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R. L. M. F. ROUANET ET AL
CONTROL LIMITATING DEVICES ON AIRCRAFT
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Fig. 1

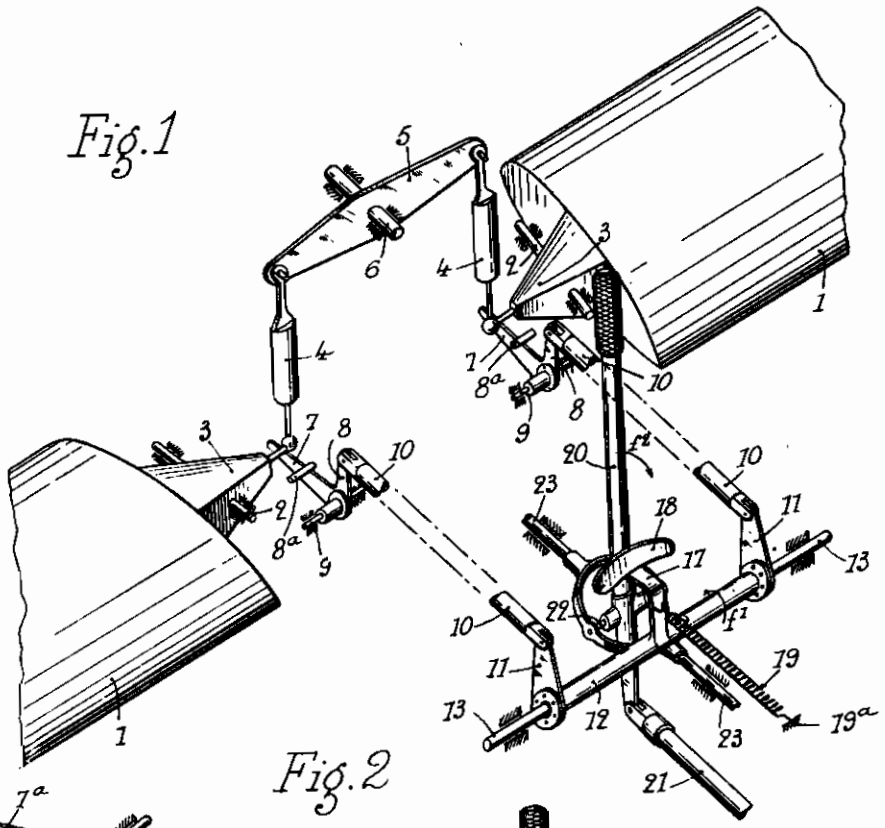
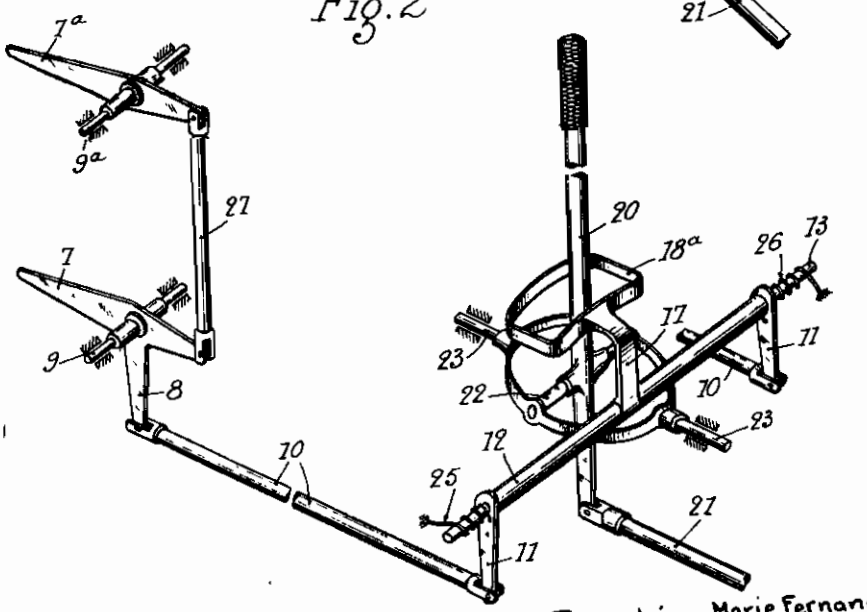


Fig. 2



Roger Léger Marie Fernand Rouanet
INVENTOR
By Otto Munn
his ATTY.

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CONTROL LIMITATING DEVICES ON AIRCRAFT

Roger Léger Marie Fernand Rouanet and François Victor André Joseph Rey, Paris, France; vested in the Alien Property Custodian

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It is a known fact that it is of interest to limit the abruptness of the evolutions of aeroplanes and other aircrafts, and particularly the longitudinal evolutions. In fact the greatest stresses which are to be supported by the cells are those which are due to a sudden "resource" i. e. a considerable and rapid increase of the incidence of the wings, when flying at high speeds. A "resource" which is too strongly marked, which is brought about by a too abrupt and a too extensive operation of the elevator by the pilot may, in certain cases, cause the breakage of the machine.

Moreover, a sudden change in the incidence of the wings may also result artificially from the action of gusts of wind exerted upon the wings; this action may have the same harmful consequences as a "resource" and may in some cases, cause the breakage of the machine by the effect of the resultant heavy overloads.

The present invention has for its object to provide a device which serves to limit these various overloads by an automatic action upon the elevator or elevators, which device is adapted for use upon aircraft in which each wing is pivoted about an axis (which is oblique or not with reference to the longitudinal axis of the machine) and is maintained in equilibrium by suitable elastic connections.

In such machines with pivoted wings, the position of each wing relatively to the frame carrying the pivot axle will obviously depend upon the aerodynamic loads supported by this wing and upon the elastic connections mounted between the wing and the frame. A change in these loads will cause the wing to rotate about its pivot axis, in the direction corresponding to this change (an upward rotation in the case of an overload in the upward direction which is due, for instance, to a sudden increase of the incidence in one of the cases above mentioned).

The device forming the subject-matter of the invention is based upon this property. It is characterized by the fact that it consists of a connection (mechanical, hydraulic, pneumatic, electric or the like) between each wing and the control surfaces for elevation and/or for lateral inclination, or their controlling mechanism, which connection is designed in such manner that when the loads supported by any one of the wings shall exceed a given value (which causes a rotation of a given amplitude of this wing about its pivot axis) the said connection will automatically cause a correcting action upon the control surfaces or their operating mechanism.

For example, if one of the wings should receive a heavy load in the upward direction, the resulting movement of rotation of this wing in the upward direction about its pivot axis will automatically produce, by reason of the said connection, an action upon the control surfaces or upon their controlling mechanism, in the direction creating a noseheavy moment upon the areoplane; this action will actually reduce or limit the incidence of the wings and hence the above mentioned overload.

The same system can of course be used in the case of excessive overloads in the downward direction.

In the accompanying drawings, which are given merely by way of example:

Fig. 1 illustrates a mechanical connecting device according to the invention, in the case in which it is desired only to automatically limit the overloads acting upwardly on the wings.

Fig. 2 shows another embodiment, providing for a limitation of the loads in both directions.

In the embodiment shown in Fig. 1, the aircraft comprises two wings 1, each of which is pivotally mounted on the central body of the aeroplane on an axle 2. Each wing 1 is provided with an appendage 3 to which is attached the end of an elastic connecting member 4 whose other end may be secured directly to the central body of the machine or (as in the embodiment illustrated) to one end of a rocking lever 5 adapted to turn about an axle 6 carried by the central body of the machine.

When one of the wings 1 turns upwardly about the axle 2, its appendage 3 descends, and if the rotation attains a certain extent, the end of this appendage will engage one arm 7 of a bell-crank lever 7, 8 which is loose upon a transverse axle 9. The upward rotation of the arm 7 is limited by a stop 8^a whose position can be fixed or adjustable.

The second arm 8 of each bell-crank lever 7, 8 is connected by a link 10 to a crank-arm 11 which is keyed to a sleeve 12 adapted to rotate about a transverse axle 13. The said sleeve has rigidly secured to it an arm 17 ending in a plate 18. A spring 19, attached to a fixed point 19^a, tends to rotate the arm 17 and the sleeve 12 in the contrary direction to the arrow f^1, and hence to turn the bell-crank lever 7, 8 in the direction applying the arm 7 against the stop 8^a.

In the present embodiment (which corresponds, as above stated to the case of upwardly

directed overloads) the plate 18 is situated in the rear of the elevator actuating means; this being illustrated as a control stick 20 which is connected by a link 21 with the elevators, not shown, which are thus actuated by the rotation of the control stick 20 about the transverse axle 22. The movement of the elevator or elevators in the direction of the "resource" corresponds to a force exerted upon the control stick 20 in the direction of the arrow f^2.

As the said control stick can also turn upon a longitudinal axis 23 (this rotation being used to actuate the control surfaces for the lateral inclination of the machine), the plate 18 has a sufficient length to enable it to remain on the path of the control stick when this latter turns on the transverse axle 22, whatever be the possible rotation of the stick on the longitudinal axis 23.

If the control lever is of the steering wheel type, the lever serves only to actuate the elevator, i. e., it turns only on a transverse axle 22 which is fixed relative to the machine. The length of the plate 18 may thus be suitably reduced.

It should be noted that in the embodiment illustrated, the longitudinal axle 23 of rotation of the control stick extends below the sleeve 12 without engaging the latter.

From the foregoing, it is clear that if one of the wings 1, (or both wings 1, if they have the same inclination about their respective axis 2) pivots upwardly about its axis 2 to a sufficient degree to bring its appendage 3 into engagement with the arm 7, it will cause this arm to pivot downwardly, and this will cause (owing to the connection 8, 18, 11, 12) the rotation of the sleeve 12 and the plate 18 in the direction of the arrow f^1. This rotation of the plate has the effect of limiting the movement of the control stick to the rear, and hence the possible upward overloads on the wings. This limit cannot be exceeded by the pilot, as he cannot overcome the resistance offered by the said plate which is maintained by the wing or wings 1.

Fig. 2 which is given merely by way of example and is not of a limitative nature, illustrates a mechanical connecting device according to the invention, in the case in which it is desired to limit automatically, on the one hand, the excessive overloads in the upward direction and on the other hand the excessive overloads in the downward direction.

This figure does not show the pivoted wings, the elastic connections nor the rocking-arm which are supposed to be the same as in Fig. 1.

Above and below the end of the appendage 3 of each wing, are mounted two arms 7 and 7^a which are rotatable respectively on parallel transverse axles 9 and 9^a, and are constantly urged into their mean position, for example by two biasing springs 25, 26 or by a single spring having a dead center.

The arrangement of the arms 7 and 7^a with reference to the appendage 3 of the corresponding wing is such that they are not actuated by the movement of the wings about their respective axes, except when this movement attains a predetermined extent, which corresponds, as above stated to a predetermined limitation of the overloads on the wings in the upward or downward direction.

The arms 7 and 7^a are connected together by a link 27 and each arm 7 is integral with an arm 8 whose end is connected by a link 10 with the crank-arm 11, keyed to the sleeve 12 which is rotatable on the transverse axle 13. To the sleeve 12 is rigidly secured an arm 17 terminated by a ring 18^a, through which the control lever 22 passes. In the case in which this lever is of the control stick type (which is the case for Fig. 2) the ring 18^a is formed in such a manner as to allow a lateral movement of the control stick about the axle 23 which is sufficient to provide for the lateral control of the machine. In the case in which the control lever is of the steering wheel type, it only serves to operate the elevator. In this case, the transverse axle 22 about which it is rotatable is fixed with reference to the machine and the transverse dimension of the ring 18^a can be suitably reduced. The ring 18^a can obviously be replaced by any other piece having a different form, whether closed or open (such as a fork) which will afford the same results.

It will be noted that the two wings, if they have the same inclination about their axes of oscillation 2, or the wing which is the farther from the mean position, will determine, starting from positions corresponding to the limits of the admissible loads in the upward or downward direction, the position of the ring 18^a, by the connection 3, 7, 10, 11, 12, 17, 18^a, or by the connection 3, 7^a, 10, 11, 12, 17, 18^a. Hence they will determine the limits for the movement of the elevator actuating lever 20 which are compatible with the conditions of safety of the machine.

Obviously, the invention is not limited to the embodiments herein described and shown, which are given solely by way of example.

The action exerted upon the plate or the ring may be such that it can be overcome by the pilot, and thus it will serve only as a warning to this latter.

Instead of acting upon the elevator actuating lever, it is possible to act at any point of the control surface actuating mechanism, or upon the control surface itself.

These direct actions can be completed by warning devices.

It is further possible to use the same device in order to exert a correcting action connected with the rotation of the wings about their respective pivot axes, upon the control surface or surfaces for the lateral inclination of the machine (or upon the operating mechanism of said controls). This action which can of course be overcome by the pilot, will induce him to make a correct turn, and it may be further used to assure the lateral stability of the machine.

ROGER LÉGER MARIE
FERNAND ROUANET.
FRANÇOIS VICTOR ANDRÉ
JOSEPH REY.