

April 22, 1924.

1,491,310

E. PERRIN

HELICOPTER

Filed March 16, 1921

3 Sheets-Sheet 1

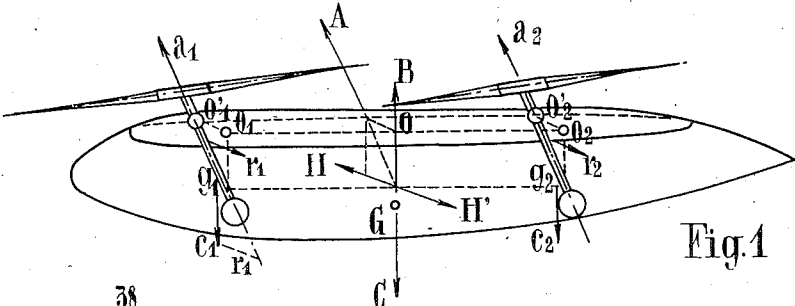


Fig. 1

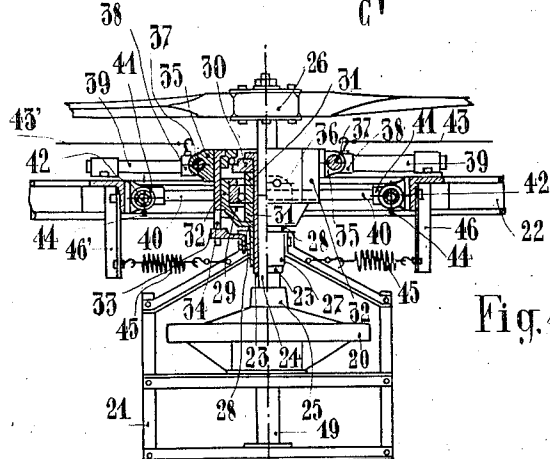


Fig. 4

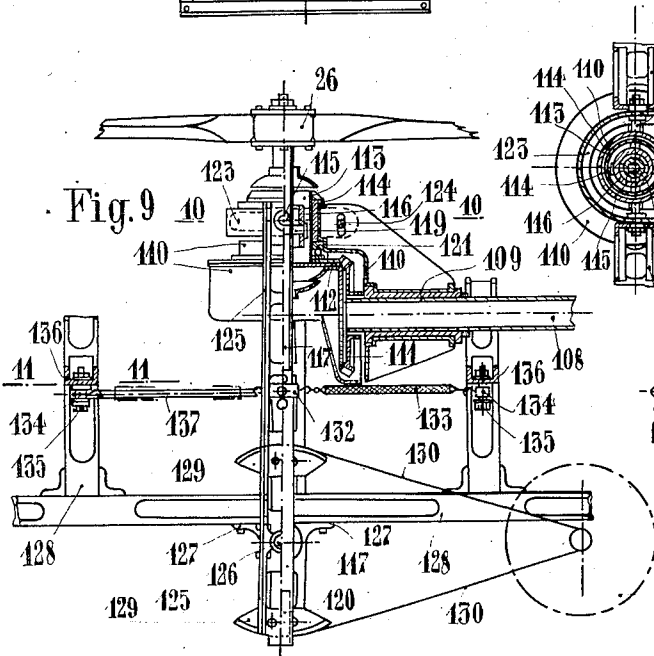


Fig. 9

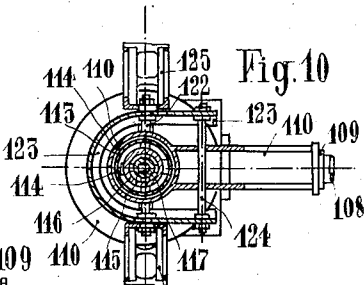


Fig. 10

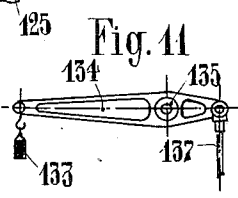


Fig. 11

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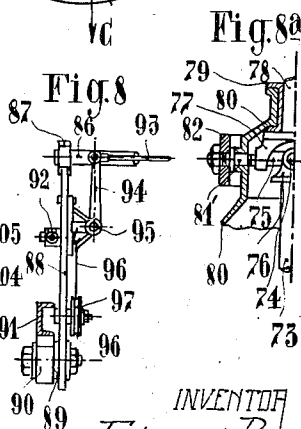
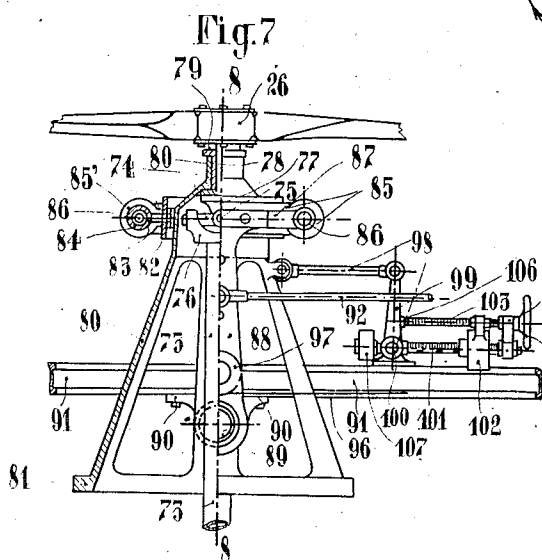
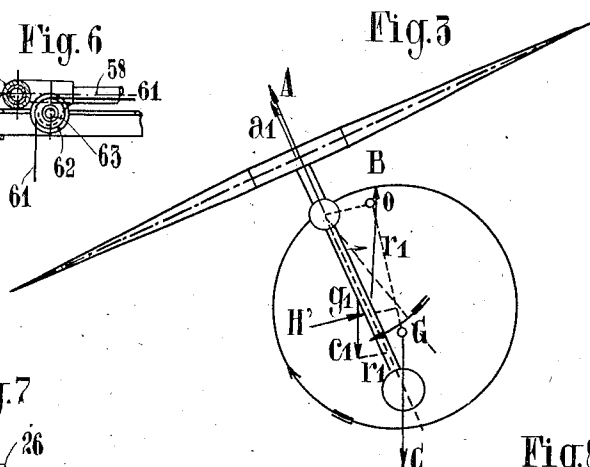
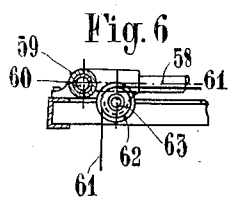
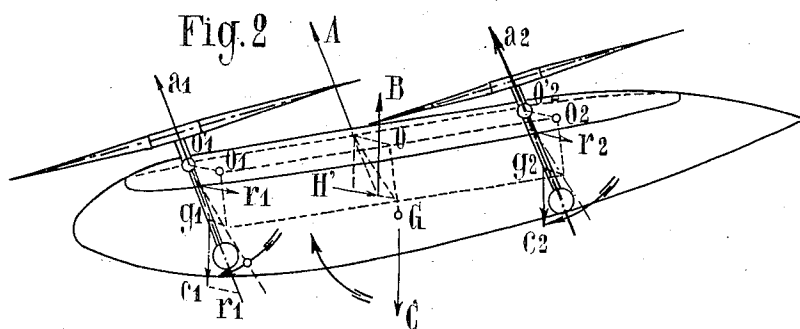
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1,491,310

HELICOPTER

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3 Sheets-Sheet 2



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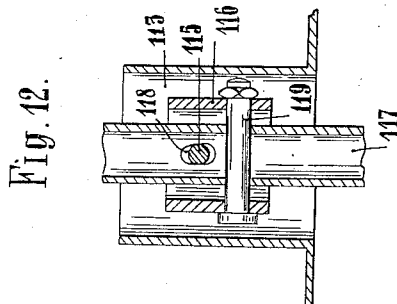
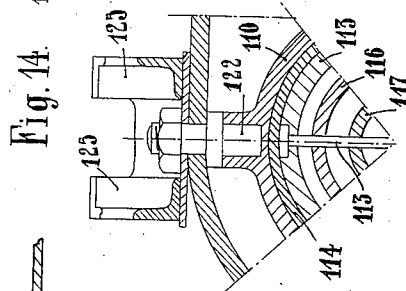
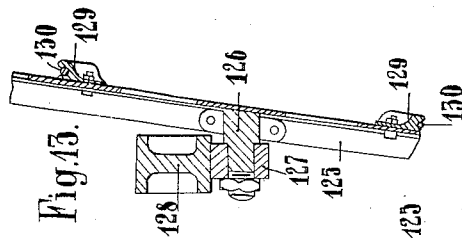
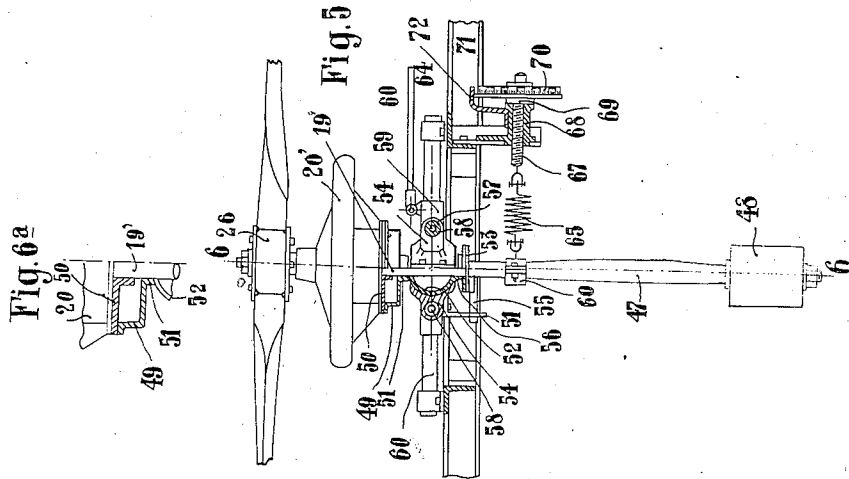
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Filed March 16, 1921

3 Sheets-Sheet 3



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BY

BT
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UNITED STATES PATENT OFFICE.

EDOUARD FERRIN, OF PARIS, FRANCE.

HELICOPTER.

Application filed March 18, 1921. Serial No. 452,709.

To all whom it may concern:

Be it known that I, EDOUARD FERRIN, citizen of the Republic of France, and resident of Paris, France (post-office address 61 Avenue Victor Emmanuel III), have invented a new and useful Helicopter, which improvements are fully set forth in the following specification.

This invention relates to aeronautical machines, and more particularly to machines of the helicopter type.

According to the invention, there is provided a helicopter which, at the will of the pilot, is capable of traveling in either a longitudinal or a transverse direction, or in any intermediate direction. The helicopter may be automatically maintained in a stable position during the time that it advances, whatever be its speed and direction; this double result being obtained solely by the manipulation of the supporting propellers, without the intervention of other propelling means.

The characteristic features of the invention consist in:—

1. The use of universal joints by means of which the supporting efforts of the propellers are transmitted to the general frame of the machine, these universal joints enabling the axes of the propellers to assume any possible inclination relative to the machine;

2. The use of a device enabling the universal joints to be "shifted" either in the longitudinal direction relatively to the machine, or in the transverse direction, or in an intermediate direction;

3. For the purpose of insuring the automatic stability of the machine, the use of balance weights mounted in oscillating or swinging frames carrying the supporting propellers so as to bring the center of gravity of the frames below the universal joints; the action of gravity on the parts of the frames, and that of the gyroscopic forces, tending jointly, if they were acting alone, to bring the axes of the propellers to a stable vertical position of equilibrium;

4. Together with the use of balance weights, the use of a system of springs for returning the parts to normal position, which system acts on the oscillating or swinging frames and the action of which may either be set in operation auto-

matically, owing to the "shifting" of the universal joints, or may be controlled by the pilot.

This return system is designed to act on the swinging frame along a line which may be practically parallel to the direction of the "shifting" imparted to the universal joint of the frame, and with an intensity varying in accordance with the magnitude of the "shifting." When acting, the system inclines the axes of the supporting propellers; and the extent of the "shifting" is so calculated that the helicopter will remain in equilibrium. Therefore, the inclination will be such that in normal position of flight, the resultant of the supporting efforts or forces, acting in the new direction of the inclination of stable equilibrium of the swinging frames, the weight of the entire helicopter and the effort of resistance of the surrounding air to the advance of the ship, conjointly constitute a system of three concurring forces in equilibrium. In other words, this inclination will be such that the resultant of the supporting efforts in the new position of stable equilibrium of the swinging frames will pass through the quasi-fixed point in the helicopter situated at the intersection of the vertical line representing its weight and of the line along which the resistance to the advance from the surrounding air is acting (Fig. 1).

In the case of direct control by the pilot, it is possible to determine the necessary relation between the "shifting" of the universal joints and the efforts produced by the return system of the swinging frames, by the use of two sets of graduations or scales corresponding to each other and arranged on the parts or members of each of the two control systems.

Referring to the accompanying drawings, Figures 1, 2 and 3 are diagrammatic views of an air ship equipped with the invention, showing the direction and application of the various forces to which the ship is subjected during flight.

Fig. 4 is a view, half in elevation and half in vertical section, of one form of the invention.

Fig. 5 is a similar view of a modification.

Figs. 6 and 6^a are sectional views of details of Fig. 5, both views taken in the plane indicated by line 6—6.

Fig. 7 is a similar view of another modification.

Figs. 8 and 8^a are sectional views of details of Fig. 7, taken in the plane indicated by line 8—8.

Fig. 9 is a view, half in elevation and half in vertical section, of a further modification.

Figs. 10 and 11 are horizontal sectional views of details of Fig. 9, taken on lines 10—10 and 11—11 of that figure.

Figs. 12, 13 and 14 are enlarged sectional views of other details of Fig. 9.

In the conditions obtained by the use of the devices set forth in the foregoing, the resultant force A (Fig. 1) of the supporting efforts or forces is resolved into a lifting force B balancing the weight C of the whole ship, and a force H parallel to the direction of the "shifting" of the universal joints. This effort or force H produces the advance of the system in a direction practically identical with that of the "shifting" of the universal joints, and at such a speed that the resistance opposed by the surrounding air to the advance movement balances the force H. The "shifting" of the universal joints may be taken as zero when the force H is zero, and the term "origin" will be employed to indicate the corresponding position of the universal joint. Therefore, the "origin" of the "shifting" will be the position of the universal joints at which the resultant A of the supporting forces is vertical and passes through the center of gravity of the whole ship. In Fig. 1, O_1 , O_1' , O_2 , O_2' are the "shifting" movements of the universal joints, and r^1 and r^2 the corresponding return or pulling-back efforts or forces.

Owing to the action of the spring returning system adjusted as hereinbefore described, the helicopter will remain in stable equilibrium when the universal joints are placed in any "shifted" position.

Thus, supposing the system to be in the normal flight position and advancing in a uniform manner, any longitudinal or transverse inclination will cause the resultant B of the supporting force A and of the advance resistances H' to pass in front or behind and either to the right or to the left of the center of gravity of the entire helicopter (Figs. 2 and 3). The vertical component B of the force A forms then with the weight C a stabilizing couple; and there is, therefore, a constant tendency to bring the system into equilibrium (Fig. 1) which occurs when the resultant force A, the weight C and the resistance H' balance each other.

The various characteristic devices described in the foregoing can be constituted by any suitable mechanical parts.

By way of example, the universal joints could be constituted either by a spherical ball joint (Fig. 5); by two spindles each

at right angles to the other and constituting a Cardan joint arrangement (Figs. 7 and 9), or by any other equivalent mechanical device.

The transmission of power to the propellers through the universal joints can be effected by mounting the engine directly on the propeller shaft above or below the universal joints (Fig. 4); by driving the propellers by means of auxiliary shafts or spindles (Fig. 5) rotating in bearings secured to the fuselage and driving the propellers by means of a Cardan joint, these shafts or spindles being arranged in line with the propeller shaft (Fig. 7) or being hollow and enclosing the latter (Fig. 9); or by similar means.

The "shifting" of the universal joints may be effected by combining "shifting" movements along two directions at right angles to each other, for instance, along the direction of the longitudinal axis and along the direction of the transverse axis of the ship.

The device for "shifting" the universal joints can be constituted

(a) By a group of two rectangular cross-bars, each sliding along guide rods secured to the fuselage, the universal joint being carried by a block which can slide on both cross-bars and is thus compelled to stay at their intersection (Fig. 4);

(b) By a slide block carrying the universal joint and adjustable on a cross-bar sliding along guide rods secured to the fuselage (Fig. 5);

(c) By one or more frames mounted to swing about lower pivots and bearing at top a transverse tube on which is adjustably mounted a slide block carrying the universal joint (Fig. 7);

(d) By any other desired analogous device.

The movement could, moreover, be limited to a single direction (longitudinal or transverse) if the forward travel of the ship is to take place only in that single direction (Fig. 9).

The balance weight system may comprise any part of the swinging frames, such as the engine, the ballast proper, the bottom part of the propeller shaft, or the like.

The returning system, the importance of which has already been pointed out, may be constituted either by a spring, one end of which is secured to the swinging frame at a distance from the universal joint, while the other end is secured to the fuselage at such a point that when rising vertically, the spring does not exert any effort on the frame (Fig. 4); or by a similar spring, the efforts of which are amplified by securing one end to a slide block controlled by the pilot and having its position indicated by a scale similar to that provided on the gear for controlling the universal joints (Fig. 5); or by

a balance weight acting on the frame by means of a lever, to one branch of which lever a balance weight is secured at a point which can be varied at will by the pilot. The various positions of the balance weight are determined by means of graduations identical with those provided on the controlling gear (Fig. 7). The return system may also be constituted by a spring similar to that hereinbefore mentioned which has one end secured to the swinging frame and the efforts of which are amplified by securing the other end to a lever, the operation of which is procured simultaneously with the "shifting" of the universal joints (Fig. 9); or by any combination of the elements of the devices previously described or by any equivalent mechanical device.

In Fig. 4, the non-rotating crank shaft 19 of the rotary engine 20 is secured on a swinging frame 21 carried on the fuselage 22 through the intermediary of the universal joint shifting device, so as to be capable of inclining freely relatively to the fuselage in any direction.

To obtain this action, there is secured on the top end of the frame 21 a vertical bearing 23 in which the propeller shaft 24 rotates freely. This shaft is secured at its lower end in the rotating crank case 25 of the rotary engine and carries at its upper end the hub 26 of the supporting propeller. The vertical bearing 23 carries on its lower portion a sleeve 27 connected with the frame 21 and shaped, just above the frame, to form a spherical collar 28. A ball bearing 29, provided with a spherical outer race, is connected to the central portion of bearing 23; and a thrust ball bearing 30, provided with a spherical outer race, is connected to the upper end of bearing 23, the center of the thrust bearing being common with those of the outer race of bearing 29 and the spherical collar 28. The sleeve 27 and the inner races of the bearings 29 and 30 are secured on the bearing 23 by means of spacing rings 31; and the outer races of said bearings are secured inside a two-part external sleeve 32, the bottom part of which exactly fits the spherical collar 28, so that it supports this collar and, at the same time, permits a free inclination of the bearing 23 in the sleeve 32, owing to the formation of a central hole provided in the bottom part of the sleeve 32 and having a diameter sufficient for that purpose.

During the inclination of the bearing 23, the balls of the bearings 29 and 30 run along their outer spherical races, so that the inclination takes place round the common center of the said spherical races. Moreover, the supporting thrust is transmitted from the propeller through the engine 20, the swinging frame 21 and the vertical bearing 23 to the thrust bearing 30, thus obviating

the friction which would otherwise interfere with the free inclination of the frame. It will be then easily understood that the two ball bearings 29 and 30 have the same action as a universal joint, the center of which should be the common center of the outer races of said bearings. In this instance the balance weight formerly mentioned is constituted by the frame 21 itself together with the engine 20. The rotation of the frame 21 and, consequently, of the crank shaft 19 is prevented by a tappet 33 secured on the top of the frame and designed to slide or rotate, as necessary, in a groove 34 cut in the external sleeve 32.

The device for shifting sleeve 32 may be constituted as follows: On sleeve 32 are secured two blocks 35 and two similar blocks 36 set at right angles with the former ones, (only one of which appears on the drawing). The blocks 35 are slidably mounted on two cross-bars 37 which are secured at opposite ends on two sleeves 38 (only one of which is shown); and these sleeves 38, in turn, are slidably mounted on two parallel guide rods 39 (only one of which appears) secured on the fuselage 22. In a similar way, the blocks 36 are slidably mounted on two cross-bars 40 which are secured at opposite ends on two sleeves 41, which, in turn, are slidably mounted on two guide rods 42 secured on the fuselage and set at right angles to the guide rods 39. Each of the sliding sleeves 38 is connected at opposite ends with pairs of pull cables 43 and 43' adapted to be operated by the pilot; and similarly, each of the sliding sleeves 41 is connected with pairs of pull cables 44. It will, then, be easily understood that by pulling on the pair of cables 43 (or 43') the pilot may "shift," in the longitudinal direction of the machine, both cross-bars 37 and consequently the external sleeve 32 and the universal joint device inside the latter. In like manner, by pulling on one of the pairs of cables 44 the pilot may "shift" the universal joint device relatively to the machine, shifting at the same time both cross-bars 40 and connected parts.

The system for returning the parts may be constituted as follows: Two springs 45 and 45' are connected at one end to the swinging frame 21 and at the other end to depending supports 46 and 46' fixed to the fuselage. The said springs, which have a tension action exclusively, work alternately according to the direction in which the "shifting" of the universal joint device takes place (from the "origin of shifting" to one or other side of the neutral position). The points of attachment of the springs to the frame, together with the extent of the return action of the springs and their amount of extension, are selected so that the resultant of the supporting forces, the weight

of the apparatus and the resistance of the air to the advance, shall be concurrent, whatever be the movement of the universal joints, which necessitates the two springs being extended when the universal joint is in the position which has been hereinbefore described as the "origin of shifting."

The construction represented in Fig. 5 comprises a propeller mounted directly on the front of the rotating crank case of the rotary engine 20'. The non-rotating crank shaft 19' is prolonged downwards by a shaft 47, on the lower end of which the balance weight 48 is secured. A frame 49 is bolted on the crank shaft plate 50; and this frame is extended downwards to form spaced upper and lower bearings 51 which fit the crank shaft 19' and an intermediate spherical part or ball 52 between said bearings 51. The bottom bearing 51 is extended radially to provide a collar which can be bolted to a corresponding collar 53 secured on shaft 47.

The ball 52 fits in a two-part block 54 in which it can oscillate freely. The said block, which is connected to the fuselage as will be explained hereinafter, can thus meet the thrust of the propeller and at the same time can allow the relatively-free inclination of the group of parts consisting of the propeller and engine 20', crank shaft 19', shaft 47, balance weight 48 and frame 49, 50, 51, 52. This group of parts thus acts in the same way as the swinging frame 21 and connected parts in Fig. 4 and constitutes an equivalent thereof; and similarly, the ball 52 oscillating in the block 54 acts as an universal joint whose center is the center of the ball. In this instance, the balance weight is constituted, as will be understood, by shaft 47 together with the balance weight proper 48.

The rotation of the collar 53 and consequently of shaft 47 and crank shaft 19' is prevented by a tappet 55 fixed to the collar 53. The said tappet moves in the groove of a plate 56 secured on the block 54, in the same way as tappet 33 and groove 34 in Fig. 4.

The device for shifting the ball 52 may be constructed as follows: The two-part block 54 is provided with two projecting sides 57 constituting sleeves which are mounted to slide on two cross-bars 58. These cross-bars are mounted at opposite ends on sliding tubes 59 (only one of which appears on the drawing), set at right angles with the cross-bars 58 and which link together the said cross-bars. The two sliding tubes 59 are slidably carried by two guide rods 60 secured to the fuselage. The block 54 is connected on both sides with the ends of a pair of symmetrical pull cables 61 (only one of which appears) controlled by the pilot. The cables 61 are carried on two pulleys 62 (only one of which is shown), the pins of which

are carried by the end parts of cross-bars 58. By pulling on one or the other of cables 61, the pilot may thus shift the block 54 (which slides on the cross-bars 58) transversely relatively to the machine. In like manner, both sliding tubes 59 are connected with rods 64 controlled by the pilot; and by pulling the rods or by pushing them, the pilot may thus shift longitudinally both slide tubes 59 and consequently both cross-bars 58 and the block 54. In this way the longitudinal shifting of the universal joint device relatively to the fuselage is obtained.

The returning system is constituted by a spring 65 which may work either in tension or in compression. This spring is connected at one end to an adjustable collar 66 on shaft 47, and at the other end to a non-rotating screw 67 which is keyed in an unthreaded bearing 68 attached to the fuselage. The said screw may be moved longitudinally by means of a nut 69 which may be rotated by the pilot. The rim 70 of this nut is provided with notches for engagement by a projecting tooth 71 on a flexible blade 72 fixed to the bearing 68, and graduations or division marks are indicated on the rim opposite the said notches. A double-entry table is placed in front of the pilot; and in one of the entries are indicated the divisions of a scale provided along the gear controlling the longitudinal "shifting" of the universal joints, while in the other entry are indicated the similar divisions of the transverse "shifting" of the universal joints. The corresponding figures in the table indicate the divisions on the nut rim which correspond to the correct adjustment of the return system when the universal joint is shifted accordingly.

In the case in which only the longitudinal movement of the universal joints is utilized, the double-entry table is no longer necessary and may be replaced by a concordance table. The arrangement may be simplified by providing both graduations in the concordance table with the same figures. Therefore, when the universal joints have been "shifted" to a certain extent corresponding to one figure of the scale on the controlling gear, the rim of the nut is set for correct adjustment to the division indicated by the same figure.

In Figs. 7, 8 and 8^a, the engine (which is not shown) drives the propeller by means of an auxiliary shaft 73; the said shaft terminating at its upper end in a Cardan joint. This joint is composed of two spindles 74 and 75 disposed at right angles to each other and made in one piece, one spindle 74 being capable of rotating freely in the two branches of a fork 76 secured to the upper end of the shaft 73. The spindle 75 can rotate freely in a similar fork 77 secured to the lower end of the upper propeller shaft 78, which

latter is supported by, and rotates freely in, a non-rotating sleeve 79; the bottom collar of said sleeve taking the supporting thrust of the propeller. The sleeve 79 is secured on top of a perforated, frusto-conical frame 80, which is enlarged in diameter at its bottom to allow the free oscillation of the frame relatively to the engine shaft 73, as will be explained hereinafter. A metallic bottom ring 81 is provided on frame 80 and acts as a balance weight, together with the bottom part of the frame itself.

The frame 80 is pivoted at its top on two spindles 81' (Fig. 8^a) bolted on a ring 82 concentric with the Cardan joint 74—75. Two similar spindles 83 (only one of which appears) are set at right angles with the former ones and are pivoted on the ring 82 and secured to two slide tubes 84 (only one shown). Owing to the play of the spindles and of the ring, the frame 80 may incline freely relatively to the slide tubes 84. Consequently, the propeller shaft 78 and the propeller itself may incline freely relatively to the fuselage 91, and at the same time the driving torque may be transmitted from the engine shaft 73 to the propeller shaft 78 in any inclined position owing to the Cardan joint 74—75—76—77. Thus, the device acts as a universal joint whose center is the center of the said Cardan joint.

The shifting device is constituted as follows: The slide tubes 84 are connected at opposite ends by two cross-pieces 85 and 85', one of which (85) appears to the right in Fig. 8, while the other one (85') appears to the left behind the cross-section plane. The slide tubes 84 are carried by two guide rods 86 which are secured at opposite ends to two cross-pieces 87 (only one of which is shown); said cross-pieces being mounted on top of two lateral supports 88 (only one of which appears). These two lateral supports are pivoted at their lower ends on the fuselage 91, by means of spindles 89 which are secured to them and pivoted in bearings 90 bolted on the fuselage.

The supports 88 (or only one of them) are pivotally connected with a control rod or lever 92 operated by the pilot. When the latter pushes or pulls on this rod, the supports 88 rotate around the bearings 90; and consequently the cross-pieces 87 and guide-rods 86, together with the slide tubes 84, are shifted longitudinally relatively to the fuselage, this shifting movement being followed by the whole universal joint device including the ring 82 and connected parts.

On the other hand, the cross-pieces 85 and 85' are connected to the adjacent ends of two transverse connecting rods or cables 93 (only one being shown). The other ends of these connecting rods are pivoted to the ends of the long vertical arms of bell crank levers 94 (only one shown) which, in turn, are pivoted

on pivots 95 carried by the lateral supports 88. The short horizontal arms of the bell cranks 94 are connected to pull rods or cables 96 (only one shown) which lead over pulleys 97 mounted on the lateral supports 88 and are under the control of the pilot. When the latter pulls on one or the other of the cables 96, one or the other of the connecting rods 93 is pulled and thus the cross-pieces 85 and 85' and, at the same time, the slide tubes 84 are shifted transversely relatively to the fuselage, which shifting is followed by the whole universal joint device including the ring 82 and connected parts.

The return system acts on frame 80; and it comprises a connecting rod 98 (Fig. 7) pivoted to said frame at one end and at the other end to the vertical arm 99 of a bell crank lever, which latter is pivoted on a pin or stud 100 secured to the fuselage 91. The horizontal arm 101 of the bell crank lever comprises a graduated rail on which is slidably mounted a weight 102 having its upper portion formed with a threaded hole for the passage of a screw 103 therethrough. The said screw is controlled by the pilot by means of a hand wheel 104, and is carried by two non-threaded bearings 105 and 106; the first-named bearing being provided on the end of the threaded rod or rail 101, and the other bearing being provided on the vertical arm 99 of the bell crank lever. By turning the hand wheel 104, the pilot may thus move the weight 102 to any extent along the graduated rod 101. The scale divisions are determined in a manner similar to that of the divisions of the rim of the nut 70 in Fig. 5. A counterweight 107 is mounted on the opposite end of rod 101 from the bearing 105, and is calculated so as to balance the weight of the parts resting on said rod 101 when the weight 102 is placed at the division corresponding to the position of the vertical joint hereinbefore described as the "origin" of the "shifting."

In the construction shown in Figs. 9 to 14, the engine, which is not shown, drives a tubular shaft 108 rotating in a bearing 109 equipped with antifriction devices and carried by the gear-casing 110. A bevel gear 111 is secured to the end of shaft 108 and meshes with a gear 112 secured to the lower end of a tubular vertical shaft 113. This shaft 113 is journaled in an antifriction bearing 114 secured in the casing 110 so as to be capable of rotating easily and of transmitting to the casing 110 the supporting thrust of the propeller.

In the shaft 113 is secured a transverse spindle 115 pivoted on an internal ring 116 and extending through an elongated hole 118 (Fig. 12) in the propeller shaft 117. On ring 116 is secured another spindle 119 at right angles with the former one and on which the propeller shaft 117 is pivoted. It

will then be easily understood that the play of the spindles 115 and 119, together with ring 116, enables the propeller shaft to incline freely relatively to the fuselage, thus acting in effect as a universal joint. The downwardly-extending propeller shaft 117 here plays the part of the swinging frame hereinbefore described. In this instance, the balance weight is constituted by the propeller shaft itself and also by a balance weight proper 120 secured within the lower end of the hollow shaft 117.

The shifting of the universal joint is effected only in the longitudinal direction. To this end, the hollow vertical shaft 113 rotating in the bearing 114 carried in the gear casing 110 transmits to the latter the supporting thrust from the propeller through a ball thrust-bearing 121; said gear casing being pivoted at its top on two transverse supporting spindles 122 which are secured to an external half-circular ring 123. The said ring is braced or strengthened at the back by a strut 124 extending through the gear casing 110, and it forms the top part of a frame 125 of inverted V-section. The lateral branches of this frame are made of angle irons connected together by a perforated plate; and they can swing about trunnions 126 secured to them and rotating in bearings 127 fixed to the fuselage 128.

On each of the lateral branches of frame 125 are secured two quadrants 129, to which are fastened the ends of cables 130 which wind on the quadrants and on the spindle of a hand wheel 131 controlled by the pilot. When the latter rotates the hand wheel, the pull on the top or bottom end of cables 130 rotates the frame 125 around the trunnions 126. The depending ring 123 and gear casing 110 are thus "shifted" longitudinally relatively to the fuselage, and simultaneously the shifting is transmitted to the entire universal joint device.

The returning system has a close analogy to the returning system described in connection with Fig. 4. A ring 132 is fixed by a set screw on the propeller shaft 117 and is thus longitudinally adjustable. Two elastic cords 133 (only one shown) are located opposite this ring and are connected at one end thereto and at the other end to the long arms of horizontal levers 134 (see Fig. 11) pivoted on pins 135 secured on rails 136 fastened to the fuselage. The said levers 134 are actuated directly by the swinging movement of the frame 125, through connecting rods 137 (see Figs. 9 and 11) which act on the short arms of the levers 134 and are pivoted on the lateral branches of the frame 125. Thus, the longitudinal shifting of the frame 125 and, consequently, of the gear case 110 and of the whole universal joint device produces, according to the direction in which it takes

place, the elongation of one or the other of the cords or springs 133. As explained before in the position of the universal joint hereinbefore described as the "origin" of "shifting" both cords 133 are untensioned. I claim as my invention:—

1. In an aeronautical machine, the combination with a lifting propeller and its shaft, of a freely oscillating frame supporting the propeller shaft; a hollow shaft surrounding the propeller shaft; two spindles disposed at right angles to each other within the hollow shaft; and a ring mounted between said hollow shaft and said propeller shaft, one of said spindles connecting said ring and said hollow shaft, and the other spindle connecting said ring and said propeller shaft, so as to constitute a universal joint.

2. In an aeronautical machine, the combination, with the fuselage, of lifting propellers; freely-oscillating frames supporting said propellers; universal joint connections between said frames and the fuselage; and means enabling the pilot to shift said universal joint connections in a longitudinal direction relatively to the fuselage.

3. In an aeronautical machine, the combination, with the fuselage, of a lifting propeller; a freely-oscillating frame supporting said propeller; a universal joint device connecting said frame and the fuselage; a ring pivotally connected to the universal joint device; and a pair of lateral members linked together at their tops by said ring and pivotally connected at their lower ends to the fuselage, said members being operable by the pilot to shift said universal joint device longitudinally to any extent.

4. In an aeronautical machine, the combination, with the fuselage, of a lifting propeller and its shaft; a freely-oscillating frame supporting the propeller shaft; a universal joint device connecting said frame to the fuselage; means to shift said universal joint device relatively to the fuselage; and an elastic returning device connected to said frame and tensioned in accordance with the position to which the universal joint device has been shifted, so as to incline the propeller shaft correspondingly and thereby automatically maintain the stability of the machine.

5. In an aeronautical machine, the combination, with the fuselage, of a lifting propeller and its shaft; a freely-oscillating frame supporting the propeller shaft; a universal joint device connecting said frame to the fuselage; means to shift said universal joint device relatively to the fuselage; a ring adjustable along the propeller shaft; and a spring connected at one end to said ring and at the other end to the fuselage, so as to incline the propeller shaft according to the position to which the universal

joint has been shifted and thereby automatically maintain the stability of the machine.

6. In an aeronautical machine, the combination, with the fuselage, of a lifting propeller and its shaft; a freely-oscillating frame supporting the propeller shaft; a universal joint device connecting said frame to the fuselage; means to shift said universal joint device relatively to the fuselage; a ring adjustable along the propeller shaft; a spring connected at one end to said ring; and a horizontal lever having arms of unequal length pivoted on the fuselage, the other end of said spring being connected to the long arm of the lever, and the end of the short arm of said lever being connected to said frame, so as to shift the universal joint device and thereby automatically maintain the stability of the machine in any position to which the universal joint device has been shifted.

7. In an aeronautical machine, the combination, with the fuselage, of lifting propellers; freely-oscillating frames support-

ing said propellers; universal joint connections between said frames and the fuselage; means enabling the pilot to shift said universal joint connections longitudinally relatively to the fuselage; and balance weights mounted in said oscillating frames so as to bring the center of gravity of said frames below said universal joints.

8. In an aeronautical machine, the combination, with the fuselage, of lifting propellers; freely-oscillating frames supporting said propellers; universal joint connections between the frames and the fuselage; and means enabling the pilot to change the angle of the axis of one propeller relatively to the axis of another propeller, so as to obtain a rotary movement of the machine.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

EDOUARD PERRIN.

Witnesses:

CHARLES LEÓN LOISEL,
GEORGE CASCAL CARRIÈRE.