March 22, 1927. 1,622,138

F. O. ELLERMAN

AIRPLANE HELICOPTER CONTROL

Filed Sept. 12, 1922 3 Sheets-Sheet 1

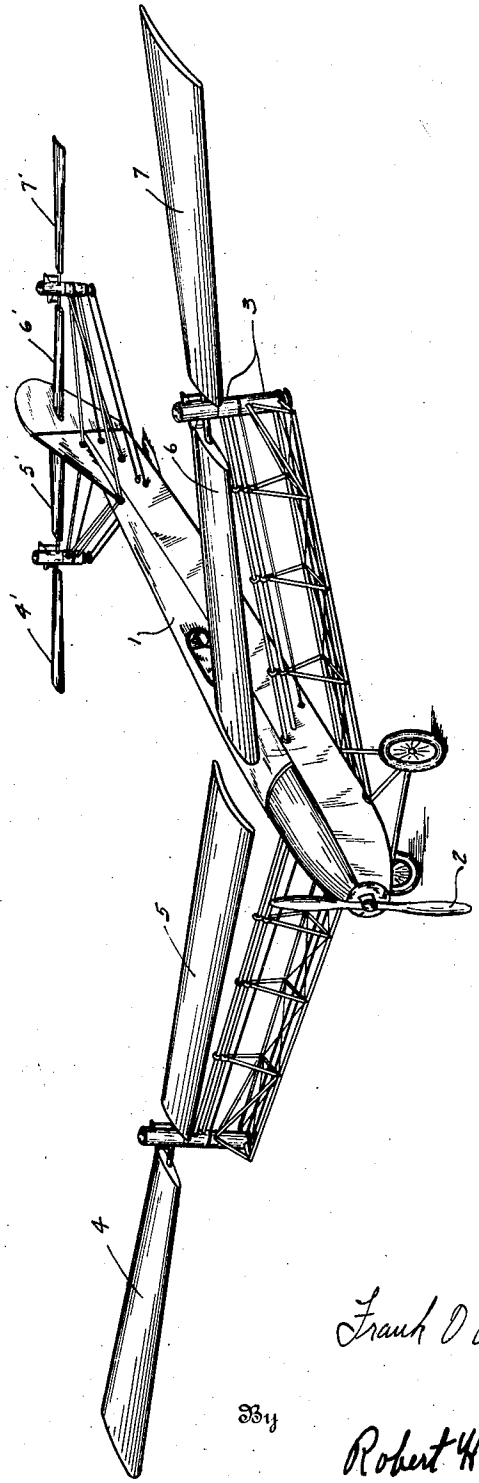


Fig. 1.

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Fig. 2.

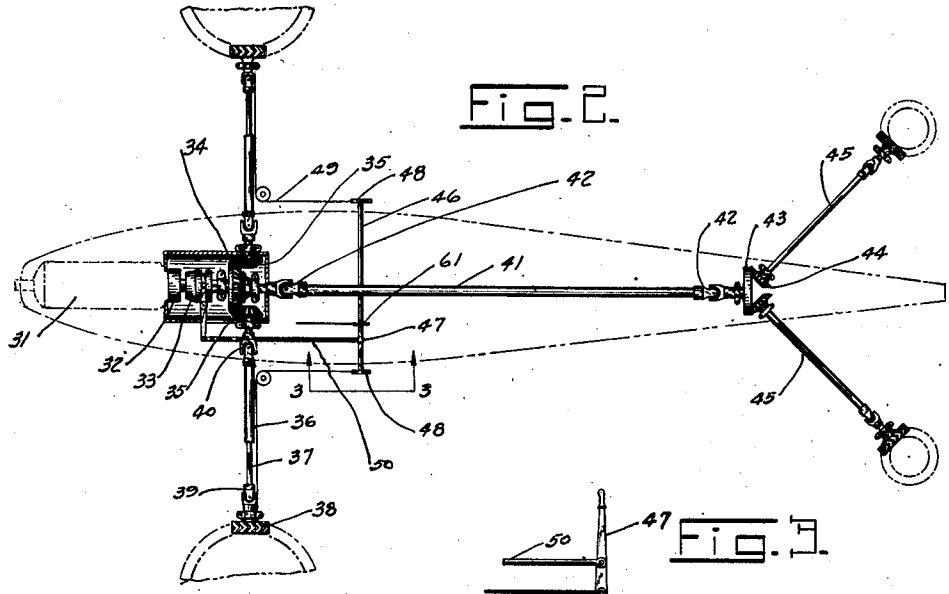


Fig. 3.

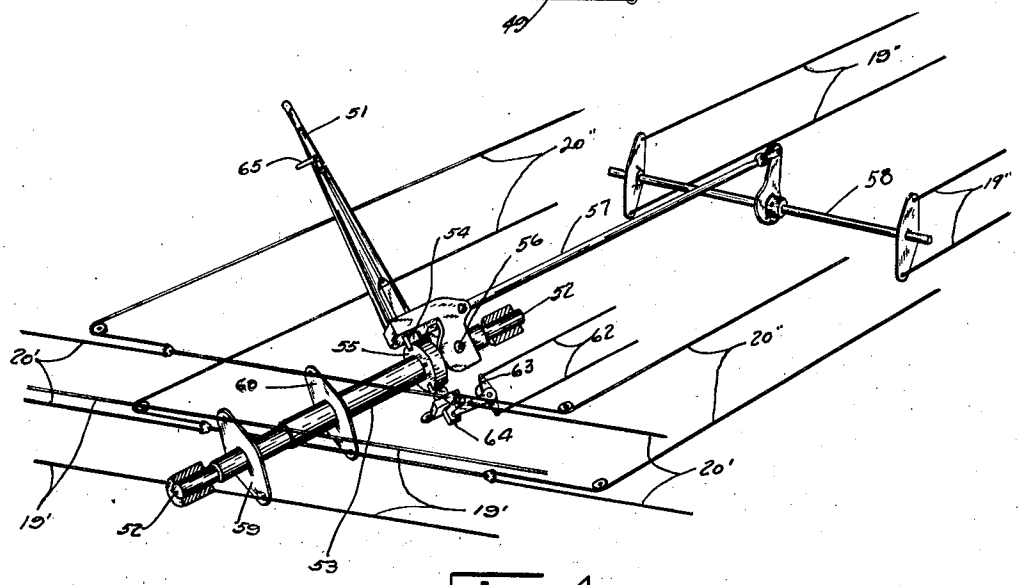


Fig. 4.

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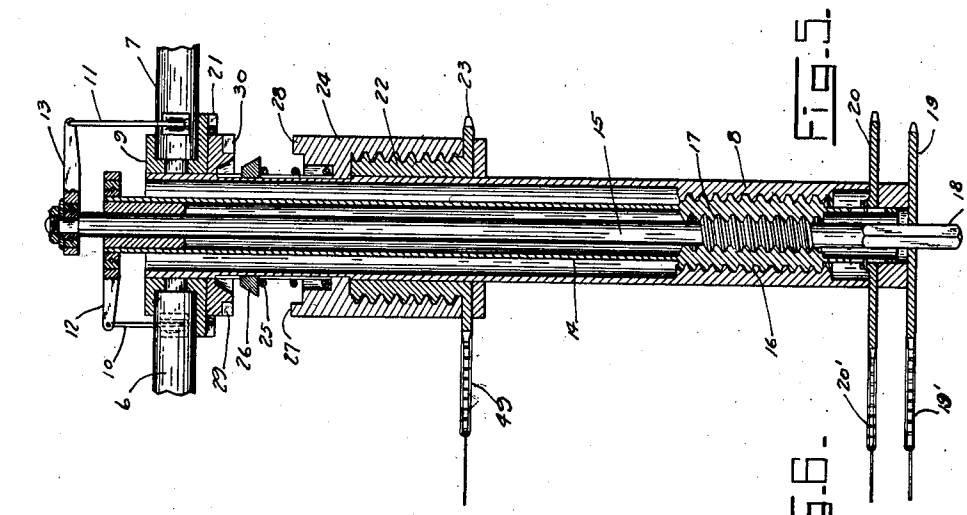


Fig. 5.

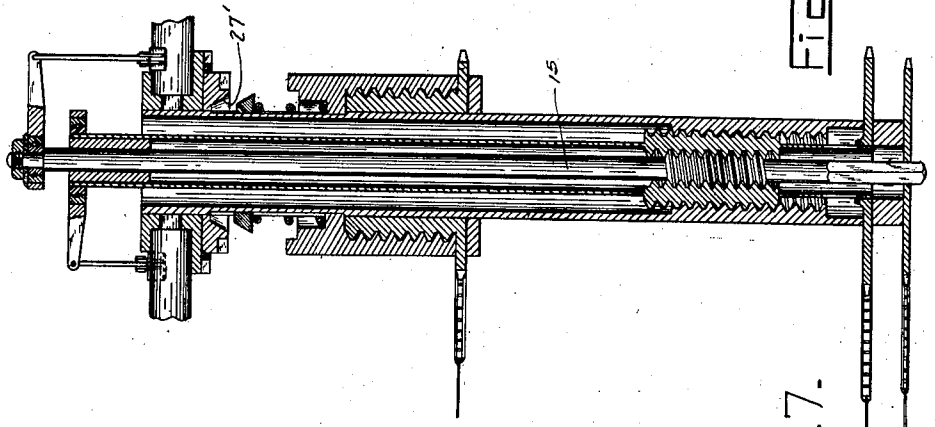


Fig. 6.

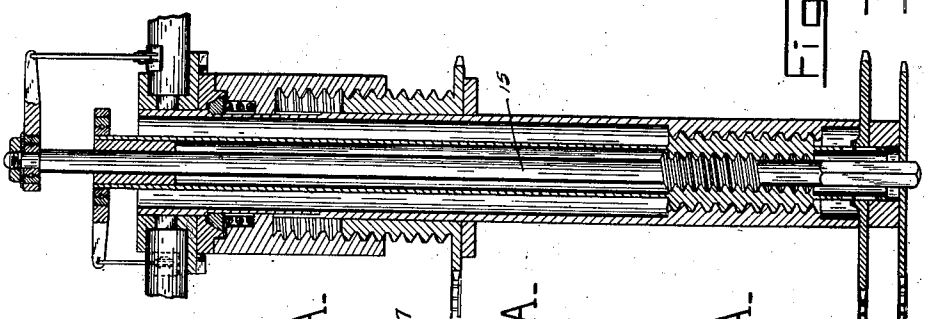


Fig. 7.



Fig. 5A.

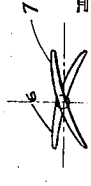


Fig. 6A.

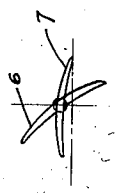


Fig. 7A.

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Patented Mar. 22, 1927. 1,622,138

UNITED STATES PATENT OFFICE.

FRANK O. ELLERMAN, OF DAYTON, OHIO.

AIRPLANE HELICOPTER CONTROL.

Application filed September 12, 1922. Serial No. 587,709.

This invention relates in general to heavier-than-air flying machines and more particularly to a machine of this nature capable of vertical flight while operating as a helicopter and also capable of forward flight with the propeller blades stopped and operating as lifting planes.

The object of this invention is to provide a practical control device for the operator to permit the ready adjustment of the blades of the propellers and the complete control of the device. With the foregoing and other objects in view which will appear as the description of the preferred embodiment of my invention proceeds, the invention resides in the combination of parts and details hereinafter claimed.

Referring to the drawing:

Fig. 1 is a view in perspective of the helicopter-airplane, showing the aircraft in its transformed arrangement as an airplane.

Fig. 2 is a plan view illustrating the method of driving the lifting propellers.

Fig. 3 is a side elevation of the clutch control lever taken on line 3—3 of Fig. 2.

Fig. 4 is a perspective view of the control device for controlling the operation of the propellers.

Figs. 5, 6 and 7 are detail sectional views of lifting propeller supports and control mechanism.

Figs. 5ª, 6ª and 7ª are detail views showing the relative positions of the propeller blades of a lifting propeller, Figure 5ª showing both blades at an appreciable angle of incidence to the line of flight, Fig. 6ª showing the blades as adjusted for use as a helicopter and Fig. 7ª showing one blade tilted for lateral stabilizing.

In the drawings in which similar reference numerals designate corresponding parts, 1 designates the fuselage at the front of which is a propeller 2 which is preferably of the variable pitch type. At each side of the fuselage is a suitable supporting truss upon which are mounted the housings 3 which enclose the lifting propeller support and control mechanism for the main lifting and supporting blades 4, 5, 6 and 7. These propeller blades are of considerable length and width as shown and are adapted to rotate around vertical axes to provide a lifting means for the airplane while ascending or descending. After the machine has ascended to the desired height the front tractor propeller is adjusted to drive the machine forward, and the blades of the lifting propeller stopped and held stationary and the angle of incidence adjusted so that the blades of the lifting propeller will function as ordinary lifting planes and support the machine in its forward flight.

The means for driving and operating the blades 6, 7 are shown in Figs. 5, 6 and 7 in which 8 designates the fixed supporting shell, suitably mounted in the casings 3. At its upper end the shell 8 freely carries the rotatable support 9 in which are revolubly mounted the blades 6 and 7. The blades are adjusted and held at the desired angle of incidence by links 10, 11, which are pivotally attached to the blades at one end and at the other end are suitably fastened to arms 12, 13. These arms rotate with the propeller blades, suitable ball bearings being provided between the arms and the rods 14, 15. It will be seen that as the rods 14, 15 are raised or lowered, the pitch of the blades 6, 7 will be adjusted while permitting the free rotation of the blades. Near the lower end of the rod 14 is a male screw thread 16 engaging a similar female thread in the part 8. The rod 15 is provided with a thread 17 engaging a female thread in member 14. The lower end of rod 15 is provided with a square shank 18 adapted for sliding in a square hole in sprocket 19 so that as sprocket 19 is rotated the rod 15 is turned and screw thread 17 causes it to move upward to raise the arm 13 so as to tilt the blade 7. Sprocket 20 which is slidably mounted on rod 14 but which rotates therewith by means of a suitable pin and slot arrangement is adapted to rotate rod 14 to change the angle of attack of the blade 6.

The propeller is rotated by gear 21 which is driven by the motor as will be later set forth. Rotatably mounted on shell 8 is a threaded member 22 rotated by sprocket 23 for vertically moving the member 24 which is keyed to shell 8 so that it can slide vertically thereon. As the member 24 is moved vertically the clutch face 26 which is also keyed to shell 8 is forced up by the spring 25, to engage with clutch face 27′ which rotates with gear 21 and propeller support 9. A braking effect is thus produced tending to stop the rotation of the propeller blades, and if the motor has been disconnected the propeller will be slowed down,

permitting the projections 27, 28 to enter the corresponding depressions 29, 30 in the upper clutch member to stop the rotation of the propeller and hold it in the position as shown in Figure 1. The projections 27, 28 are of different shapes so that the propeller when locked is always in the same position. At the rear of the machine are provided two smaller lifting propellers having blades 4′, 5′, 6′, and 7′, the propellers being mounted one at each side of the fuselage upon a suitable supporting truss. It will be understood that the means for supporting, driving and operating the two front and two rear propellers is exactly the same.

Referring now to Fig. 2 the motor 31 is connected through suitable clutch members 32, 33, to bevel gear 34 driving bevel gears 35, connected to driving shafts 36, in which are splined shafts 37 which drive gears 38 at their outer ends. Suitable universal joints 39 and 40 are provided to care for any flexing which may be caused by the upward pull at the outer ends due to the propeller lift. Each gear 38 is adapted to engage and drive the corresponding gear 21 of the propellers. The bevel gear 34 also drives the rear propellers through shaft 41, universal joints 42, gear 43, gears 44 and shafts 45.

Mounted transversely of the fuselage in suitable bearings is a shaft 46 operated by hand lever 47 and provided with operating levers 48 at each end, which are connected to the corresponding sprocket 23 by wires 49 and suitable sprocket chains. Connected to lever 47 is rod 50 which operates the clutch 32, 33, to disconnect same when the lever 47 is pushed forward, the movement of the lever 47 at the same time turning the sprocket 23 so as to lock the propellers. The sprocket 23 of the rear propellers is operated simultaneously with sprocket 23 of the front propellers by cables extending rearwardly from levers 48.

The propellers are controlled by a hand lever 51 mounted on shaft 52 which is rotatably held in suitable bearings. The lever 51 is also adapted to rotate sleeve 53 through locking pin 54 which engages in a notch in a flange 55 at the end of the sleeve 53. It will be understood that the sleeve 53 is freely rotated on shaft 52 but prevented from endwise movement. When the lever 51 is pulled rearwardly, it pivots about point 56 to push on rod 57 to operate shaft 58 and cables 19″ connected to sprocket 19 of the rear propellers by suitable sprocket chains. The shaft 52 carries an arm 59 connected to cables 19′ which operate sprocket 19 of the front propellers. Shaft 53 carries an arm 60 connected to cables 20′, and cables 20″ as shown, cables 20′ operating sprocket 20 of the front propellers and cables 20″ operating sprocket 20 of the rear propellers. 61 designates an operating lever on shaft 46 similar to levers 48. Lever 61 is connected to cables 62 which operate a lever 63 to withdraw a locking pin 64, downwards, so as to release the sleeve 53. Locking pin 64 is adapted to enter a notch in the bottom of flange 55 when the lever 51 is in an upright position so as to prevent the lateral movements of lever 51 and the consequent unbalanced change of propeller pitch when the motor is driving the propellers. The locking lever 65 is adapted to withdraw the locking pin 54 from its notch when it is desired to operate cables 19′ when sleeve 53 is locked.

The operation of my device is as follows:—

When it is desired to ascend vertically, the motor is set in operation and lever 47 is pulled back to connect the motor to the propellers. The locking devices 27, 28, 29, 30 and the locking clutches 26 are, by the same movement disconnected, permitting rotation of the propellers. The same movement also pulls down and releases the locking pin 64 allowing movement of the control lever 51. The propellers at this time are all at their normal flying angle as shown in Figs. 5 and 5ª, having a few degrees positive angle of incidence. The hand lever 51 is now operated laterally and rearwardly to operate arms 59 and 60 and shaft 58 so as to move all the propellers to the position as illustrated in Figs. 6 and 6ª in which the opposing blades of each propeller are given the same but opposite angles of incidence somewhat greater than the normal flying angle. This is accomplished by having the sprocket 20 of larger size than the sprocket 19 so that the blade 7 in Fig. 5 is moved to a greater extent than blade 6, and in the opposite direction. Both sprockets 19 and 20 rotate in the same direction raising both rods 14 and 15 but as the rods 10 and 11 are connected to opposite sides of the blades, the blades will be rocked in reverse directions.

The propeller blades of each rear propeller are operated to the same but opposite pitch for acting as helicopter propellers by rearward movement of lever 51 as it is moved laterally. When the desired height has been reached the lever 51 is again brought to an upright position, placing the propellers at their flying angle of a few degrees positive angle of incidence, and hand lever 47 moved forward to disconnect the propellers from the motor and to stop them in the desired position as shown in Fig. 5ª. The forward movement of lever 47 also locks the shaft 53 by the locking pin 64. It will be seen that lever 47 cannot be pushed forward until the lever 51 is upright and the lower notch in flange 55 is aligned with the locking pin 64.

The front tractor propeller 2 is now

brought into action by suitably adjusting the pitch of the blades, or the front tractor propeller may be thrown in pitch before stopping the lifting propellers by a suitable lever (not shown). When the machine tips laterally due to a sudden gust of wind or for any other reason, the locking lever 65 is turned down to withdraw the locking pin 54 to permit lateral movements of lever 51 which is now moved sideways to operate cables 19′ alone, this movement operating the outer front blades of the front propellers so that the outer propeller on the right of the machine has its angle of incidence increased while the angle of incidence of the left outer blade is decreased and vice versa, in the same manner as the operation of the ordinary aileron control.

When it is desired to ascend or descend the lever 51 is moved forwardly or rearwardly to operate cables 19″ thus moving the outer blades of the rear propellers in the same direction to simultaneously increase or decrease their angle of incidence in the same manner as the operation of the ordinary norizontal control. The locking pin 54 may remain engaged with the slot in flange 55 while the lever 51 is moved forwardly and rearwardly. It will be understood that the cables 19′, 20′, 19″ and 20″ are so connected to the sprockets which they operate that the lever 51 has the same movements laterally and fore and aft as the ordinary joy stick. For steering in a horizontal plane an ordinary vertical rudder is provided which may be operated by the customary foot bar (not shown).

It will be understood that my invention is capable of variation and modification without departing from the spirit of the invention. I therefore do not wish to be limited to the precise details of construction set forth, but desire to avail myself of such variations and modifications as come within the scope of the appended claims.

1. In a flying machine, in combination, a variable pitch propeller having blades rotatably supported in a rotating part, means for driving said rotating part to rotate the propeller, means for stopping said rotating part in a predetermined position, a rod and a sleeve coaxially located extending through said rotating part, screw threads on said rod engaging screw threads on said sleeve, screw threads on said sleeve engaging a fixed part of the flying machine, means for connecting the rod to one blade of the propeller, means for connecting the sleeve to the other blade, and means for turning the rod and sleeve to cause endwise movement thereof whereby the angle of incidence of the propeller blades is adjusted.

2. In a flying machine, in combination, a fuselage, a variable pitch lifting propeller at each side of the fuselage, mechanism for changing the pitch of each propeller blade, a hand lever within said fuselage, a shaft supporting said hand lever, said shaft being connected to the mechanism for one blade at each side of the fuselage, a sleeve mounted on said shaft and connected to the mechanism for the other blade at each side of the fuselage, and means for operably connecting and disconnecting the hand lever and sleeve whereby lateral movements of the shaft and sleeve together simultaneously changes the pitch of all of the blades and movement of the shaft alone changes the pitch of one blade at each side of the fuselage while the remaining blade remains fixed.

3. In a flying machine, in combination, a fuselage, an adjustable pitch propeller at each side of the fuselage, mechanism for each blade of the propellers for adjusting the pitch of the blades, a single hand lever connected to one blade on each side of the fuselage to adjust the blades connected thereto in opposite directions, and additional means adapted to be connected to said hand lever when desired to simultaneously adjust the pitch of the remaining blades.

4. In a flying machine as set forth in claim 3, means for simultaneously stopping said propellers in predetermined positions.

5. In a flying machine, in combination, a fuselage, an adjustable pitch propeller at each side of the fuselage, mechanism for each blade of the propellers for adjusting the pitch of the blades, a single hand lever connected to one blade on each side of the fuselage to adjust the blades connected thereto in opposite directions, additional means adapted to be connected to said hand lever when desired to simultaneously adjust the pitch of the remaining blades, means for simultaneously stopping said propellers in pre-determined position and means preventing the operation of said last named means until the blades of the propellers are all at the same angle of incidence relative to the line of flight.

6. In a flying machine as set forth in claim 3, an auxiliary propeller at each side of the rear of the machine, and mechanism for adjusting the pitch of said auxiliary propellers.

In testimony whereof I affix my signature.

FRANK O. ELLERMAN.