outboard aileron in a neutral position, notwithstanding deflection of its inboard aileron, and further shiftable in conjunction with the movement of the flap into low-speed position to reestablish the second operative connection for deflection of the outboard aileron in correspondence with deflection of the inboard aileron.

8. Lateral control means for a high-speed airplane comprising, in combination with its back-swept elastic wings, an inboard and a separate outboard aileron hingedly mounted upon each wing, a pilot's control element for all said ailerons, a first and continuously effective operative connection from said control element to the inboard ailerons, for deflection of the latter at all speeds, a second and continuously effective operative connection from each inboard aileron to its corresponding outboard aileron, to deflect the latter, means to disable said second operative connection, an instrumentality shiftable between a first position which corresponds to high-speed flight and a second position which corresponds to low-speed flight, and a third and continuously effective operative connection between said instrumentality and the disabling means, to actuate the latter for disablement of the second operative connection and for return of the outboard aileron, if deflected, to its non-deflected position and its retention therein, and conversely to actuate the disabling means to restore the effectiveness of the second operative connection and to deflect the outboard aileron, if the inboard aileron is then deflected, into a correspondingly deflected position suited to low-speed flight.

9. In combination with the opposite wings of a high-speed aircraft, each having sufficient elasticity to produce a reverse-lift effect at an outboard aileron upon normal aileron operation at higher speeds, an inboard and a separate outboard aileron mounted upon each wing for deflection relative to such wing; a pilot's aileron control; a first operative connection extending from said pilot's aileron control to each inboard aileron, and permanently connected to the latter to effect deflection thereof always in the same sense for each given movement of the pilot's control, regardless of the speed of flight or elastic flexure of the wings; means constituting an outboard extension of and movable with each of said first operative connections, said outboard extensions each including a lever oscillatable about its pivot to opposite sides of a neutral position such as corresponds to neutral position of the corresponding inboard aileron; mechanism operatively interconnecting each outboard extension to the corresponding outboard aileron, and including a first link of the same length as said lever, pivotally connected at one end to the outer end of the lever, and means to shift the free end of the link into substantial registry with the lever's pivot, or from such registry; a flap upon each wing and deflectable between a non-operative and a deflected operative position; a pilot's flap control operatively connected to said flaps to effect such deflection thereof; means interconnecting said flap control and said link, to shift the latter's free end into coincidence with the lever's pivot by movement of the flap into non-operative position, to maintain the outboard aileron in its neutral position, and from such coincidence by movement of the flap into its operative position, to effect like deflection of the outboard and inboard ailerons while the flap is in its operative position.

10. In combination with the opposite elastic sustaining wings of a high-speed airplane, an inboard and a separate outboard aileron mounted upon each wing for deflection relative thereto, a pilot's aileron control, means continuously connecting said pilot's control to the respective ailerons for conjoint and like deflection of the inboard and outboard ailerons of each wing for normal functioning of both thereof during low-speed flight conditions, and means for moving the outboard aileron of each wing into and for retaining the same in a neutral position during high-speed flight conditions, but leaving the inboard aileron of each wing still operatively connected to the pilot's control, for continuing normal functioning of the connecting means.

11. The combination of claim 10, wherein the connecting means includes an operative connection between each inboard aileron and its outboard aileron, and the means for moving the outboard aileron into neutral position during high-speed flight conditions includes means for simultaneously disabling said operative connection, and including further, sensing means sensitive to high or to low speed of the airplane, and an operative connection between said sensing means and the disabling means, to actuate the latter automatically for disablement and movement of the outboard aileron upon the sensing by said sensing means of an airplane speed in a range higher than a predetermined critical low speed.

12. The combination of claim 10, wherein the connecting means includes an operative connection between each inboard aileron and its outboard aileron, and the means for moving the outboard aileron into neutral position during high-speed flight conditions includes means for simultaneously disabling said operative connection, and including further, an instrumentality shiftable between high-speed and low-speed positions, and an operative connection between said instrumentality and the disabling means, to actuate the latter for disablement of the outboard aileron and its movement into its neutral position upon movement of the instrumentality into high-speed position, and conversely, for reestablishment of control of the outboard aileron and its movement into position corresponding to the position of its inboard aileron upon movement of the instrumentality into low-speed position.

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