Aug. 23, 1949. L. M. HILTON ET AL 2,479,619

CONTROL SURFACE FOR AIRCRAFT, INCLUDING FULL SPAN FLAPS AND SPOILERS

Filed June 4, 1943 5 Sheets-Sheet 1

Fig. 1.

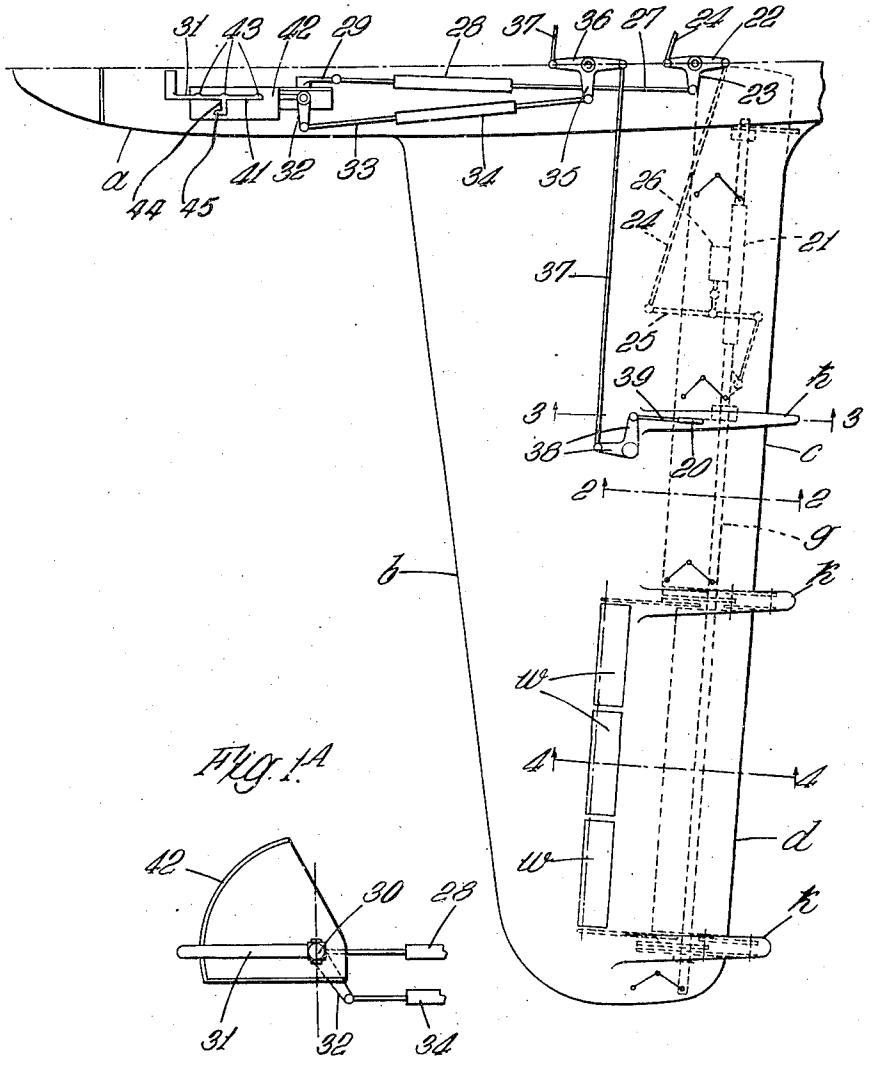


Fig. 1A.

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CONTROL SURFACE FOR AIRCRAFT, INCLUDING FULL SPAN FLAPS AND SPOILERS

Filed June 4, 1943 5 Sheets-Sheet 2

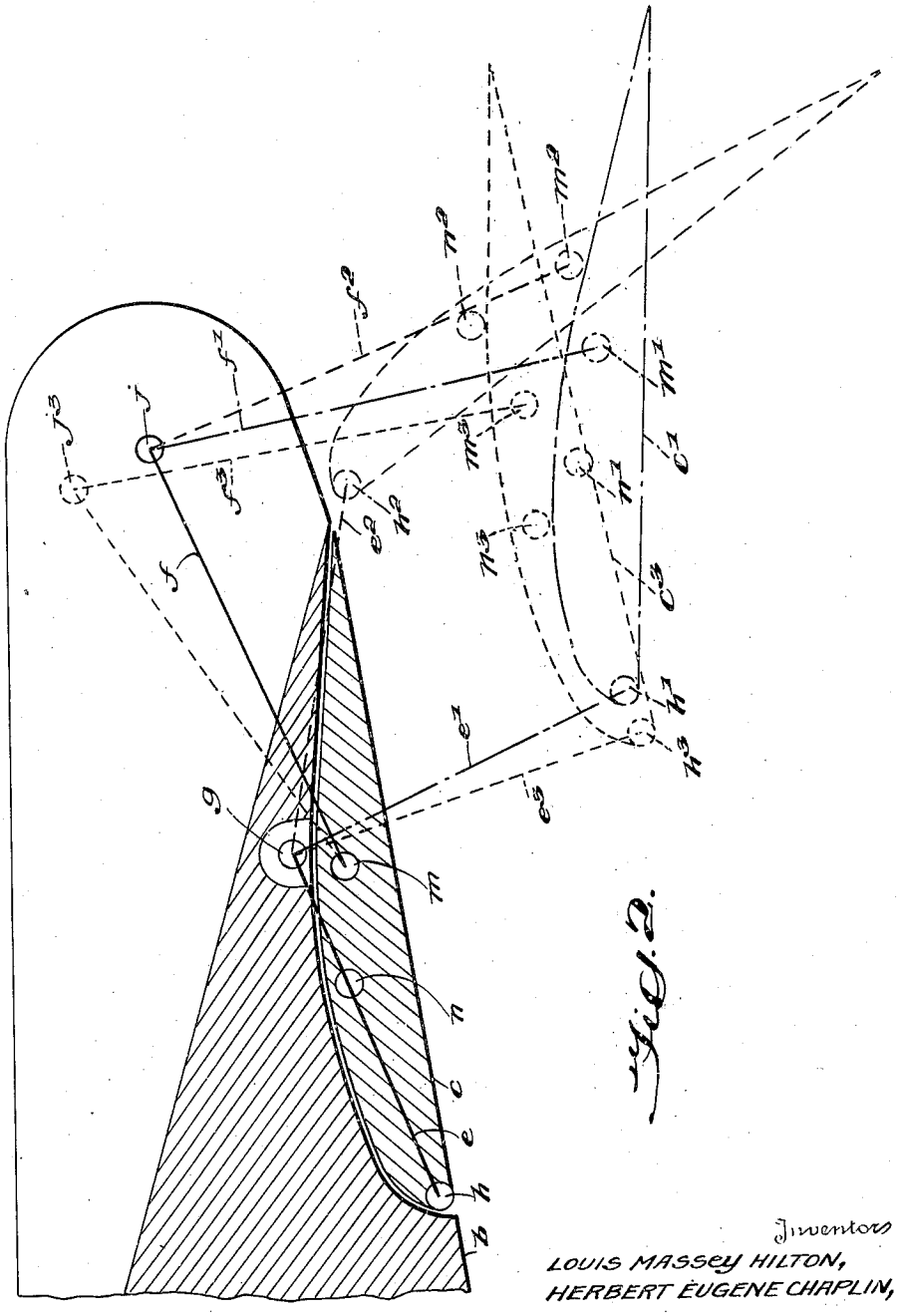


Fig. 2.

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CONTROL SURFACE FOR AIRCRAFT, INCLUDING FULL SPAN FLAPS AND SPOILERS

Filed June 4, 1943 5 Sheets-Sheet 3

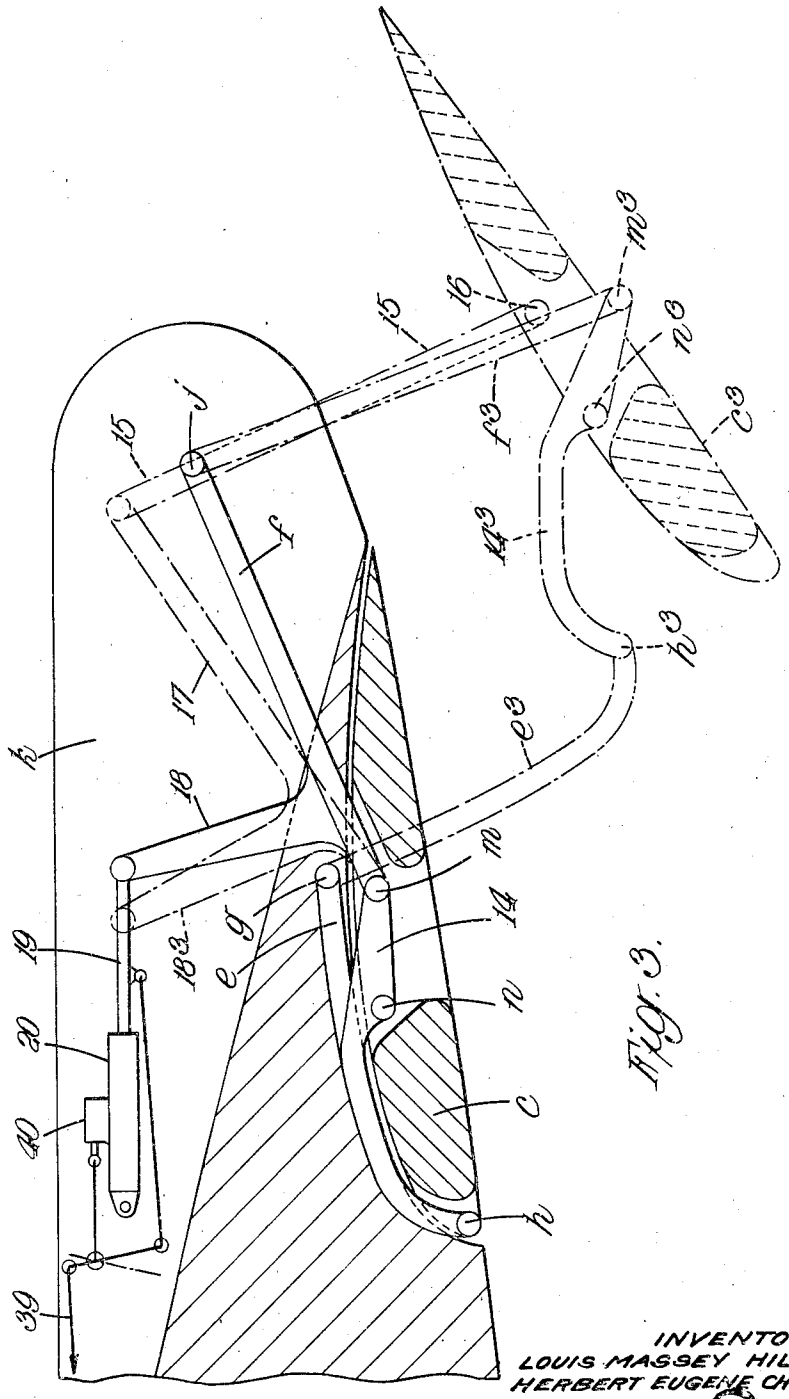


Fig. 3.

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CONTROL SURFACE FOR AIRCRAFT, INCLUDING FULL SPAN FLAPS AND SPOILERS

Filed June 4, 1943 5 Sheets-Sheet 4

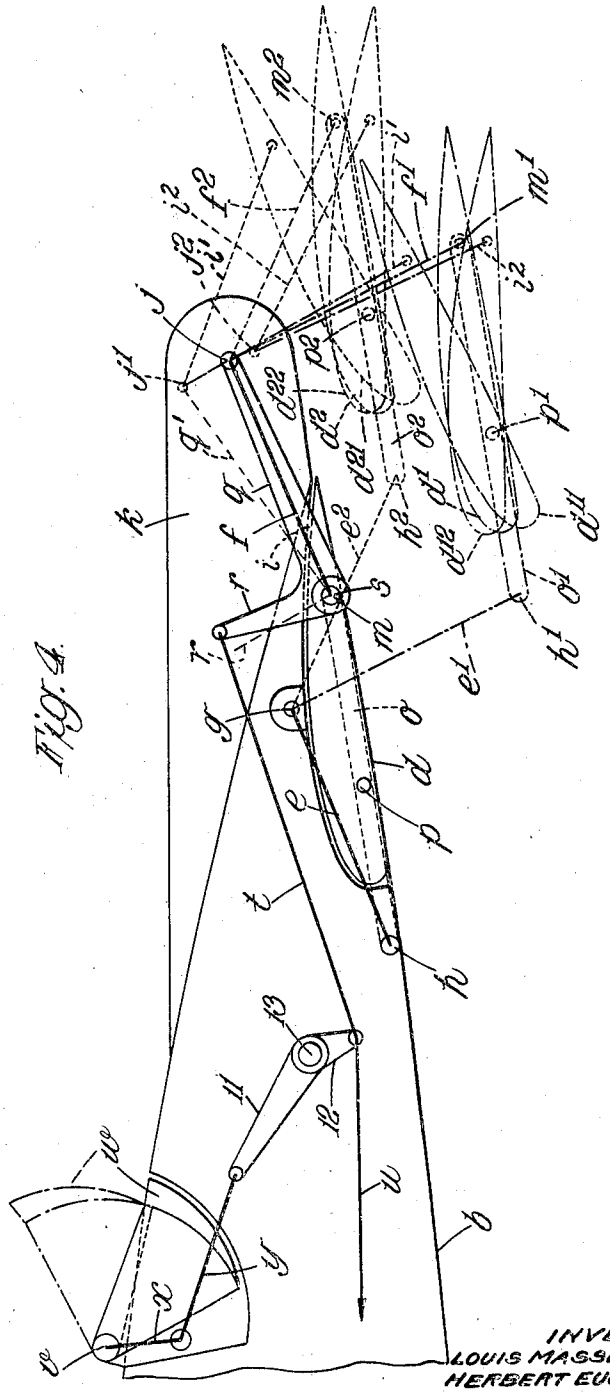


Fig. 4.

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CONTROL SURFACE FOR AIRCRAFT, INCLUDING FULL SPAN FLAPS AND SPOILERS

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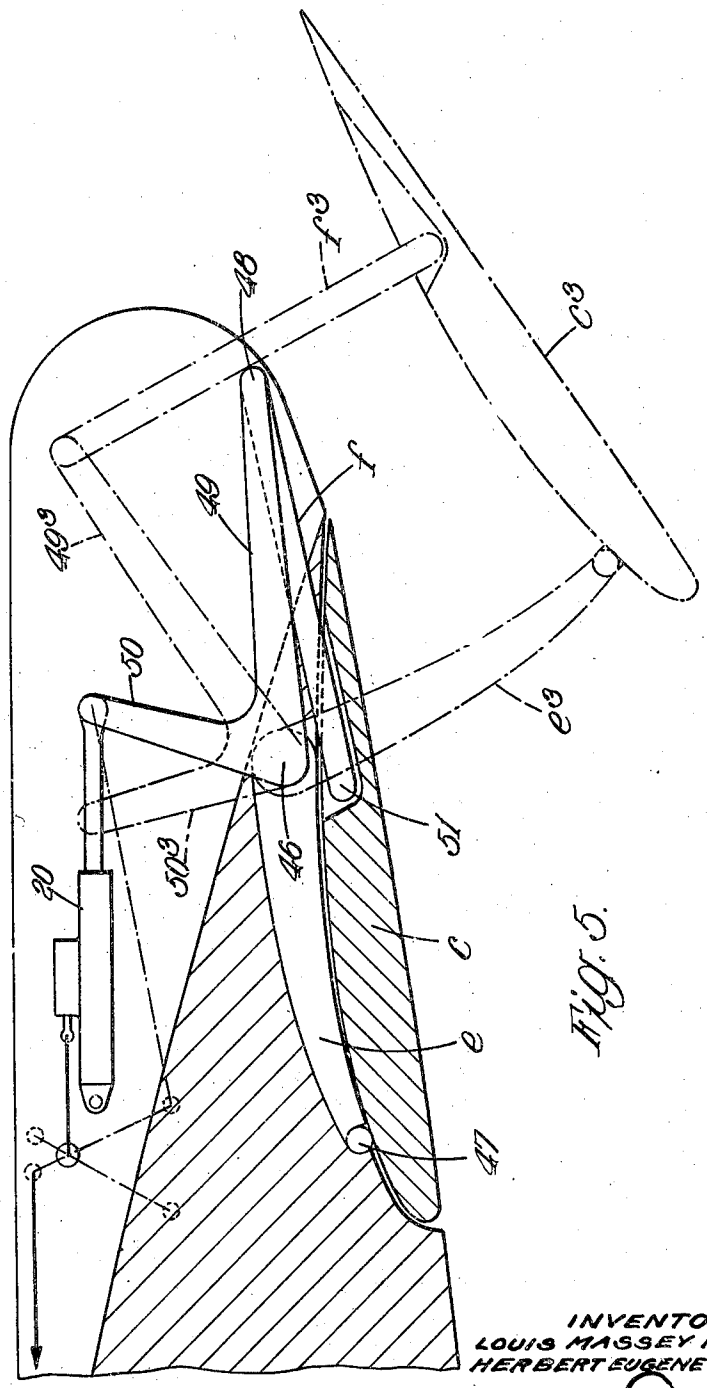


Fig. 5.

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Patented Aug. 23, 1949 2,479,619

UNITED STATES PATENT OFFICE

2,479,619

CONTROL SURFACE FOR AIRCRAFT, INCLUDING FULL SPAN FLAPS AND SPOILERS

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Application June 4, 1943, Serial No. 489,680
In Great Britain April 9, 1942

2 Claims. (Cl. 244—42)

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Among the known control surfaces for aircraft, apart from a simple aileron disposed at the trailing edge of a wing near the tip thereof, are a pivoted flap extending the full span of a wing without any aileron, or with an aileron forming part of the wing, the flap being arranged in rear of the trailing edge of the wing and of the aileron, and also a so-called spoiler, usually arranged to be projected upwardly from the upper surface of a wing for the purpose of destroying the lift. It is also known to arrange a flap to be lowered bodily below the level of a main aerofoil and to be turned, about an axis at, or near to, the centre of pressure, to raise or lower the leading edge of the flap, the turning of the flap being effected independently of, or concurrently with, the bodily lowering movement.

In another known arrangement a flap may be housed in a recess at the trailing marginal portion of a wing or lowered rearwardly to an inclined position, while a gap through the main portion of the wing may be opened and closed by members pivoted at the upper and lower surfaces of the wing and operated concurrently with said flap. Further, it is known to effect the bodily lowering and raising of flaps by means of a pair of double acting hydraulic jacks, the circuit of which is controlled by known means. In such a hydraulic system the movement of the pistons is transmitted to levers or similar members by which the flaps are actuated via operating shafts formed with long pitch threads co-operating with corresponding female threads in the aforementioned levers or similar members, to convert rectilinear movement of said shafts into rotary movement of the levers or similar members, the pitch of the threads being such that movement cannot be transmitted in the contrary direction. The object of the present invention is to retain the advantages of a full spin flap, to obtain a great degree of control of the aircraft at its slower speeds and to obtain a clean wing at its higher speeds.

To this end and in accordance with the invention a wing provided with a full span flap arranged to be housed in a recess in, and to be lowered bodily below the level of, the main wing, has the tip portion of the flap arranged to be usable as an aileron. The wing may also be provided at its upper surface with a spoiler, which may be used either alone or in conjunction with the aileron flap-part for control purposes. The spoiler and the aileron flap-part, when both are provided, may be actuated independently of one another each by its appropriate control means

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or they may be actuated concurrently by common control means. Preferably common control means for the spoilers and the aileron flap-parts on the opposite sides of the aircraft are so arranged that when the flaps are in their housed positions the means act only on the spoilers and do not produce any movement of the aileron flap-parts, but when the flaps have been lowered the means act on the spoilers and on the aileron flap-parts concurrently. Further, the connections of the spoilers and the aileron flap-parts with their common control means, as for example, the usual control lever or joy-stick, may be such that when the spoiler at one side of the aircraft is raised the leading edge of the aileron flap-part at the same side is depressed and the leading edge of the aileron flap-part at the other side is raised, but to a smaller extent than that to which the aileron flap-part at the first mentioned side is depressed. Simultaneously therewith the spoiler at the other side is depressed, but since the depression of the spoiler takes place within the thickness of the wing it is of no effect.

If desired, the inboard parts of the flaps (when the flaps, each as a whole, have been lowered bodily) may be arranged to be turned simultaneously and in the same direction about a transverse axis independently of the aileron flaps to act as air brakes for use when diving. For this purpose a single control lever may be arranged to act through alternative control means, one of said control means bringing about the bodily lowering and raising of the flaps, each as a whole, and the other bringing about the turning of the inboard parts of the flaps to act as air brakes. For example, a pivotally mounted control lever may be movable in a slotted arcuate guide. Notches are formed in one side of the slot to receive the lever when it has been brought to predetermined positions corresponding with predetermined positions of the flaps, each as a whole. The control means on which the lever acts when it is moved in the slot bringing about the lowering and raising of the flaps, each as a whole. The other side of the slot may be provided, at a predetermined position, with a gate through which the lever may be displaced laterally and then moved about its pivotal axis to act on the alternative control means which bring about the turning of the inboard parts of the flaps to act as air brakes.

In the accompanying drawings, Figure 1 is a diagrammatic plan of the leading end of the port side of an aircraft having control surfaces arranged in accordance with one form of this

invention; Figure 1A is a diagrammatic elevation of a portion thereof; Figure 2 is a diagrammatic presentation of the links and their connections, while Figures 3 and 4 illustrate the actual arrangement of the links and their connections. Figures 2, 3 and 4 are sections taken on the lines 2—2, 3—3 and 4—4, Figure 1, respectively; and Figure 5 is a fragmentary diagrammatic section similar to Figures 2, 3 and 4, but illustrating a modification.

As shown in Figures 1 to 4*a* is the fuselage of an aircraft, *b* is a wing thereof and *c d* is a full span flap mounted on the wing *b* substantially in a known manner by means of pair of links such as *e f* so that it may be lowered bodily from its normal housed or retracted position shown in full lines in Figures 2 and 4 to positions below the wing level. Figure 2 is purely diagrammatic in order to illustrate the general arrangement and positions to which the inboard parts of flap *c d* may be moved as some of the sections of such links *e f* with the flap *c d* as a whole are modified for the purposes of the present invention. The actual means for carrying the inboard part *c* are shown in Figure 3 and those for carrying the outboard part *d* are shown in Figure 4. The dotted line positions illustrate (I) a normal cruising position indicated at *c'* in Figure 2, and *d'* in Figure 4 when the links *e f* will be in the positions *e'*, *f'*; (II) a landing position indicated at c^2 in Figure 2 and d^2 in Figure 4, when the links *e f* will be in the positions e^2 f^2; and for part *c* (III) a diving position c^3 when the link *e* will remain in the position e^1 but the link *f* will be in the position f^3.

The flap *c d* is formed in two parts, an inboard part *c* and an outboard aileron flap-part *d*, both said parts moving as one during the bodily lowering movement to the position c^1. The aileron flap-part *d* when actuated by the joy-stick has a further turning movement (up or down), while the inboard part *c* of the flap, for diving purposes, may be turned independently of the aileron flap-part *d* to the position c^3 by alternative actuating means as hereinafter described.

The upper end of the front link *e* of each pair is pivoted to the aircraft wing on the axis of a shaft *g* formed with long pitch threads (as mentioned above and to which further reference will be made hereinafter) above the recess in the wing *b* in which the flap *c d* is housed. The lower end of the link *e* is pivoted, virtually at *h*, in relation to the leading edge of the flap *c d*. The upper end of the rear link *f* of each pair is pivoted, actually or virtually at *j*, to a bracket *k* extending upwardly and rearwardly from the trailing marginal portion of the wing *b*. The lower end of the link is pivoted, virtually at *m*, in relation to the flap *c d* near its upper surface and in rear of its centre of pressure at *n*. The lengths of links *e f* is such that during the bodily lowering movement of the flap *c d*, as a whole, said flap moves through a series of positions substantially parallel with its housed position. However, after the links *e f* have passed from forward and downward inclination, through vertical positions, to rearward and downward inclination, the flap rises again and the leading edge is raised slightly when it reaches its "cruising" position c^1. Further rearward movement of the links *e f* causes the leading edge of the flap-part *c* to be raised further to bring the flap to its "take off" position (not shown in Figure 2) and still further rearward movement of the links *e f* causes said leading edge to be raised still further to bring the flap-part to its "landing" position c^2.

At the ends of the outboard part *d* of the flap (see Figure 4) the lower ends of the flap-lowering links *e f* are pivotally connected at *h* and *m* with the front and rear ends of carrier links such as *o*, and the aileron flap-part *d* is pivotally mounted on a spindle *p* extending between a pair of such carrier links, one at each end of the aileron flap. The axis of the spindle *p* passes through, or near, the centre of pressure of the aileron flap-part *d* and through intermediate points approximately midway of the length of the carrier links *o*.

In order that the aileron flap-part *d* may be moved above its pivotal axis *p* to act as an aileron after the flap *c d*, as a whole has been lowered, the flap-part *d* has pivotally connected therewith the lower end of an operating link *i* which corresponds with a rear flap-lowering link *f*. The upper end of link *i* is pivoted at a point which is normally coaxial with the upper pivot of said rear flap-lowering link *f* to one arm *q* of a bell crank lever *q r* pivoted at *s* on the wing *b*, the other arm *r* of the bell crank lever being connected by links *t u* with the control lever or joy-stick (not shown). Hence it is seen that when the joy-stick is actuated, the pivot *j* at the upper end of link *i* is raised or depressed, for example, to the positions j^1 or j^2. Thus the aileron flap-part *d* may be turned about its pivotal axis *p* irrespective of the inclination imparted to the carrier links *o* according to the position to which the flap *c d*, as a whole, has been moved by the flap-lowering links *e f*.

In Figure 4 the aileron flap-part *d* is shown in full lines in its housed position and in broken lines in (*i*) its cruising position d^1, angularly adjustable as at d^{11} and d^{12} and (*ii*) its landing position d^2, angularly adjustable as at d^{21} and d^{22}. The corresponding positions of the lowering and carrier links are indicated at e^1, f^1, o^1 and e^2, f^2, o^2 respectively and the corresponding positions of the pivotal points *h*, *m* and *p* being indicated at h^1, m^1 and p^1 and h^2, m^2 and p^2 respectively.

In the upper surface of the wing *b* and forward of the recess for the aileron flap-part *d*, there is pivoted on a spindle *v* a spoiler *w*, the top of which, when in its neutral position is substantially flush with the upper surface of the wing. A crank arm *x* is mounted on the spindle *v* of the spoiler *w* and is connected by a link *y* with one arm 11 of a lever 11, 12 of the first order. The lever 11, 12 is pivoted at 13 on the wing *b*. The other arm 12 of said lever is shorter than the arm 11 and is connected by the link *t* with the arm *r* of the bell crank lever *q r* which brings about the turning of the aileron flap-part *d*. As stated above the link *t* is also connected with the link *u* which in turn is connected with the control lever or joy-stick. Hence, when the flap *c d* as a whole, is lowered and the control lever or joy-stick is actuated, the spoiler *w* is raised or lowered concurrently with the actuation of the aileron flap-part *d*. When the flap *c d*, as a whole, is in its housed position the pivotal axis *m* of the connection between the lower ends of the rear flap-lowering links *f* and the rear ends of the carrier links *o* coincides with that *s* of the bell crank lever *q r*. Hence, the actuation of the control lever or joy-stick to raise or lower the spoiler *w* does not produce any

movement of the aileron flap-part *d* but merely turns the rear flap-lowering links *f* about the common axis.

At the ends of the inboard part *c* of the flap *c d* (see Figure 3) the upper ends of the front and rear flap-lowering links *e* and *f* are pivoted to the wing *b* at *g* and virtually at *j* to the upwardly and rearwardly extending bracket *k*, respectively. The lower ends of the links *e, f* are pivotally connected at *h* and *m* with the front and rear ends, respectively, of carrier links such as 14 as shown in Figure 3, the inboard part *c* of the flap *c d* is pivotally mounted between a pair of such carrier links 14 on an axis *n* passing through, or near, the centre of pressure of the inboard part *c* and through intermediate points approximately midway of the length of the carrier links 14.

In order that the inboard part *c* of the flap *c d* may be turned about its pivotal axis *n* to a "braking" position c^3 for diving, shown in broken lines, after the flap *c d* as a whole, has been lowered to its "cruising" position c^1, (not shown in Figure 3, but see Figure 2) the front flap-lowering links *e* are not actually pivoted to the inboard part *c* but their pivotal connections at *h* with the front ends of the carrier links 14 are situated at the leading edge of part *c*. The lower ends of operating links such as 15 are pivoted to the inboard part *c* at 16 in rear of its pivotal axis *n* on the carrier links 14. The upper ends of the operating links 15 are pivoted to the rear ends of the horizontal members, such as 17, of inverted T-shaped levers 17, 18, the front ends of which are pivoted to the wing *b* at the top of the flap housing. The pivotal axes at the upper and lower ends of the operating links 15 are coincident, in all positions of the inboard part *c* except its "diving" position c^3, with those of the pivotal connections *j* and *m* of the upper and lower ends of the rear flap-lowering links *f*. In the same manner, the pivotal axis of the front ends of the members 17 of the inverted T-shaped levers 17, 18 is coincident, or substantially coincident, with that *m* of the lower end of the front flap-lowering link *f* when the flap-part *c* is in its "housed" position.

In view of this coincidence of pivotal axes except when the inboard part *c* of the flap *c d* is in its "diving" position c^3, only the housed and "diving" positions *c* and c^3 of said part are shown in Figure 3, the former indicating the coincidence, while the latter shows the elements in their "diving" positions c^3, e^3, f^3, h^3, j^3, (see also Figure 2), m^3, n^3, 14^3. This view also permits the operating link 15, the pivot 16, and the horizontal member 17 to be seen; 18^3 indicates the position of the member 18 of the inverted T-shaped levers 17, 18 when the part *c* is moved to its "diving" position c^3.

The free ends of the upright members 18 of the inverted T-shaped levers 17, 18 are connected with operating means such as the plunger 19 of an hydraulic jack 19, 20 mounted on the wing *b*. The arrangement is such that, when the flap-lowering links *e f* have been actuated to bring the flap *c d* to the "cruising" position and the hydraulic jack 19, 20 is actuated to rock the inverted T-shaped levers 17, 18 about their pivotal axis *m*, they move the operating links 15 connected therewith upwardly (each substantially in its own direction), for example upwards from behind the link *f* shown in full lines in Figure 3. This causes the inboard part *c* of the flap *c d* to turn about its pivotal axis *n* on the carrier links 14, its leading edge being depressed and the inboard part *c* is thus brought to its "diving" attitude c^3.

Referring now to Figures 1 and 1A, the flap-lowering links *e f* are actuated by means of threaded parts of longitudinally movable shafts *g* co-operating with nuts as set out in the specification of Letters Patent No. 538,545. The controlling means for the hydraulic jacks 21 of such mechanism includes a T-shaped lever 22, 23, the opposite ends of the member 22 of which are connected by links 24, 24 and levers such as 25 with the control valves such as 26 for the hydraulic jacks 21 on the opposite sides of the aircraft *a*; the free end of the upright member 23 of said lever 22, 23 is connected by a link 27 (including a spring buffer box 28 to take up, or provide for, lost motion) with a crank arm 29 on a spindle 30 extending across a selector box and with which an operating lever 31 may be connected by a clutch (not shown) when it is displaced in the appropriate direction along the spindle 30. On said spindle 30 is a second crank arm 32 which is connected by a link 33 (including a spring buffer box 34) with the free end of the member 35 of another T-shaped lever 35, 36. The opposite ends of the horizontal member 36 are connected through links 37, 37, to a bell crank lever 38, and link 39 with the control valves such as 40, Figure 3, for those hydraulic jacks 20 disposed on the opposite sides of the aircraft *a* which actuate the inverted T-shaped levers 17, 18 for bringing the inboard parts *c* of the flaps *c d* to their "diving" positions c^3. The operating lever 31 is movable in a slot 41 in an arcuate guide 42 and is clutched to the crank 29 on the spindle 30 so that movement of lever 31 about the axis of the spindle 30 will actuate the flap-lowering links *e f*. At the appropriate side of the slot 41 in the arcuate guide 42 are notches 43 corresponding with the "housed", the "cruising", the "take off" and the "landing" positions of the flaps (see Figure 1A), into which notches 43 the lever 31 is spring urged. At the other side, and opposite the "cruising" notch 43, the slot 41 is formed with a gate 44 leading to a short slot 45 parallel with the former so that, after the flaps *c d* have been brought to the "cruising" position, the lever 31 may be moved through the gate 44 and thereby declutched from the crank arm 29 and clutched to the second crank arm 32. Movement of lever 31 in the short slot 45 will then bring about the turning of the inboard parts *c* of the flaps *c d* to their "diving" positions c^3.

In a modification illustrated by Figure 5, the upper ends of the front flap-lowering links *e* at the ends of the inboard part *c* of the flap *c d* are pivoted to the wing *b* at 46. Their lower ends are pivotally connected at 47 with the inboard part *c* of the flap *c d* near its leading edge. The upper ends of the rear flap-lowering links *f* are pivoted at 48 to one arm 49 of a bell crank lever 49, 50 and their lower ends are pivoted at 51 to the inboard part *c* of the flap *c d* in rear of its centre of pressure. The bell crank lever 49, 50 may be pivoted about the same axis 46 as the upper ends of the front flap-lowering links *e*. The arm 50 of the bell crank lever is connected with an hydraulic jack 20 or like operating means, the actuation of which will cause the bell crank lever 49, 50 to be turned about its pivot 46 to raise the upper ends of the rear flap-lowering links *f* to bring the inboard part *c* of the flap *c d* to its "diving" position, c^3, the positions of other elements being shown at e^3, f^3, 49^3 and 50^3.

In the foregoing example of the invention

different means are described and illustrated in Figures 3, 4 and 5 for bringing about the actuation of the inboard and outboard parts of the flaps *c d*, but it is apparent that any of these means may be used for either or both the inboard and/or outboard parts of the flaps.

The improved construction is such that at all speeds the advantages of a full span flap are retained, while at slower speeds, as for example when taking off and landing, when the spoilers *w* are not very efficient, the positions of the aileron flaps *d* below, and in rear of, the trailing edge of the wing *b* give very efficient control of the aircraft. At cruising speeds the spoilers *w* and the aileron flaps *d* combine for effecting lateral control. Further, at higher speeds when the spoilers *w* are efficient, a very clean wing may be obtained by housing the flaps *c d*, each as a whole. The means for turning the inboard parts *c* of the flaps enable very efficient air brakes to be presented for diving purposes without detracting from the lateral control which can be obtained by the aileron flaps *d*.

We claim:

1. A full span flap for aircraft wings, each of said wings having a recess formed therein for housing said flap, said wings being disposed on opposite sides of an aircraft, means for lowering said flap bodily from said recess to below the level of said wing, a separate outboard portion forming part of said flap and pivotally mounted in relation to said wing, a spoiler mounted at the upper surface of said wing, and common control means for actuating said spoilers and said outboard portions on the opposite sides of the aircraft, said means acting on said spoilers only, when the flaps are housed in said recesses, without producing any movement of said outboard portions, and acting on said spoilers and said outboard portions concurrently, when said flaps are lowered from said recesses, the connections of said spoilers and said outboard portions with the common control means being such that when the spoiler at one side of the aircraft is raised the leading edge of the outboard portion at the same side is depressed and the leading edge of the outboard portion at the other side is raised, but to a smaller extent than that to which the outboard portion at the first mentioned side is depressed, said spoiler at said other side being depressed simultaneously.

2. A full span flap for aircraft wings, each of said wings having a recess formed therein for housing said flap, said wings being disposed on opposite sides of an aircraft fuselage, said flap having an inboard portion and a tip or outboard portion, pivotal relatively to said inboard portion, means for lowering said flap bodily from said recess to below the level of said wing and means for turning the inboard portions at the opposite sides of the aircraft simultaneously and in the same direction about an axis transverse of the aircraft independently of pivotal movement of the tip or outboard portions, both said means being operable by a single control lever acting through alternative control means, one of said alternative control means bringing about the bodily lowering and raising of the flaps, each as a whole, and the other alternative control means bringing about the turning of the inboard portions of the flaps to act as air brakes, an arcuate guide having a slot within which said control lever is movable, the slot having at one side notches adapted to receive said lever when it has been brought to predetermined positions corresponding with predetermined positions of the flaps, each as a whole, the alternative control means on which the lever acts when it is moved in said slot bringing about the lowering and raising of the flaps, each as a whole, and the slot having at a predetermined position at its other side a gate through which the lever may be displaced laterally and then moved about its pivotal axis to act on the alternative control means which bring about the turning of the tip or inboard portions of the flaps to act as air brakes.

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HERBERT EUGENE CHAPLIN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,723,653	Lybrand	Aug. 6, 1929
1,862,902	McDonnell	June 14, 1932
2,066,336	Crouch et al.	Jan. 5, 1937
2,220,194	Albright	Nov. 5, 1940
2,252,656	Youngman	Aug. 12, 1941
2,329,177	Baker	Sept. 14, 1943

FOREIGN PATENTS

Number	Country	Date
517,895	Great Britain	Feb. 12, 1940
521,190	Great Britain	May 15, 1940

Certificate of Correction

Patent No. 2,479,619 August 23, 1949

LOUIS MASSEY HILTON ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 1, line 40, for the word "spin" read *span*;

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of December, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.