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JUNE 8, 1943.

BY A. P. C.

C. R. WASEIGE

CONTROL MECHANISMS FOR LOWERING FLAPS AND HYPER-LIFTING DEVICES FOR AIRCRAFT

Filed Jan. 24, 1941

Serial No.

375,866

5 Sheets-Sheet 1

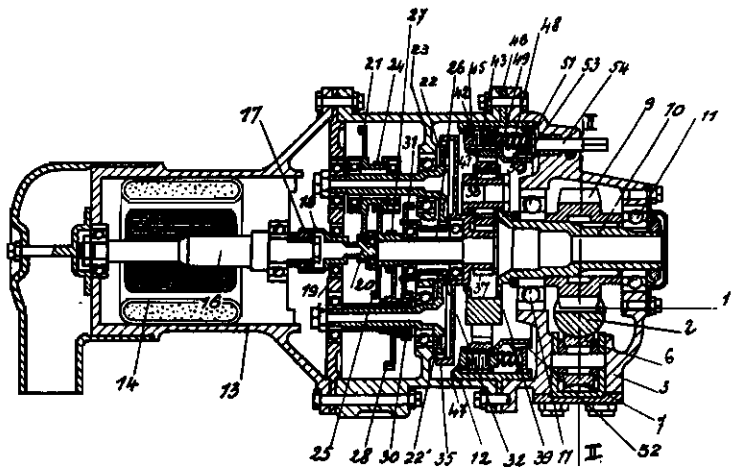

Fig: 1

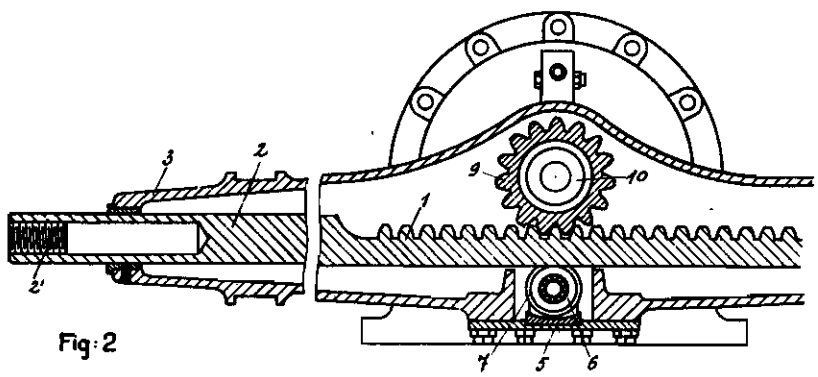

Fig: 2

Inventor,

C. R. Waseige

By: Glascock Downing & Seibold

Attys.

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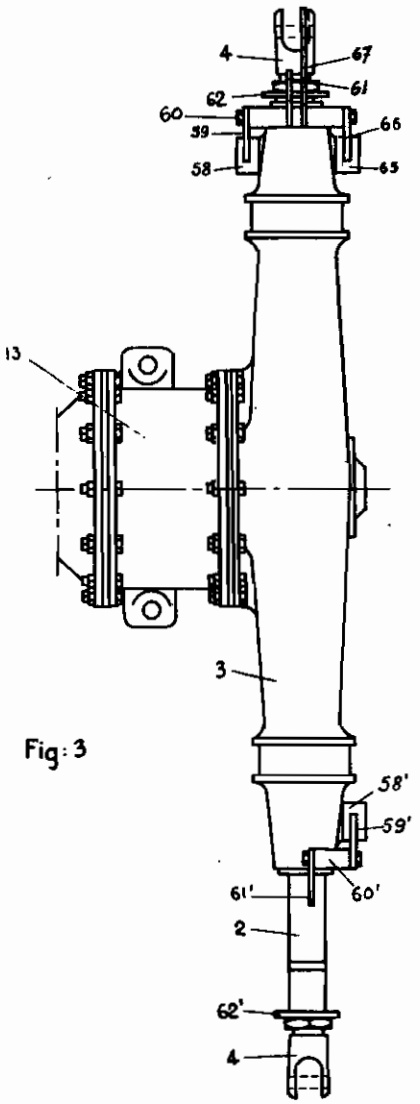

Fig: 3

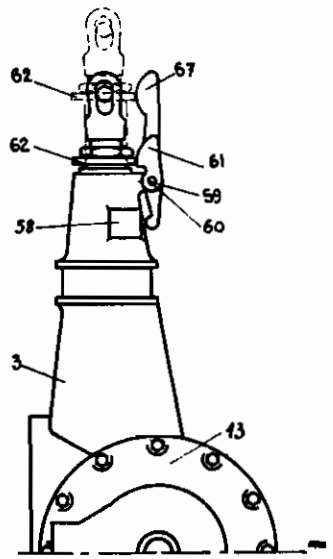

Fig: 4

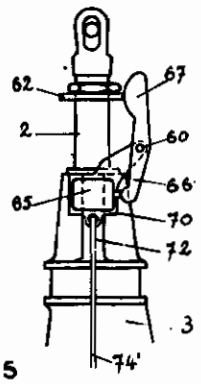

Fig: 5

Inventor,
C. R. Waseige

By: Glascock Downing & Seebold
Attys.

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5 Sheets-Sheet 3

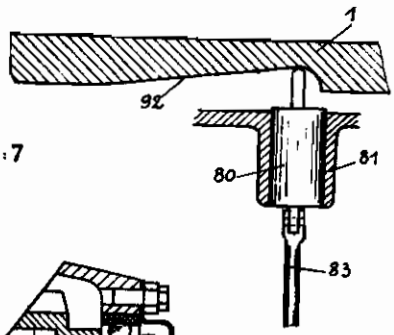

Fig: 7

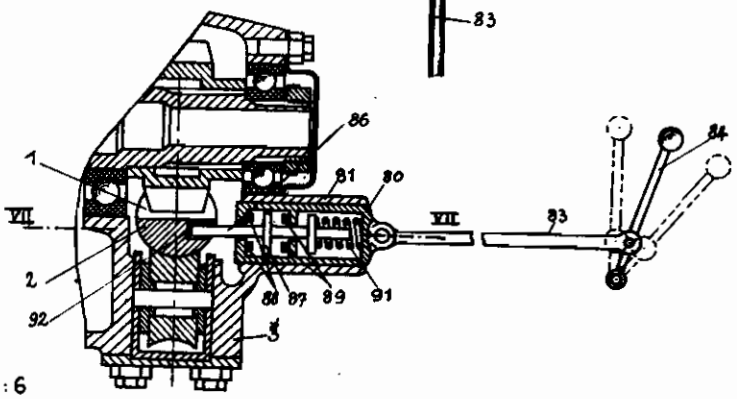

Fig: 6

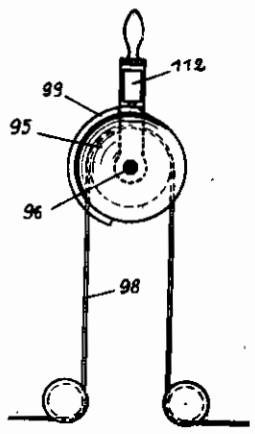

Fig: 9

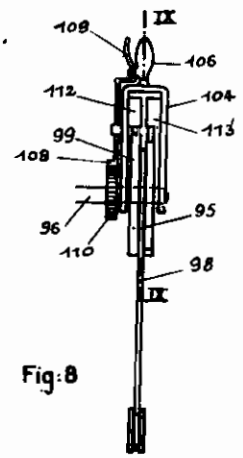

Fig: 8

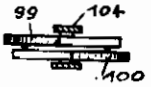

Fig: 10

Inventor,
C. R. Waseige

By: Glascock Downing & Seibold
Attys

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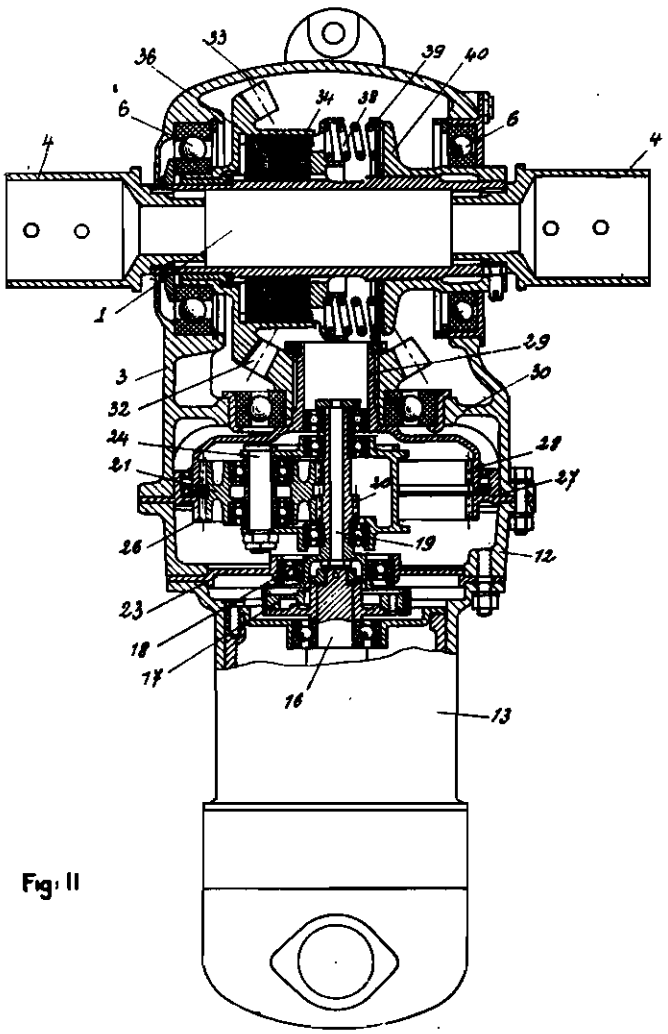

Fig. 11

Inventor,
C. R. Waseige

By: Glascock, Downing & Seibold
Attys.

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C. R. WASEIGE
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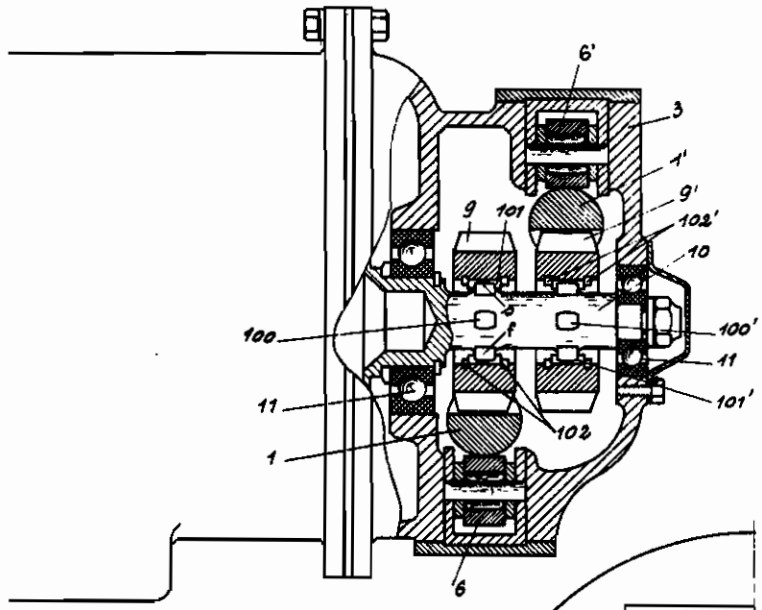

Fig: 12

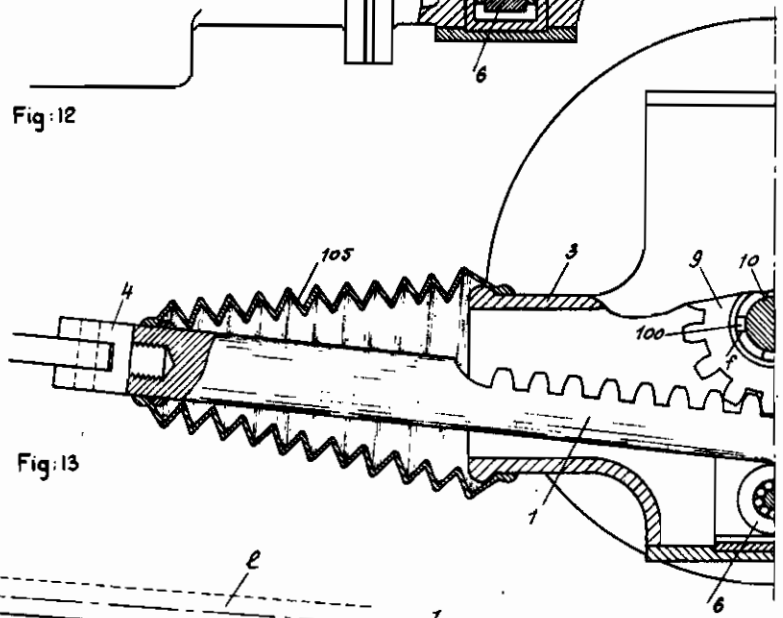

Fig: 13

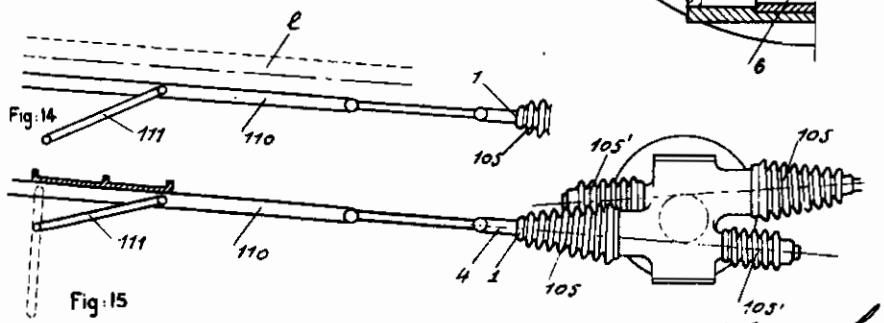

Fig: 14

Fig: 15

Inventor
C. R. Waseige
By: Glascock Downing & Seebold
Attys.

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ALIEN PROPERTY CUSTODIAN

CONTROL MECHANISMS FOR LOWERING FLAPS AND HYPER-LIFTING DEVICES FOR AIRCRAFT

Charles Raymond Waselge, Rueil, France; vested in the Alien Property Custodian

Application filed January 24, 1941

The present invention relates to a control mechanism for lower wing flaps and similar hyperlifting devices for aircraft.

The object of the present invention is to actuate flaps or other hyperlifting devices by a motor connected to a torque limiting device.

A further object of the invention is to provide a motor actuating, through a transmission in which is inserted a torque limiting device, one or several moving control means which can be coupled to the flaps, or to the other hyperlifting devices.

Another object of the invention is to provide a motor connected with and actuating flaps or other hyperlifting devices through a transmission one part of which, between the motor and the torque limiting device, being practically non-reversible, the other, between the torque limiting device and the said moving control means being reversible.

A still further object of the invention is to obtain a simultaneous and equal effacement of all flaps or same, without affecting the part of the transmission placed between said motor and said torque limiting device, when they are actuated or being actuated, and when a squall applies on them a total thrust superior to the thrust for which the limiting device has been set, whatever be the effect of the thrust due to the squall upon each of the flaps separately.

The part of said transmisison between the torque limiting device and the moving flaps controlling means is preferably designed so that the transmission quotient be the same in all the positions of the flaps.

A further object of the invention is to provide a control mechanism as a self-contained independent unit comprising a motor, generally an electric motor, one or several controlling means connected to said motor through a speed limiting device and a torque limiting device, and coupling means between said moving parts and the different flaps to be actuated.

Said moving control device, or each of same may be formed, either by alternating moving means comprising for instance a rack meshing with a gear at the end of said transmission, or a rotating axle which can be directly connected to an axle rotating with the flaps or other hyperlifting devices which are to be actuated by the first rotating axle.

In accordance with an embodiment of the invention, only one moving control device is provided, and comprises two coupling devices through which it can be connected to the lower wing flaps or other which it has to control, situated on the wings, respectively on each side of the fuselage.

In accordance with another important embodiment of the invention, which can be separately used, the mechanism comprises two moving control devices actuated simultaneously by the same transmission preferably comprising said torque limiting device, and joining their motions, each of these devices being coupled to the lower wing flaps or other hyperlifting devices situated on one side of the fuselage.

It is advantageous to provide an angle between these two devices, so that they be parallel to the wings of the airplane, said wings forming generally an dihedral angle and sweeping back so that the coupling between the flaps or other and the devices is made easy.

According to the last mentioned embodiment, the part of the mechanism connecting with the flaps is preferably made of two control devices with rectilinear alternating motion, each of which can be coupled to a sliding rod placed alongside the corresponding wing, connected by links to the flap or flaps to be controlled, such design being a part of the invention.

It is also advantageous to combine the moving device, or devices to which the flaps are connected, with a device stopping the motor when it comes at least to a predetermined position, in order to precisely bring the flaps or other to any desired position.

To that effect and, according to another characteristic which is also an object of the invention, at least one switching device permitting to cut off the motor part of the mechanism cooperates with one or several parts moving with reference to said motor, according to the displacements of the moving part of the mechanism, in order to control said switching device and stop the motor for one or several predetermined positions of said moving part.

Moreover, one actuating device may cooperate with several switching devices, which it controls for different positions of the moving part, one or the other being at will on circuit.

Considering the switching device and its actuating part together, one of them is not bound to the motion of the moving control part, and it is generally the switching device. That element which is not bound to the motion of the moving control means is advantageously designed so that its position can be regulated at will, by a hand controlling device, in order to modify the stopping position of the flaps. The other element, which is bound to the motion of the moving con-

trol means, generally the device actuating the switching device, can be geared by the moving control means, or moved by it directly through a cam, or indirectly.

In an advantageous embodiment, two switching devices connected to the circuit of the motor to control the rotation respectively in both ways, are fixed upon a common support, the position of which can be regulated with respect to an element movable according to the displacement, with reference to said support of the moving control device, said element being designed so as to actuate either one or the other switching device when it moves with reference to said support in one or the other way from a determined position, and as a result the position of the moving device is related to that of said support.

Said moving element is for example a pulley concentrically to which is fixed said support in such a way that its angular position can be regulated.

In the accompanying drawings, different embodiments of the invention have been illustrated by way of examples only:

Fig. 1 is a cross section along the axle of the motor in an embodiment of the invention.

Fig. 2 is a cross section along line II—II of the Fig. 1.

Fig. 3 is a plane view of the embodiment according to Fig. 1 and Fig. 2.

Fig. 4 is a partial elevation of the embodiment according to Figs. 1 to 3.

Fig. 5 is a partial elevation similar to Fig. 4 showing a modification of the automatic stopping device.

Fig. 6 is a partial cross-section similar to Fig. 1 showing another embodiment of the same system.

Fig. 7 is a partial cross-section along line VII—VII of Fig. 6.

Fig. 8 is a front view of a modification of the embodiment according to Fig. 6.

Fig. 9 is a cross-section along line IX—IX of Fig. 8.

Fig. 10 is a partial view of the embodiment according to Fig. 6 with the modification according to Fig. 8.

Fig. 11 is a cross-section along the axis of the motor according to another embodiment of the invention.

Fig. 12 is a partial cross-section similar to Fig. 1 of another embodiment.

Fig. 13 is a front elevation, with several parts being represented in cross-section.

Fig. 14 is a schematic elevation showing the adaptation on an airplane of the mechanism according to the embodiment shown on Figs. 11 to 13.

Fig. 15 is a schematic plan view of the adaptation according to Fig. 14.

In the embodiment represented on Figs. 1 to 4, the flap control device for the moving flaps is a rack 1, prolonged by cylindrical bearings 2 sliding inside of a part of casing 3 from which they project and terminated by threaded bearings 2' for the fixation of the connecting ends 4, binding them to the flap controlling rods. A roller 6 is mounted at the center of casing 3 with an additional plate. The roller 6 comprises a groove 7 of cylindrical cross-section which supports the back side, of circular cross-section, of the rack 1. The rack 1 meshes with a gear 8 secured to the part 3 of the casing. The shaft 10 projects outside of said part 3 of the casing, which has its plane of junction perpendicular to the axis of said shaft, and on which is secured another part 12 of said casing, prolonged by a third part 13 containing a motor 14, which in case of Fig. 1 is an electromotor. The shaft 15 of this motor is coaxial with shaft 10, and carries a clutch coupling device 17 engaging a corresponding element 18 journaled in a partition 19, said partition being placed between the contacting faces of the two parts 12 and 13 of the casing. This element 18 is secured to a gear 20 meshing with a gear wheel 21, freely rotating on a shaft which forms the hub of a gear 22 and is journaled at one end in partition 18 and at the other in a web 23 projecting on the inside of the part 12 of the casing. The wheel 21 is secured to a gear 24 meshing with a wheel 25 coaxial with shafts 10 and 18 and secured to a shaft 26 and to a gear 27 said gear meshing with a wheel 28 freely rotating on a shaft which forms the hub of a gear 22' exactly similar to gear 22, both gears 22 and 22' being equally distant from the common axis of shafts 18 and 10. Said wheel 28 is secured to a gear 30 meshing with a wheel 31 freely rotating on shaft 26, and secured to a gear 32 meshing with the two wheels 22 and 22'. Said wheels 22 and 22' together with two exactly similar wheels are placed around the general axis, all these wheels meshing with one large wheel 35 having an interior gearing, the wheel 35 rotates freely on one end of shaft 26, the other end of which is freely supported by a bearing of the coupling device 18. The centering and balancing of the whole device are therefore obtained by gears 22 and 22'. Wheel 35 is secured to a pinion 37, which is the planetary wheel of an epicycloidal gear comprising satellites 38, supported by axles mounted on a plate 39 rigidly secured to shaft 10, and an exterior planetary wheel 41. Said wheel 41 is connected to casing 12 by a friction coupling device comprising disks 42 axially sliding inside of peripherical grooves of said wheel 41, and disks 43 axially sliding inside of a sleeve 45 secured to an exterior rim 46, situated between the contacting faces of the parts 3 and 12 of the casing. These disks 42 and 43 are pressed together and abutted on an annular inside brim 47 of sleeve 45 by helical springs 48 placed around a circle, and situated between the collar 49 of a sliding sleeve 50, and another plate 51 screwed in an interior thread of the sleeve 45 and sliding inside of grooves 52 of said sleeve 50. These grooves 52 mesh with a pinion 53 mounted on an axle 54 which extends through the casing and projects outside of same where it terminates by an element which may be actuated by means of a wrench or the like. It is evident that by rotating this axle 54, the sleeve 50 is rotated through the means of pinion 53 and grooves 52 so that the plate 51 is screwed into or out of sleeve 54, and compresses more or less the springs 48, which permits the adjustment of the value of the torque for which the clutch starts its sliding action.

Outside and at each end of casing 3 is mounted a switch 58, 58' connected to the feeding circuit of the motor so as to cut off said circuit when actuated. Each switch 58, 58' is actuated by fingers 59, 59' pivoted on an axle 60, 60' secured to casing 3 and integral with a cam 61, 61' cooperating with an abutment 62, 62' mounted on the projecting part of rack 1. The two switches respectively stop the motor for the two terminal positions of the rack 1.

Furthermore, another switch 65, secured to the casing cooperates with a pinion 66 pivoted on axle 60 and bearing a cam 67. Said cam is actuated

by the abutment 62 when same reaches the position indicated in dotted lines in Fig. 4.

The contacting device 65 is closed when it is desired to stop the motion of rack 1 at the intermediate position defined by cam 67, cooperating with the abutment 62 and corresponding to a determined angular position of the flaps. This stopping may be controlled when the rack is moved in one or the other way corresponding to the opening or effacement of the flaps.

Other switches may be provided to define other intermediate positions of rack 1.

The working is as follows:

When motor 14 is rotated in one or the other way corresponding to the opening or to the effacement of the flaps, the rotation of its shaft 18 is transmitted by the coupling device 17, 18 and the demultiplicating gear 20, 21, 24, 25, 27, 28, 30, 31, 32 and 22 to wheel 35 integral with the planetary wheel 37. If the resisting torque upon planetary wheel 41 is inferior to the torque producing the sliding of the coupling device 42, 43, 44, 45 which forms the torque limiting device, said wheel 41 remains motionless, and the satellites 38 rotate around it and produce the rotation of shaft 10, which rotation is transformed by pinion 9 and rack 2 into a sliding motion of said shaft.

This motion goes as far as the contact between the abutment 62 and the cam 67, when the switch 80 is closed, or as far as the contact of said abutment and one of the cams 61, 61', depending upon the way of rotation of the motor.

If the resisting torque which acts upon the wheel 41 is superior to the torque producing the sliding of the coupling device 42, 43, 44, 45, said coupling device slides, and wheel 41 rotates instead of remaining motionless. This motion is not transmitted to that part of the mechanism situated between the limiting device and the motor, said part being nonreversible. Such a torque is produced for instance in the case of a squall exerting too big a stress upon the flaps being actuated. As soon as the resisting torque becomes a new inferior to the friction torque of the coupling device, either as a result of the effacement of the flaps, or as a result of the lessening of the intensity of the squall, planetary wheel 14 stops, and the motor may again drive shaft 10, the stopping of the motor depending only upon the position of rack 1.

Furthermore, the same torque limiting device permits the effacement of the flaps when a squall stresses upon them at any moment when they are actuated.

It is advantageous to have the flaps cooperating with a potentiometer, permitting the distance reading of their angular position.

The various embodiments which will be described with reference to Figs. 5, 6, 7, 8, 9 relate only to methods for stopping the motor for a determined position of the moving element 1.

With reference to Fig. 5 the switch 65 is fixed upon a slide 70 bearing also the articulated axle 60 of finger 66 and cam 67 which are integral and cooperate with abutment 62. This slide moves along a guiding groove 72 which is parallel to the way of motion of rack 1. The sliding motion of slide 70 is obtained by a control rod 74 which may be actuated by the pilot and enables same to define any stopping position of rack 1. The switches 58, 58' as above described may in this case be dispensed with.

In the embodiment shown on Figs. 6 and 7, the stopping of rack 1 is controlled by a single switch the casing 80 of which may slide perpendicularly to the motion of said rack in a recess 61, provided in the casing 3. The position of casing 80 in its recess 61 is defined by a control rod 83 remotely controlled by a lever 84. The switch is actuated by a rod 86 integral with a plate 87 made of conducting material, and movable between two opposed couples of contacts 88 and 89, both contacts in each couple being separated by a short distance.

The two contacts of each couple are connected with the feeding circuit of the electric motor actuating the mechanism so that their short-circuiting by plate 87 produce the rotation of the motor in one or the other way, respectively.

The rod 86 projects inside the casing 3 and is driven towards there by a spring 91 supported by a widening of said rod at the bottom of casing 80. The end of said rod is contacting the bottom of a groove 82 acting as a cam, provided in rack 1 and having a variable depth along said rack.

It is understood that the displacement of lever 84 in one way or the other when the plate is situated between the couples of contacts 88 and 88, short-circuits one or the other of these couples of contacts, and starts the motor in the corresponding way. Rack 1 is therefore moved in the way corresponding to the displacement of rod 86 towards the inside or the outside, depending upon which of the couple of contacts 88 or 89 have been short-circuited, so that plate 87 is driven back to its median position and cuts off the motor. To each position of lever 84 corresponds therefore one position of rack 1, and consequently one well defined angular position of the flaps.

According to still another embodiment shown on Figs. 8, 9, 10 a pulley 95 having an axle 96 is connected by means of cables 98 with the rack 1 in such a way that its angular position be under the dependance of the position of said rack 1. The periphery of the pulley comprises two continuous ridges 99 and 100 provided side by side and extending respectively over about 180 degrees, leaving a little angular space between their ends.

A support 104 pivoting around the axle 96 of the pulley bears a control handle 108 and may be fixed in any angular position by means of a lock 108 actuated by a lever 109 and cooperating with the rack 110.

The support 104 bears two switches 112 and 113 which are situated in front of the ridges 99 and 100 respectively, the closing of said switches controlling the rotation of the motor of the mechanism in one or the other way respectively.

It is evident that one or the other of the two switches 112 and 113 is always actuated by the corresponding ridge 99 or 100, as long as the pulley is not, with reference to the support, in the angular position called "neutral position", in which the space left between the ends of the ridges is in front of the two switches and in which position the circuit of the motor is cut off.

Under these conditions, the displacement of the support 104 in one or the other way from said neutral position always closes one of the switches, thus producing the rotation of the motor in the corresponding way until the pulley resumes, with reference to the support, said neutral position. Therefore, the position of the rack 1 is related to that of the support 104.

According to the embodiment shown on Fig. 11, the movable control element of the flaps is a

tubular rotating axle 1, both ends of which have interior threads, receiving ending elements 4 which are to be connected directly with the axles of the flaps respectively provided on both sides of the fuselage. The axle 1 is journaled in ball-bearings 6 mounted in part 12 of the casing onto which is secured another part 13 of the casing, which is itself prolonged by a third part 14 of the casing, the last mentioned part enclosing an electromotor. The shaft 16 of said motor drives, by means of a centrifugal clutch 17, a sleeve 16 journaled in a partition 23 placed between the contacting faces of the two partial casings 3 and 12. The sleeve 18 is prolonged by a shaft 19, integral with a pinion 20 meshing with pinions 21, mounted for free rotation on axles 24, said last mentioned pinions meshing with an internal gear 26 provided on a partition 27 which is situated between the contacting faces of the partial casing 3 and 12. The pinions 21 comprise a second gear meshing with an interior geared wheel 28, the axle 29 of which is journaled in a partition 30, integral with the interior face of the partial casing 3. A pinion 32 is secured, by means of grooves, on said axle 29, and meshes with a pinion 33 integral with the outer body 34 of a torque limiting device concentrical with the shaft 4 and comprising disks 36. One series of disks 36 of said torque limiting device is assembled by means of outside grooves of the body 34 and the other series is assembled by inner grooves of said shaft 1, in order to transmit the motion between the body 34 and the shaft 1. The disks 36 are pressed against each other by equally pressing springs 38, abutting on a washer 39 held by a nut 40, screwed on the shaft 1 and allowing the adjustment of the tension of the springs, and therefore of the sliding torque of the limiting device.

It is evident that the rotation of the motor in one or the other way controls the rotation of the shaft 1 in one or the other way, and, consequently, the actuating or the effacement of the flaps, the torque limiting device having the same function as in the already described embodiment. The stopping of the flaps in any position may be obtained as aircady described in the foresaid embodiment.

The other embodiment represented in Figs. 12, 13, 14 and 15 differs from that described with reference to Figs. 1, 2, 3 and 4, only by the design of part 3 of the casing, the design of the mechanisms it comprises, and the design of the device connecting the mechanism to the flaps. Following description is limited to said points.

With reference to Figs. 12 and 13, shaft 10, supported by bearings 11 and driven by the motor together with a demultiplication gear, as formerly described with reference to Fig. 1, comprises two parallel series of teeth 100 and 100'. Each series comprises a small number of identical teeth, for instance four of them, the sides *f* of which are cylindrically shaped, perpendicularly to the axis of shaft 10, or else receive a similar shape, to facilitate their manufacture. The ends *s* of these teeth are spherical surfaces.

Two identical pinions 9 and 9', with external gearing, the internal cylindrical surface of which surrounds the horizontal shaft 10, are respectively meshing with the series of teeth 100 and 100' with their teeth 101 and 101' which are in equal number but have a greater length in a direction parallel to that of the axis of the shaft 10. Metallic washers 102 and 102', elastically secured in both sides of each gearing 101 and 101', limit the relative movements of pinions 9 and 9' on the shaft 10, these relative movements of pinions 9 and 9' being rendered possible by the shape of sides *f* and ends *s*. A rack 1 is meshing with pinion 9 and is supported on its back side with circular cross-section, by a cylindrical roller 6 secured to the lower part of casing 3 by means of an additional plate. In a similar way, a rack 1', meshing with the pinion 9', comprising a circular cross-section back side, is contacting a cylindrical roller 6' secured to the upper part of casing 3.

Racks 1 and 1' are projecting from both sides of casing 3 which comprises openings for that purpose, the tightness being insured by means of bellows 105, 105' secured between the edges of the openings and the corresponding rack. There are four bellows, i. e. two, 105, cooperating with rack 1, and two, 105', cooperating with rack 1'.

The two racks bear, one on one side of casing 3, the other on the other side, an end 4, which is to be coupled with the lower wing flap control device. To that effect, shaft 10 being parallel to the longitudinal axis of the aircraft, racks 1 and 1' are parallel to the wings which have as well a dihedral angle as back sweeping.

This direction, which is rendered possible by the gears connecting pinions 9 and 9' to the shaft 10, is represented in Figs. 14 and 15 showing the whole design respectively in half-plan, the wing beam being drafted in dotted lines *l*, and in half-elevation, the part corresponding to the other wing being symmetrical.

The flaps are actuated on each wing by a sliding rod 110 directly coupled with the corresponding rack 1, and situated in the prolongation of said rack. This rod is connected by links 111 to the nonfigured flaps, the dotted line position of the link, in Fig. 15, corresponding to the actuated flap.

The flaps placed on each wing could be actuated by two moving devices, moving simultaneously in opposed directions under control of a mechanism quite different from a mechanism described with reference to Figs. 12, 13, 14 and 15.

Obviously, one wheel such as 9 may be provided with helical teeth and cooperates with two racks such as 1 and 1', Fig. 12.

While I have illustrated and described preferred forms of construction for carrying my invention to effect, this is capable of variations and modifications without departing from the spirit of my invention.

CHARLES RAYMOND WASEIGE.