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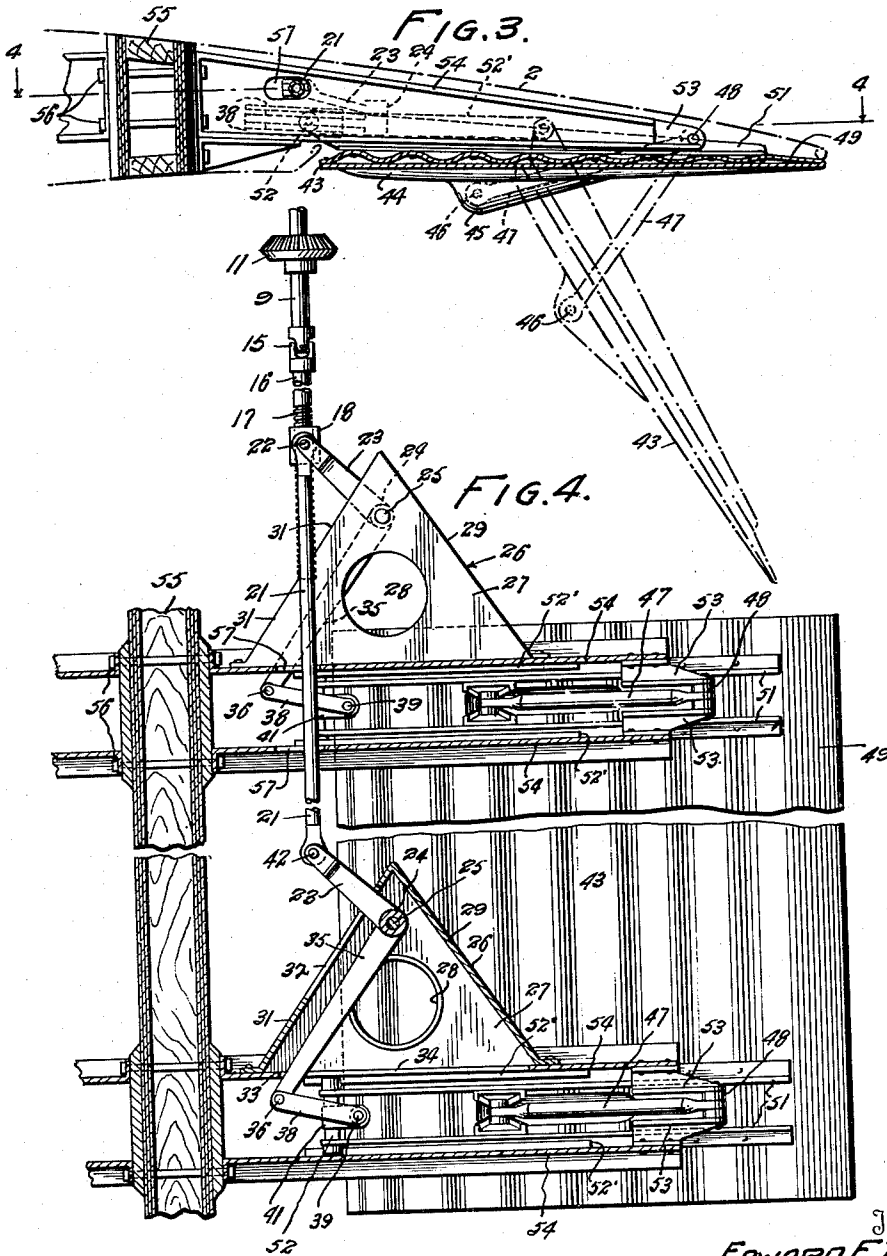
E. F. ZAPARKA

2,170,886

AIRFOIL MECHANISM

Original Filed May 31, 1933

4 Sheets-Sheet 2



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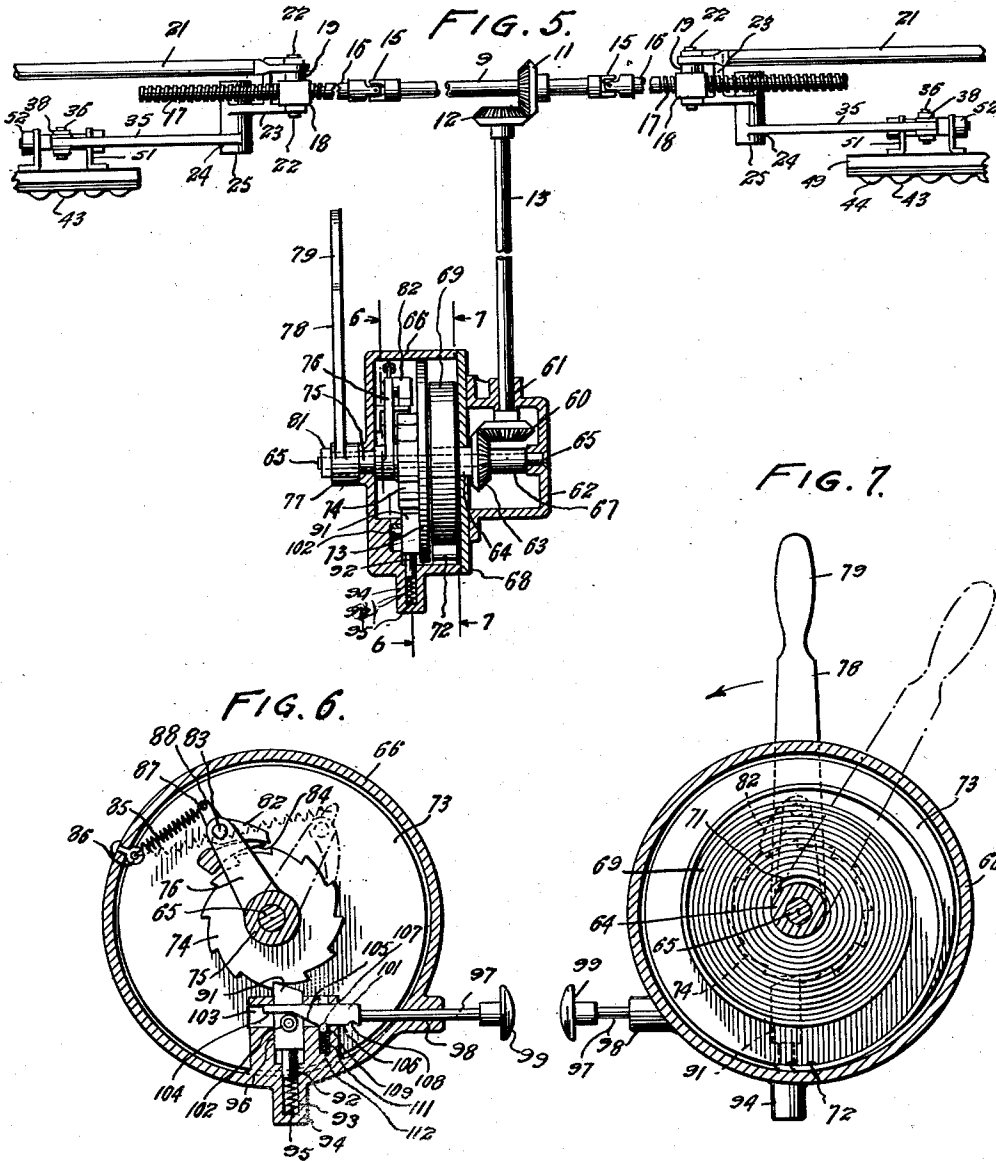
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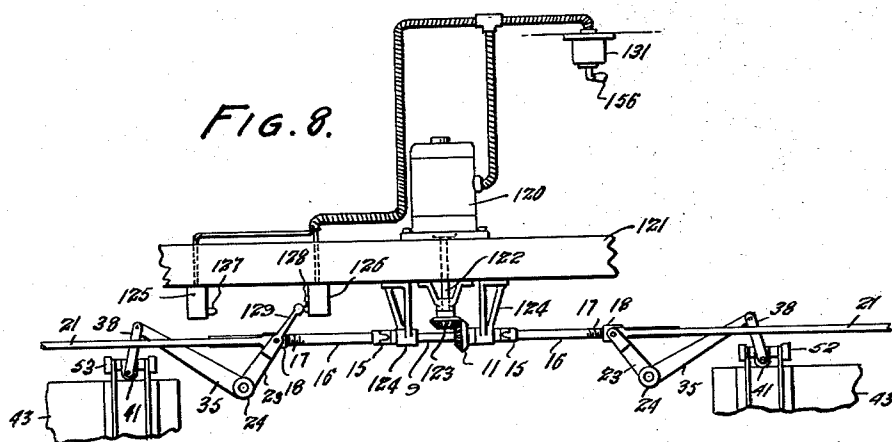
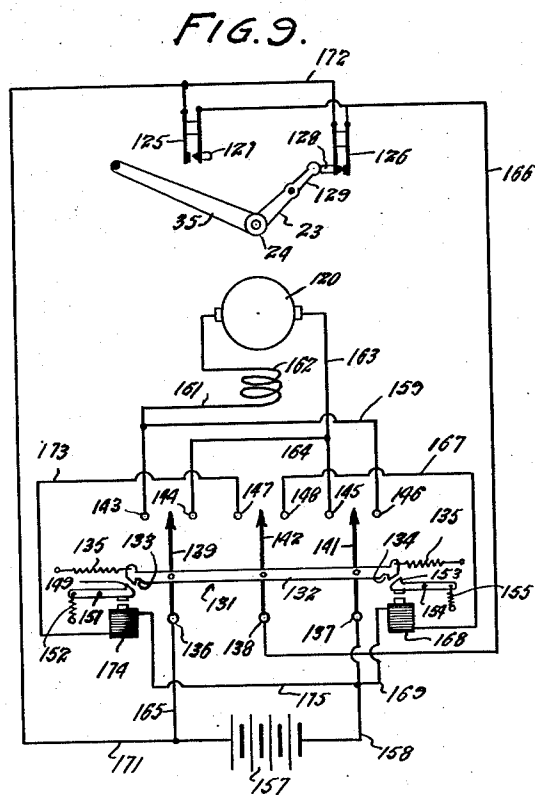
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AIRFOIL MECHANISM

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Application May 31, 1933, Serial No. 673,730
Renewed December 19, 1936

11 Claims. (Cl. 244—42)

My invention relates to airplanes, and more particularly to operating mechanisms for moving wing flaps or similar constructions into their operative and inoperative positions.

5 An object of my invention is to provide a means for stored energy on the plane which will permit the wing flaps to be quickly moved from inoperative to operative position.

10 A further object of my invention is to control the movement of the flaps so that their motion can be arrested at any desired point in their travel from operative to inoperative position.

Yet another object of my invention is to provide means for controlling the operation of an 15 electric or other motor carried on the plane so that the source of electrical energy flowing to the motor shall be cut off adjacent the limit points of movement of the flap mechanism.

While I have shown in the drawings certain 20 embodiments of the invention, these embodiments are but examples, and I do not desire that my claims be limited to the exact showings made.

In the drawings:

Figure 1 is a perspective view of an airplane 25 having wing flaps and my aileron constructions;

Fig. 2 is a detail view of the fuselage, with parts broken away to show the ratchet handle for the spring power type of flap operating mechanism;

30 Fig. 3 is a side view partly in section of a wing tip showing the position of the flap operating parts; the flap being shown in dotted lines in the down position;

Fig. 4 is a detail top plan view of the flap operating mechanism for one of the wings, parts being 35 broken away to show the construction;

Fig. 5 is a detail view of the spring power mechanism for operating the flaps, parts being shown in section to indicate the construction;

40 Fig. 6 is a view taken along the line 6—6 of Figure 5, looking in the direction of the arrows;

Fig. 7 is a view taken along the line 7—7 of Figure 5, looking in the direction of the arrows;

Fig. 8 is a detail view of a modification employing electric power to operate the wing flaps; 45

Fig. 9 is a schematic view showing the wiring diagram for the form of invention illustrated in Figure 8.

Referring to the drawings, Figures 1 to 7 inclusive, I have shown an airplane having a fuselage 1, wings 2, empennage control surfaces which I have designated generally by the numeral 3, ailerons 4 mounted above the wings, and wing flaps 5.

55 The ailerons 4 are mounted on horns 6, and

operated by aileron control rods 7 which are attached to horns 8 mounted on the ailerons. The mechanism for operating the ailerons and their principle of operation has been fully described by me in other co-pending applications, such as my 6 application Serial No. 653,918.

The wing flaps 5 may be of the type whose trailing edge in all positions of extension or retraction lies within the locus of perpendiculars 10 to the datum lines of the wing sections which pass through the trailing edge of the wing. It is obvious, however, that other types of wing flaps may be used. The mechanisms which I have shown for the operation of wing flaps may be adapted to other types. 15

The principles of operation of the ailerons 4 and the wing flaps 5 are given in my co-pending application Serial No. 657,134, where the mutual interaction of these elements is clearly expanded.

The flaps 5 are adapted to be operated by the 20 rotation of a shaft 9 which carries a bevel gear 11 which meshes with a bevel gear 12. The bevel gear 12 is carried on a shaft 13 suitably journaled in a support 14 which is attached to the interior of the airplane construction. The mechanism for 25 rotating the shaft 13 will be later described.

The mechanism for operating the wing flaps 5 upon rotation of the shaft 9 will now be described.

The shaft 9 is provided with gimbal joints 15 which permit transmission of torque and also permit free movement in all planes. The gimbal joints 15 carry shafts 16 which are provided with screw-threaded sections 17. In screw-threaded engagement with the portions 17 of the shafts 16 are operating heads 18 to which are pivoted at 35 19 operating rods 21, which are adapted to operate remote stations in the wings for effecting movement of the flaps.

The operating heads 18 carry pivots 22 to which are pivoted forked arms 23 of bell crank 40 levers 24 which are pivoted at the angle of the bell crank arms to pins 25 which are anchored in a triangular box-like support construction 26 which has triangular sides 27 with holes 28 cut away in them to lighten the construction. The 45 triangular box-like members are provided with three side pieces. One side piece 29 has no aperture in it. Another side piece 31 is provided with an aperture or slot 32, and another side piece 33 is provided with another slot or aperture 34. The 50 bell crank levers 24 have other arms 35 which carry pivot pins 36 at their ends over which fit links 38. The other end of the links 38 are pivoted at 39 to connecting members 41 which are attached to the flap construction. 55

The linkages described are the same for various flap operating stations on the wings. The stations most adjacent to the gimbal joints 15 have the arms 23 of the bell crank levers 24 attached directly to the operating heads 18 which are on the screw-threaded portions 17 of the shafts 16. The stations most remote from the gimbal joints 15 have the arms 23 of the bell crank levers 24 pivoted at 42 to the end of the operating links 21, the link ends thus constituting the operating heads for these remote stations.

The shaft 9 is adapted to be rotated in either direction by a mechanism to be described. This rotation is transmitted to the shafts 16 beyond the gimbal joints 15, and through the linkages described the links 38 are thrust either towards the rear of the wing or pulled towards the front of the wing. When the links 38 are thrust to the rear of the wings, the flaps are extended; when they are pulled towards the leading edge of the wings, the flaps are retracted. The wing flap constructions have been described in some detail in previously filed applications.

The wing flaps themselves I have designated by the numeral 43. The flaps comprise a lower smooth surface 44 having downwardly extending housing portions 45 in which are pivoted at 46 links 47, whose other ends are pivoted at 48 in the wing construction. There are provided corrugated metallic bracing members 49 having channel members 51 on their upper surface. The links 41 are pivoted to pivot pieces 52 which slide in tracks 52' on the support members. The pivots 48 for the links 47 are attached to support pieces 53 carried on the ends of support members 54 which are attached to the rear wing spar 55 by means of bolts 56. The rods 21 pass through apertures 57 formed in the support members 54 at the stations nearest the fuselage. When the links 38 are pushed to the rear, they pull on links 41 and these, through pins 52, move the flaps downward into the position shown in dotted lines in Figure 3. When the movement of the links 38 is in the opposite direction, the flaps are moved into the position shown in full lines in Figure 3. Pins 52 are attached to channel members 51 carried by the flaps.

These flaps, as hereinbefore stated, may be of the type wherein the dimensions of the flap, length of linkages and other factors are such as to cause the trailing edge of the flap to lie in positions of extension and retraction within the locus of perpendiculars drawn through the trailing edge of the wings and perpendicular to the datum lines of the wing sections. It is to be understood, however, that I am not limited to this particular type of flap in connection with the use of the operative mechanisms and systems which are described in this application.

In order to rotate the shaft 9 to either extend or retract the flaps, as before explained, I rotate the shaft 13. The shaft 13 carries at its lower end a beveled gear 60. The shaft 13 at its lower end is journaled at 61 in a gear casing 62. Within the casing 62 in mesh with the beveled gear 60 is a beveled gear 63. The beveled gear 63 is mounted on the end of an annular sleeve 64 which is adapted to rotate on a shaft 65, which is attached at one end to the casing 62 and which passes through a casing 66 at its other end. A spacing sleeve 67 on the shaft 65 tends to prevent play between the gears 60 and 63.

The casing 62 rests against a cover plate 68 which covers the open side of the casing 66. Mounted within the casing 66 is a spirally

wound spring 69, the inner end of which is attached at 71 to the sleeve 64. The outer end of the spring 69 is attached by suitable rivets or otherwise, as indicated at 72, to the interior of the casing 66.

The sleeve 64 carries a revoluble circular plate 73 which carries a ratchet wheel 74. The ratchet wheel 74 may be made integral with the plate 73, or may be suitably attached to it. Mounted to revolve on the shaft 65 is a sleeve 75 which carries a pawl lever 76. The sleeve 75 passes through an aperture made in the casing 66 and projects beyond the casing. There is attached to the sleeve 75 an encircling collar member 77 which carries an operating lever 78 provided with a handle 79. The encircling collar 77 may be attached to the sleeve 75 by screws or any other suitable device. The shaft 65 at its end which terminates in the casing 62 may be provided with an enlarged head to hold it in place in a suitably formed aperture in the casing 62. At its other end the shaft 65 may be screw-threaded and provided with a holding nut 81.

The pawl lever 76 is provided with a pawl member 82 which is pivoted at 83 on the pawl lever 76. The member 82 is adapted to contact with the ratchet teeth on the ratchet wheel 74, when the handle 79 is pulled in a direction corresponding to that indicated by the arrow in Figure 7. A cam member 84 operates to hold the pawl 82 from contact with the ratchet teeth when the handle 79 is held in its off position.

The handle 79 is held in its off position by means of a spring 85 which is attached to a ring construction 86 suitably riveted or otherwise attached to the interior of the casing 66. The other end of the spring is attached at 87 to a lug 88 formed on the end of the pawl lever 76. When the handle 79 is pulled in the direction indicated by the arrow in Figure 7, i. e., when the pilot seated in his seat 89 in the cockpit pulls the handle 79 towards him the pawl 82 slides off the cam 84, contacts with one of the ratchet teeth on the ratchet wheel 74 and moves the ratchet wheel 74 in a clockwise direction, looking at the parts as they are indicated in Figure 6. The position of the parts in the rearmost movement of the handle 79 is indicated in dotted lines in Figure 6. The spring 85 is extended in this position and will tend to return the lever 78 and its handle 79 to the forward position, such position being indicated in dotted lines in Figure 7.

The mechanism for holding the ratchet wheel 74 in the position to which it has been advanced by the operation just described comprising a spring pressed pawl member 91 which has a downwardly projecting guide member 92 which fits within an aperture 93 formed in an extension of the casing 66, which I have indicated by the numeral 94. There is a spring 95 which bears against the interior bottom portion of this extension at one end and against the bottom of the guide member 92, tending to hold the pawl 91 in the up position to prevent counterclockwise movement of the ratchet wheel 74, looking at the parts as shown in Figure 6. The pawl member 91 is adapted to reciprocate in guides 96 formed in the interior of the casing 66.

A release plunger 97 is provided, which is adapted to slide in an aperture formed at 98 in the casing 66. The release plunger 97 is provided with an operating button 99. The other end of the release plunger carries a cam member 101 which has surfaces that are adapted to bear against a roller 102 carried by the spring pressed

pawl member 91. The cam member 101 slides in an aperture 103 formed in the top of the guides 96. The lower surface of the cam member is provided with a substantially horizontal surface 104, a sloping surface 105 and another substantially horizontal surface 106 having notches 107 and 108 formed therein. A latch 109 is held in an aperture 111 formed in one of the guides 96. A spring 112 presses the latch 109 against the lower horizontal surface 106 of the cam member 101. The latch member 109 is adapted to ride along the surface 106 and to engage notches 107 and 108 to hold the cam member in desired positions after moving the operating button 99 to adjust the cam.

Upon pushing the operating button 99 inward, the roller 102 is operated upon by sloping cam surface 105, and the pawl member 91 is retracted downwardly against the pressure of the spring 95. This permits the spring 69 to unwind and to revolve the bevel gear 63 to extend the flap. If the operating button 99 is pushed in until the latch 109 engages the notch 108 on the surface 106, the operating button 99 will be held in such position as to permit the spring 69 to fully unwind and to fully extend the flaps 5. However, by pulling on button 99, the cam member 101 can be moved in the opposite direction, permitting the spring 95 to push the pawl member 91 in the upward direction to engage a tooth on ratchet wheel 74 and to arrest the unwinding of the spring 69.

By suitable manipulation of the button 99, therefore, the flaps may be extended to any desired extent from the fully retracted position to their fully extended position, and the power for accomplishing the work necessary to extend the flaps is furnished by the stored energy of the spring 69.

As before explained, by operation of handle 79 of lever 78, the flaps can be rewound into their retracted position and the spring 69 coiled tightly ready to expend its force in moving the flaps into the desired operative position. In working the handle 79 back and forth, the pawl member 82 engages the ratchet teeth on wheel 74 and the wheel 74 is revolved. It is prevented from sliding backward when the handle 79 is moved in the opposite direction by the spring 85 by reason of the engagement of the pawl member 91 with the ratchet teeth. The pawl member 91 in the position of the parts shown in Figure 6 is free to slide over the surface of the ratchet teeth on ratchet wheel 74, and to be pushed into the notches formed by these teeth to prevent a counter-clockwise movement of the ratchet wheel 74 when looking at that wheel from the position in which the view in Figure 6 is taken. By having the spring 69 of considerable power, the flaps can be quickly extended as needed in emergency, and the degree to which they may be extended by the spring 69 is readily controllable through the operating button 99, as just described.

Referring to Figures 8 and 9, I have shown an electrical system for operating the flaps.

In Figure 8 I have shown a detailed view which is somewhat diagrammatic, in which is mounted a motor 120 on a spar or beam 121 carried in the airplane construction. The motor is provided with a shaft 122 which carries a bevel gear 123 which meshes with the bevel gear 11 which operates the shaft 9 of the flap operating mechanism previously described. The shaft 9 may be journaled at 124 on the spar or beam 121. The spar or beam 121 carries switch mechanisms 125 and 126 which have switch buttons 127 and 128,

respectively, which are adapted to contact with a switch operating arm 129 formed as an extension of one of the arms 23 of the bell crank levers 24.

The switches 25 and 26 are automatic in operation to arrest the operation of the motor 120 when it has wound up the flap into its furthestmost retracted position or extended the flap into its lowermost extended position. To control the movements of the flap in either direction and to stop them at any desired point, I have provided a hand switch 131.

Referring particularly to Figure 9, I have shown the switch 131 as comprising a bar 132 having a notch at one end 133 and a notch at the other end 134. Springs 135 at either end tend to hold the bar 132 in the position shown in Figure 9. The switch 131 is provided with terminals 136 and 137 for completing the motor circuit, and a terminal 138 for completing the solenoid circuits, as will later be described. Pivoted on the bar 132 and in contact with the terminals 136, 137 and 138 are three movable switch elements 139, 141 and 142, respectively. The switch element 139 may contact within the switch with terminals 143 or 144 or be held in the neutral position, as indicated in Figure 9. The switch element 141 may be in contact with terminals 145 and 146, or be held in the neutral position, as indicated in Figure 9. The switch element 142 may be in contact either with terminal 147 or 148, or be held in the neutral position, as indicated in Figure 9.

The notch element 133 of the bar 132 of the switch 131 is adapted to be engaged by a latch 149 which is pivoted at 151 and normally held in the up position by means of a spring 152. The notch 134 is adapted to cooperate with a latch 153 pivoted at 154, and normally held in the up position by means of a spring 155.

Let us assume that the mechanism in the switch 131 which is controlled by a handle 155 is so moved by the handle 156 that the bar 132 is moved to the extreme right so that latch 153 engages with notch 134 on the bar 132. This completes a circuit through a battery 157 carried on the plane, through a lead 158 to terminal 137, through switch element 142, terminal 146 through a lead 159 to a lead 161, through a field 162 of the motor 120, through the armature of the motor back through lead 163, lead 164 to terminal 144, through switch element 139, terminal 136, lead 165, back to the battery 157. This will cause the motor 120 to move in one direction.

Let us assume that the motor has been stopped before the flap is moved either to its fully retracted or fully extended position by movement of the handle 156 so that the switch 131 occupies the neutral position shown in Figure 9. The direction of movement of the flap may be reversed by reversing the movement of the handle 156 of the switch 131 to cause connection to be made by switch element 141 with terminal 145, and by contact of the switch element 139 with terminal 143. This will cause the flap to move in the opposite direction by reversing the direction of rotation of the motor 120. The flaps can be moved in either direction by controlling the switch 131 as desired.

There is provided an automatic means to prevent overrunning of the motor and harm to the operating mechanism which comprises the switches 125 and 126.

Let us assume that motor 120 has caused the flap elements to be moved into a position such that the operating arm 129, which is attached

to the arm 123 of the bell crank 24, has contacted with the button 128 of the switch 126, and closed the switch terminals. When this happens, the circuit is completed through a lead 166 to terminal 138, through switch element 142, terminal 148, lead 167, solenoid 168, lead 169, lead 158 to the battery 157. The other side of the battery is connected through lead 171 and lead 172 back to the switch 126. Thus the solenoid 168 is energized, pulling down on latch 153 against the tension of spring 155 and releasing the notch 134 on bar 132, thus permitting the springs 135 to center the bar 132 in the off position, as indicated in Figure 9, thus stopping the operation of the motor.

On the limiting movement of the flaps in the opposite direction the switch operating arm 129 contacts with switch button 127 and closes the circuit through switch 125, which closes the following circuit: through lead 166, terminal 138, switch element 142, terminal 147, lead 173, solenoid 174, lead 175, lead 158, to the battery 157. The other side of the battery is connected through lead 171, through the switch to the lead 166, thus completing the circuit. When this occurs, the solenoid 174 is energized, pulling downwardly on latch 149 against the tension of spring 152, and releasing the contact of latch 149 in notch 133 and the switch bar 132 moves into the neutral position indicated in Figure 9, cutting off the motor and preventing overrunning thereof, and consequent possible injury to the operating parts.

With the circuits just described there is a safety factor introduced in the operation of the electric motor to prevent injury to the flap operating mechanism, which is of considerable importance when the inertia of the moving armature of the motor when rotating at high speeds is considered. I claim:

1. An airplane construction comprising means for affecting the flow around a wing to effect a change in the lift co-efficient thereof, a source of power carried by the airplane, a screw-threaded shaft adapted to be driven by said source of power, an operating head in screw-threaded engagement with the screw-threaded portion of the shaft, bell crank linkages operated by the operating head to modify the position of the first named means and support means for the bell crank on which it is pivoted, said means formed with apertures through which the arms of the bell crank pass.

2. A flap mechanism comprising an airplane, wings for the airplane, wing flaps for the wings, a source of power carried by the airplane, a screw-threaded shaft adapted to be driven by the source of power, operating heads in screw-threaded engagement with the screw threads on the shaft, bell crank linkages for each operating head to move the flaps, and support means for the bell crank on which it is pivoted and through apertures in which the arms of the bell crank pass.

3. A flap operating mechanism comprising an airplane, wings for the airplane, wing flaps for the wings, a spring motor of sufficient power to quickly move the flaps to operative position, a screw-threaded shaft adapted to be driven by the spring motor, operating heads in screw-threaded engagement with the screw-threads on the shaft, linkages for each operating head to move the flaps, and support means for the linkages on which they are pivoted, said means formed with apertures through which the linkages pass.

4. A flap operating mechanism comprising an

airplane, wings for the airplane, wing flaps for the wings, a spring motor of sufficient power to quickly move the flaps to operative position, a screw-threaded shaft adapted to be driven by the spring motor, operating heads in screw-threaded engagement with the screw-threads on the shaft, linkages for each operating head to move the flaps, trigger means to effect quick release of the spring and quick movement of the flaps into operative positions, and support means for the linkages on which they are pivoted, said means formed with apertures through which the linkages pass.

5. A flap operating mechanism comprising an airplane, wings for the airplane, wing flaps for the wings, a spring motor of sufficient power to quickly move the flaps to operative position, ratchet means to coil the spring in the spring motor, a screw-threaded shaft adapted to be driven by the spring motor, operating heads in screw-threaded engagement with the screw-threads on the shaft, linkages for each operating head to move the flaps, trigger means for quick release of the spring and quick movement of the flaps into operative positions, and support means for the linkages on which they are pivoted, said means formed with apertures through which the linkages pass.

6. An airplane construction comprising a wing, means affecting the flow around the wing to effect a change in the lift coefficient thereof, a screw-threaded shaft, means to rotate the shaft, an operating head in screw-threaded engagement with the screw-threaded portion of the shaft, bell crank linkages lying between the wing surfaces operated by the operating head to modify the position of the first named means, and support means for the bell crank on which it is pivoted, said means formed with aperture through which the arms of the bell crank pass.

7. A flap mechanism comprising an airplane, wings for the airplane, wing flaps for the airplane, a screw-threaded shaft adapted to be driven, operating heads in screw-threaded engagement with the screw threads on the shaft, bell crank linkages for each operating head to move the flaps, said bell cranks lying between the surfaces of the wing and having their thinness lying substantially parallel to the wing chords, and support means for the bell crank on which it is pivoted, said means formed with apertures through which the arms of the bell crank pass.

8. In an operating mechanism for a wing flap, an operating head, means to reciprocate the operating head, a bell crank lever having one arm attached to the operating head, the plane of the arms being approximately parallel to the wing chord, a link pivoted to the other arm of the bell crank lever and to the wing flap to move the latter, and a triangular box-like bracing means having apertures through which the arms of the bell crank lever extend.

9. In an operating mechanism for a wing flap, a plurality of flap operating stations for the flap, an operating head for each operating station, a common means to reciprocate the plurality of operating heads, a bell crank lever at each operating station having one arm thereof attached to an operating head, means at each operating station driven by the other arm of the bell crank to move the flap, and a plurality of box-like bracing means having apertures in the sides through which the arms of each bell crank lever extend.

10. In an operating mechanism for a wing flap,

5 a plurality of flap operating stations, an operating head at each station, means located at each station for reciprocating the operating head, bell crank levers at each operating station, the plane of the arms of which is substantially parallel to the wing chord, each bell crank having one arm attached to the operating head for that station, a link at each operating station pivoted to the other arm of the bell crank to move the wing flap, and a plurality of box-like bracing means having apertures in the sides through which the arms of each bell crank lever extend.

11. In an operating mechanism for a wing flap, an operating head, means to reciprocate the operating head, a bell crank lever having one arm attached to the operating head and mounted with its pivot approximately at right angles with the wing chord, means driven by the other arm of the bell crank lever to move the wing flap, and triangular box-like bracing means through the sides of which the arms of the bell crank lever extend.

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