Feb. 10, 1942. H. GROPLER 2,272,664

FLAP CONTROL

Filed July 28, 1939

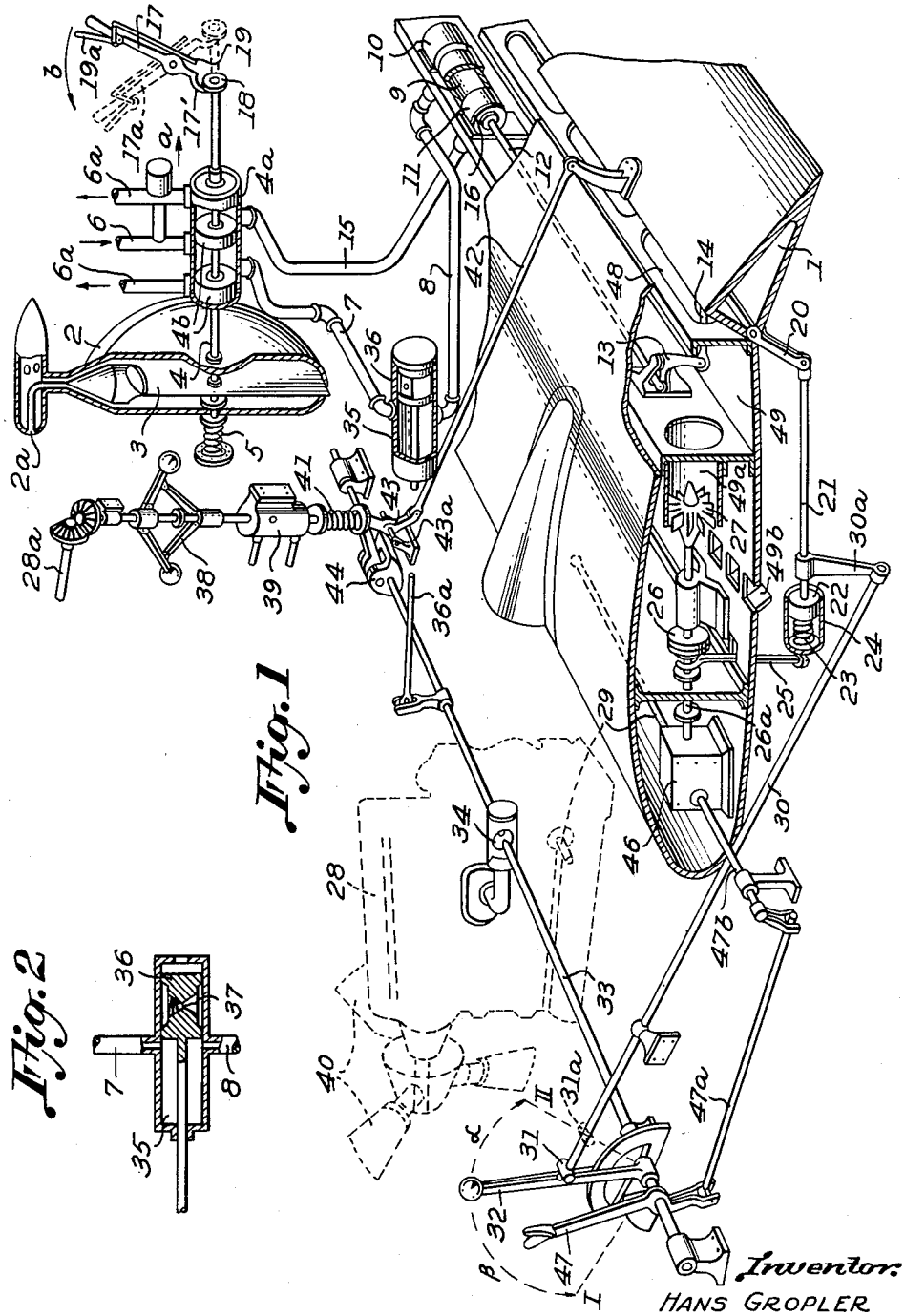


Fig. 1

Fig. 2

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Patented Feb. 10, 1942 2,272,664

UNITED STATES PATENT OFFICE

2,272,664

FLAP CONTROL

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Application July 28, 1939, Serial No. 287,149
In Germany August 1, 1938

21 Claims. (Cl. 244—42)

This invention relates to improvements in flap controls for airplanes, and refers particularly to a flap control for airplanes the wings of which are provided with means for exhausting air from the skin layer particularly when starting and landing.

This invention aims among other things to provide a flap control for use on airplanes the wings of which are provided with apertures through which air from the skin layer is exhausted, and wherein the apertures are closed by the flaps when the latter are in normal flight position and opened when the flaps are inclined relative to the wings.

Another object of the invention is to provide a flap control including means operated by movement of the flap for setting an air pumping device in motion when the flap is inclined and disconnecting the air pumping device when the flap is returned to normal flight position and the apertures closed through which the air is exhausted; wherein means are provided for driving the pumping device from the motor; and wherein means are provided for operating the air pumping device at sufficient speed to afford effective lifting capacity by exhausting air from the skin layer when only relatively slight power is being exerted by the propeller and the latter and the pumping device are both being driven by the same motor; and wherein means are provided whereby the speed of the pumping device relative to that of the propeller may also be increased. It is thus an object of the invention to provide a means whereby, while starting or landing, a substantially uniform amount of power is delivered to the pumping device, or even more while landing, although at that time the propeller, driven by the same motor, is exerting practically no propelling force.

A further object of the invention is to provide a flap control including means for retarding the action of a regulator for a variable pitch propeller when the flap is inclined so that a higher motor speed is then required to increase the pitch of the propeller. Thus means are provided for curtailing the pull of the propeller particularly while landing to allow the motor to operate at sufficient speed to provide effective lifting power by the exhaustion of air from the skin layer without supplying any great propelling force through the propeller.

Another object of the invention is to provide a flap control including automatic means for raising the flap to normal flight position when the airplane has attained a predetermined speed.

Yet another object of the invention is to provide a flap control including means actuated by the operating lever by which the throttle valve for the motor is controlled for preventing pressure being exerted upon a mechanism by which the flap is moved to its inclined position, and for permitting the release of such pressure, when the said throttle valve is fully, or almost fully, open.

Having thus briefly enumerated some of the major objects and advantages of the invention I will now proceed to describe an embodiment thereof with the aid of the accompanying drawing, in which:

Figure 1 illustrates a diagrammatic view of the lay-out in perspective, and

Figure 2 is a sectional view showing a detail.

Referring to the drawing, through one side of an airplane wing *1a* a plurality of apertures **48** are provided through which air from the skin layer is adapted to be drawn into a duct **49** provided in the said wing by means hereinafter described. Pivotally mounted on the wing *1a* is a flap **1**, which, when in normal flight position, covers the apertures **48**, and exposes the latter when moved to its inclined position which is done particularly when starting and landing.

Mounted upon the airplane is a diaphragm valve **2** having a forwardly disposed air inlet *2a*. Axially movable through the valve **2** is a rod **4** on which a diaphragm **3**, adapted to be actuated by static air pressure when the airplane is travelling at high speed, is secured within the valve **2**. Mounted on the rod **4** between one extremity thereof and the adjacent side of the valve **2** is a spring **5** which tends to move the said rod in the direction opposite to that indicated by the arrow *a*. The rod **4** extends through a cylinder *4a* having spaced piston valves *4b* secured thereon, and has a collar **18** fixed on its other extremity.

Connected to the cylinder *4a* towards its opposite extremities are discharge pipes *6a*; and **6** denotes an inlet connection into the said cylinder substantially centrally of its length. Connected also to the cylinder *4a* intermediately of its length and spaced from one another are two pipes **7** and **15**. Suitably mounted on the airplane for pivotal movement, independently of the rod **4**, is a lever **17** having a projection **17'** thereon adapted to engage one side of the collar **18** and move it and the rod **4** in the direction of the arrow *a* by pivotal movement of the said lever in the direction of the arrow *b*. Pivoted also on the lever **17** is an operating handle *19a* by movement of which an element **19** pivoted thereon is adapted to be

moved longitudinally to engage the opposite side of the collar 18 for movement of the rod 4 in the opposite direction.

The pipe 7 terminates in a control valve 35 from which a pipe 8 extends. Mounted on the wing 1a is a cylinder 9 the opposite ends 10 and 16 of which are connected to the pipes 8 and 15 respectively. Projecting from a piston 11 in the cylinder 9 is an extension rod 12 pivotally connected to a system of levers 13 and 14. The lever 14 is also connected to the flap 1 so that upon movement of the rod 12 the flap is moved pivotally.

A conventional motor is indicated at 28, and mounted thereon is a variable pitch propeller 40. A conventional throttle valve 34 is suitably connected to the motor 28, and through the throttle a spindle 33 extends by which the opening of the valve, and thus the fuel feed to the motor, is controlled. A shaft 29 driven by the motor 28 terminates in a variable speed gear box 46, and driven by gearing in the said box is a split shaft 26a having a clutch 26 provided thereon intermediately of its length. This split shaft 26a terminates in a rotary air pumping device 27 mounted in a suitable passage 49a connected to the duct 49, and having suitable air discharge outlets 49b. Extending from the flap 1 is an arm 20, and pivotally connected to the latter is a rod 21 which terminates at its opposite extremity in a plunger 22 slidably mounted in a bushing 24 the forward extremity of which is formed to provide support for one extremity of a spring 23 which extends between the said forward extremity and the plunger 22. Carried by the bushing 24 is a shifter 25 by which the clutch 26 is operated to move its coacting parts into engagement or disengagement.

Suitably connected to the rod 21 intermediately of its length is a push rod 30, which is axially movable through a suitable fixed bracket 30a and terminates in a head 31 adapted to move an operating lever 32 secured to the spindle 33. Mounted for rotation upon the spindle 33 is a gear shift lever 47 which through suitable members 47a and 47b is adapted to shift gears in the gear box 46 in a well known manner and change the speed of rotation of the driven shaft 26a relative to that of the shaft 29.

Extending from an arm on the spindle 33 and pivotally connected thereto is a flexible rod 36a which is also connected to a slide member 36 in the control valve 35. The member 36 is transversely apertured intermediately of its length, and a spring actuated non-return valve 37 is provided therein to permit a flow of fluid or liquid under pressure in one direction only, from the pipe 8 to the pipe 7, when the member 36 is interposed between them.

38 denotes a conventional governor operated by the motor 28 through a shaft indicated at 28a. This governor is connected to a known type of hydraulic regulator 39 by which the pitch of the propeller 40 is automatically regulated by the speed of the motor. Cooperating with the regulator 39 is a spring 41 so arranged that as its tension is increased higher speeds of rotation of the governor are required to actuate the regulator and increase the propeller pitch. Mounted on the spindle 33 for rotation therewith is a stop 45 having a member 44 pivoted thereon which bears against the under side of the spring 41 and controls the tension thereof. Mounted in a suitable fixed bracket 43a is a bellcrank 43 one arm of which is pivotally connected to one end of a reach rod 42, the other end of which is pivotally secured to the flap 1. The other arm of the bellcrank 43 is adapted to raise the member 44, which is also adapted to be supported by the stop 45.

The operation is briefly as follows: When the airplane is to take off the various portions of the mechanism are in the positions shown in Figure 1. On account of lack of air pressure the diaphragm 3 in the valve 2 is not flexed and consequently the spring 5 retains the piston valves 4b in their positions shown so that fluid or liquid pressure—from a source not shown—flows through the pipe 6, the cylinder 4a, the pipe 7, the control valve 35, and the pipe 8 into the end 10 of the cylinder 9; and through the piston 11, the extension rod 12, and the system of levers 13 and 14 the flap 1 is maintained in its inclined position shown. Through the lever 20 and the rod 21 the clutch 26 is held in engaged position, and the motor 28, connected to the air pumping device 27 through the shaft 29, the gear box 46 and the split shaft 26a, is running at slow speed. As the inclination of the flap 1 is increased to the maximum the spring 23 in the bushing 24 is compressed and the push rod 30 is moved so that its head 31 retains the operating lever 32 advanced at least to the position shown. Through the reach rod 42, the bellcrank 43 has been turned to raise the pivoted member 44 and compress the spring 41, so that the operation of the regulator 39 to increase the pitch of the propeller 40 is retarded.

Then the operating lever 32 is advanced to its position I, and the throttle valve 34 is fully opened to permit more fuel to pass therethrough to the motor 28. The additional power thus generated is delivered partly to the propeller 40, partly to the air pumping device 27, and is also employed to operate the governor 38, which, when it attains a certain speed dependent upon the tension of the spring 41, causes the regulator 39 to function and increase the pitch of the propeller 40. By movement of the operating lever 32 to the position shown at I the rod 36a is also moved so that the slide member 36 is interposed between the pipes 7 and 8 and the non-return valve 37 prevents any flow from the pipe 7 to the pipe 8 but permits a flow to occur in the opposite direction.

As the speed of the airplane increases the static air pressure exerted against the diaphragm 3 increases until, when a predetermined pressure is reached, the diaphragm is flexed and moves the rod 4 axially in the direction of the arrow a. When this happens the piston valves 4b connect the pipe 7 with one of the discharge pipes 6a to permit pressure to escape from the end 10 of the cylinder 9, and the pipe 6 is connected to the pipe 15 so that fluid or liquid under pressure is then applied in the extremity 16 of the cylinder 9 to return the flap 1 to its normal flight position whereupon it closes the apertures 48. When this occurs the rod 21 is moved rearwardly and the shifter 25 disconnects the cooperating parts of the clutch 26 so that the air pumping device 27 is no longer driven. The push rod 30 is moved rearwardly to bring its head 31 back to the position indicated at 31a, and the reach rod 42 is moved forward turning the bell-crank 43 so that the member 44 is now supported by the stop 45, which is now upwardly disposed. Then all the power developed by the motor 28 is utilized for operating the propeller 40. In the event of undesired movement of the diaphragm 3, due to

variation in the static air pressure during flight, the lever 17 may be moved to its position indicated at 17a when its extension 17' will prevent movement of the rod 4 and the flap 1.

At cruising speeds the operating lever 32 is moved back from its position I somewhere in the range of the angle β. Then the motor speed is reduced and the stop 45 is also turned thereby lessening the tension on the spring 41 and permitting the regulator 39 to function and increase the pitch of the propeller 40 at reduced motor speed.

Before landing it is necessary to return the lever 17 to its position shown, and the operating lever 32 must be moved back into the range of the angle α, and preferably to idling position II, because in the range of the angle β the control valve 35 does not permit a flow from the pipe 7 to the pipe 8. Owing to the reduced motor speed the velocity of the airplane decreases and the static pressure in the diaphragm valve 2 drops sufficiently to permit the spring 5 to move the rod 4 back to its position shown, thereby again connecting the pipes 6 and 7. Consequently the flap 1 is returned to its inclined position, thereby engaging the clutch 26, increasing the tension on the spring 41 through movement of the bell-crank 43 and the reach rod 42, and advancing the push rod 30 to move the operating lever 32 back to its position shown. Then the throttle valve 34 is opened more as the engine is now required to furnish power also for driving the air pumping device 27; however any slight increase in motor speed will not increase the pitch of the propeller as the pressure on the spring 41 has been increased. In order to increase the speed of the air pumping device still more the shift lever 47 may be moved, preferably while the operating lever 32 is at its position II to increase the relative speed of the split shaft 26a when the motor is only running slowly. When a higher gear ratio in the gear box 46 is being employed more power is needed to drive the shaft 26a, this can be readily supplied by slightly advancing the operating lever 32 since any slight increase in motor speed will make very little difference in the propelling force exerted by the propeller as its pitch is then so slight.

After landing the lever 17 is moved to its position 17a to return the flap 1 to normal flight position, reduce the tension of the spring 41, uncouple the clutch 26, and withdraw the push rod 30 so that the operating lever 32 may be moved to its position II and the throttle to idling position. Before starting the lever 17 must first be returned to its position shown.

While in the foregoing the preferred embodiment of the invention has been described and shown, it is understood that alterations and modifications may be made thereto provided the said alterations and modifications fall within the scope of the appended claims.

What I claim is:

1. An arrangement of the character described comprising a movable flap, a wing formed with a slot so positioned as to be opened and closed by movement of said flap, means for moving the flap, an air pumping device for exhausting air through said slot from the skin layer adjacent a portion of an airplane, a motor, disengageable driving means for operating the pumping device therefrom, and means for engaging and disengaging the driving means by movement of the flap to slot closing position.

2. An arrangement of the character described comprising a movable flap, an aperture so positioned as to be opened or closed by movement of said flap, means for moving the flap, an air pumping device for exhausting air through the aperture from the skin layer adjacent a portion of an airplane, a motor, a variable pitch propeller driven thereby, driving means for operating the pumping device from the motor, means for engaging and disengaging the driving means operated by the flap movement, and means responsive to flap movement for varying the propeller pitch.

3. An arrangement of the character described comprising an apertured wing, an air pumping device for exhausting air from the skin layer through the aperture, a movable flap adjacent the wing positioned to open and close the aperture, means for moving the flap, a motor, driving means for operating the pumping device from the motor, and means responsive to flap movement for rendering the driving means operative when the flap is in aperture opening position and for rendering it inoperative when the flap is in aperture closing position.

4. An arrangement of the character described comprising an air pumping device for exhausting air from the skin layer, a motor, a variable pitch propeller driven thereby, a regulator operated from the motor for increasing the propeller pitch, driving means for operating the pumping device from the motor, means for engaging and disengaging said driving means, and means responsive to engagement of said driving means for retarding the operation of the regulator to increase the propeller pitch.

5. An arrangement of the character described comprising an apertured wing, a movable flap adjacent thereto, means for moving the flap, an air pumping device for exhausting air from the skin layer through the aperture to the wing, a motor, a variable pitch propeller driven thereby, a regulator controlled from the motor for increasing the propeller pitch, driving means for operating the pumping device from the motor, means for engaging and disengaging the driving means, means operated by the flap movement for retarding the action of the propeller to increase the pitch, and means similarly operated for engaging said driving means.

6. An arrangement of the character described comprising an apertured wing, mounted on an airplane, a pumping device for exhausting air from the skin layer through said aperture in the wing, a movable flap so constructed and arranged as to open and close the aperture, a motor to drive the airplane and the pumping device, a throttle valve connected to the motor, means for moving the flap, and means responsive to substantially fully open position of the throttle for preventing movement of the flap to open the aperture.

7. An arrangement of the character described comprising an apertured wing mounted on an airplane, a pumping device for exhausting air from the skin layer through said aperture in the wing, a movable flap so constructed and arranged as to open and close the aperture, a propeller, a motor to drive the propeller and the pumping device, a throttle valve connected to the motor, pressure responsive means for moving the flap to close the aperture when the airplane attains a predetermined speed, and means responsive to substantially fully open position of the throttle for preventing movement of the flap to open the aperture.

8. An arrangement of the character described

comprising a wing having apertures therein through which air from the skin layer may be exhausted and delivered, a movable flap constructed and arranged to open and close some of the apertures, a diaphragm valve positioned to be operated by air pressure resulting from wind velocity, and means operated by the diaphragm valve for moving the flap to its aperture closing position.

9. An arrangement of the character described comprising a motor, a variable pitch propeller driven thereby, a regulator controlled from the motor adapted to increase the propeller pitch, a movable flap, means for moving the flap, means for retarding the action of the regulator to increase the pitch, and means responsive to the flap movement for operating the retarding means.

10. An arrangement of the character described comprising a motor, a variable pitch propeller driven thereby, a regulator controlled from the motor operable to increase the propeller pitch, a wing having apertures therethrough through which air may be exhausted, a movable flap constructed and arranged to open and close the apertures, and means operated by movement of the flap to open apertures for retarding the action of the regulator to increase the propeller pitch.

11. An arrangement of the character described comprising a wing having apertures therein, a movable flap operable to close the apertures, means for moving the flap, a pumping device arranged to exhaust air from the skin layer through the apertures, a propeller, a motor coupled with the pumping device and the propeller, a throttle valve to control the motor, and means actuated by movement of the flap to open the apertures so constructed and arranged as to move the throttle valve.

12. An arrangement of the character described comprising an apertured wing mounted on an airplane, a pumping device for exhausting air from the skin layer through said aperture in the wing, a movable flap so constructed and arranged as to open and close the aperture, a motor, a throttle valve to control the motor, disengageable means connecting the motor and the pumping device for driving the latter, means operated by movement of the throttle valve for coupling and uncoupling said disengageable means, and means connected to the flap for moving the throttle farther open when the drive for the pumping device is coupled.

13. In an airplane including a slotted wing, a pump for exhausting air through said slot from the adjacent boundary layer, a movable flap so constructed and arranged as to normally close said slot and open the same when lowered, an engine, a throttle for controlling the same, a disengageable coupling between the engine and pump, a pitch regulator, a variable pitch propeller driven thereby, and an engine driven governor for controlling the regulator according to engine speed, the combination of means for moving said flap to open the slot, means for retarding the pitch increasing action of the regulator, and means responsive to slot opening movement of said flap cooperable with said retarding means to operate the same.

14. In an airplane including a slotted wing, a pump for exhausting air through said slot from the adjacent boundary layer, a movable flap so constructed and arranged as to normally close said slot and open the same when lowered, an engine, a throttle for controlling the same, a disengageable coupling between the engine and pump, a pitch regulator, a variable pitch propeller driven thereby, and an engine driven governor for controlling the regulator according to engine speed, the combination of means for moving said flap to open the slot, means for retarding the pitch increasing action of the regulator, means responsive to slot opening movement of said flap cooperable with said retarding means to operate the same, and means responsive to slot opening movement of said flap cooperable with the throttle to preclude less than a predetermined intermediate throttle opening while the slot is open.

15. In an airplane including a slotted wing, a movable flap so constructed and arranged as to normally close said slot and open the same when lowered, an engine, and a throttle for controlling the same, the combination of means for moving said flap to open the slot and means responsive to slot opening movement of said flap cooperable with said throttle to preclude less than a predetermined intermediate throttle opening while the slot is open.

16. In an airplane including a slotted wing, a pump for exhausting air through said slot from the adjacent boundary layer, a movable flap so constructed and arranged as to normally close said slot and open the same when lowered, an engine, a throttle therefor, and a disengageable coupling between said engine and pump, the combination of means for moving said flap to open the slot, means responsive to slot opening movement of the flap for engaging said coupling, and means responsive to slot opening movement of said flap cooperable with said throttle to preclude less than a predetermined intermediate throttle opening while the slot is open.

17. In an airplane including a slotted wing, a pump for exhausting air through said slot from the adjacent boundary layer, a movable flap so constructed and arranged as to normally close said slot and open the same when lowered, an engine, a disengageable coupling between said engine and pump, a throttle for controlling the engine, a pitch regulator, a variable pitch propeller, and an engine driven governor for controlling the regulator according to engine speed, the combination of means for moving said flap to open the slot, means for retarding the pitch increasing action of the regulator, means responsive to slot opening movement of said flap cooperable with said retarding means to operate the same, means responsive to slot opening movement of said flap for engaging said coupling, and means responsive to such slot opening movement of the flap cooperable with said throttle to preclude less than a predetermined intermediate throttle opening while the slot is open.

18. In an airplane including a slotted wing, a pump for exhausting air through said slot from the adjacent boundary layer, a movable flap so constructed and arranged as to normally close said slot and open the same when lowered, an engine, a throttle for controlling the same and a disengageable coupling between said engine and pump, the combination of means for moving said flap to open the slot, means responsive to slot opening movement of the flap for engaging said coupling, and means responsive to such slot opening movement of said flap cooperable with said throttle to preclude less than a predetermined intermediate throttle opening while the slot is open.

19. In an airplane including a slotted wing, a movable flap so constructed and arranged as to normally close said slot and open the same when lowered, and means for moving said flap, the combination of pressure means cooperating with said flap moving means to normally retain said flap in slot open position, and means automatically responsive to increased air speed for reversing the direction of pressure in said pressure means to thereby move the flap to close the slot at a predetermined air speed.

20. In an airplane including an engine, a throttle for controlling the same, a slotted wing, a movable flap so constructed and arranged as to normally close said slot and open the same when lowered, and means for moving said flap, the combination of pressure means cooperating with said flap moving means to normally retain said flap in slot open position, means automatically responsive to increased air speed for reversing the direction of pressure in said pressure means to thereby move the flap to close the slot at a predetermined air speed, and means responsive to said throttle while in advanced position cooperable with said flap moving pressure means to preclude reversing its direction of pressure and consequent movement of the flap to slot open position.

21. In an airplane including an engine, a throttle for controlling the same, a slotted wing, a movable flap so constructed and arranged as to normally close said slot and open the same when lowered, and means for moving said flap, the combination of pressure means cooperating with said flap moving means to normally retain said flap in slot open position, means automatically responsive to increased air speed for reversing the direction of pressure in said pressure means to thereby move the flap to close the slot at a predetermined air speed, means responsive to said throttle while in advanced position cooperable with said flap moving pressure means to preclude reversing its direction of pressure and consequent movement of the flap to slot open position, and means responsive to slot opening movement of said flap cooperable with said throttle to preclude less than a predetermined intermediate throttle opening while the slot is open.

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