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AUTOMATIC BLADE ANGLE CONTROL FOR HELICOPTERS

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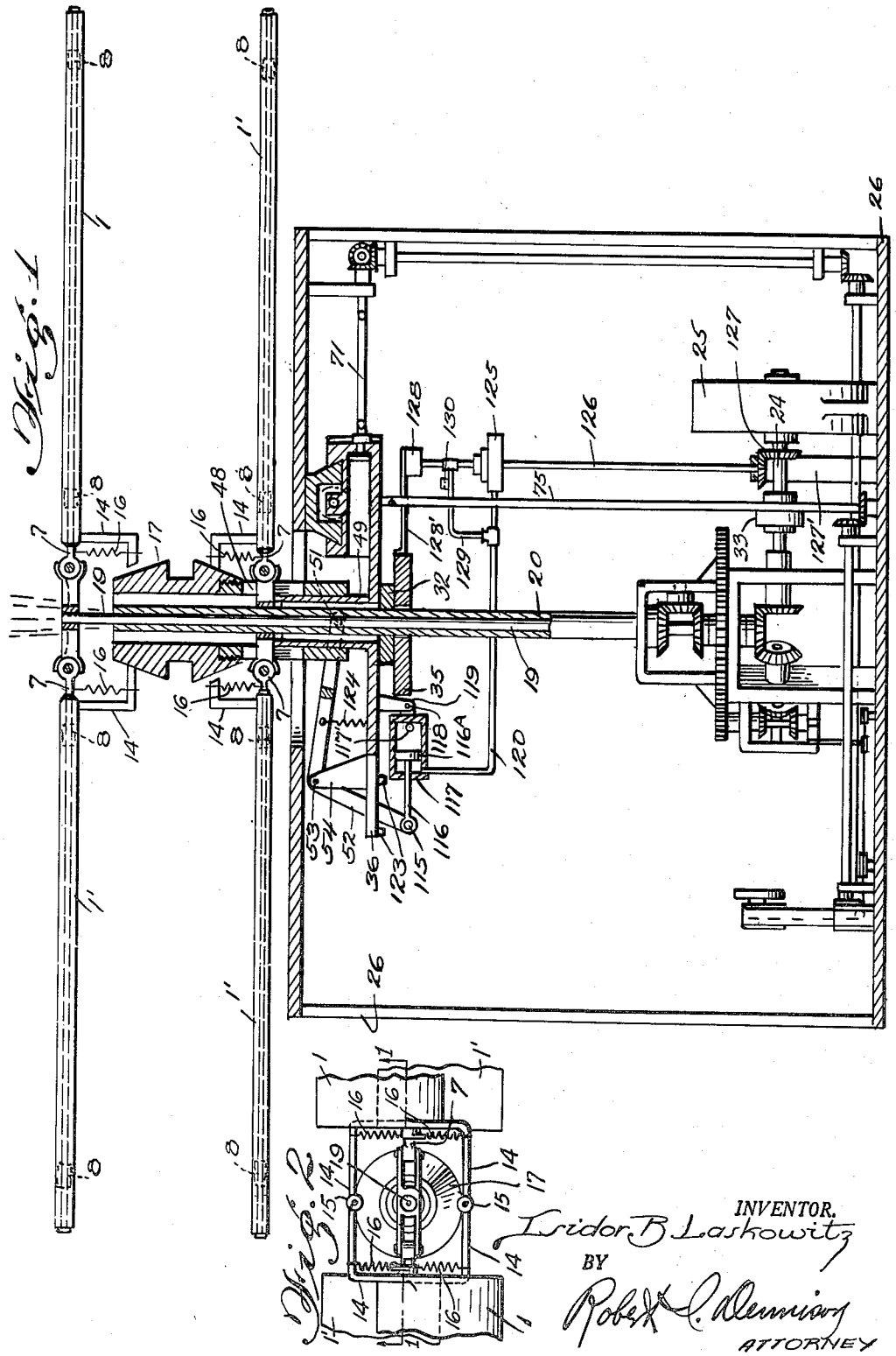


Fig. 1

Fig. 2

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AUTOMATIC BLADE ANGLE CONTROL FOR HELICOPTERS

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6 Claims. (Cl. 170—135.27)

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This invention relates to automatic blade angle controls for helicopters, and embodies certain improvements in the Tiltable Counter-Rotating Rotor System for Helicopters and Control Means Therefor, fully described and claimed in the United States Letters Patent No. 2,434,276, granted to me January 13, 1948.

It is a primary object of this invention to provide mechanism whereby the pitch angles of the blades of the rotor or rotors of helicopters may be automatically increased or decreased as the speed of the engine or motor increases or decreases and so eliminate the need for manually reducing the pitch angles of the blades to that required for autorotation should the engine or motor fail and for otherwise varying the pitch angles of the blades for their most efficient operation and preventing stalling of the engine due to overload.

Another important object of the invention is to embody the features of mechanisms having the qualities set out above which will be relatively simple in construction yet positive in action, strong and durable with parts arranged to facilitate ready and easy adjustments whenever necessary, thus assuring its practicability.

Other objects and advantages of the present invention will become apparent from the following detailed description of preferred embodiments of the invention illustrated in the accompanying drawings wherein like reference characters designate corresponding parts throughout the several views and wherein:

Figure 1 is a vertical section taken substantially in a plane indicated by the line 1—1 of Fig. 2 embodying the invention, showing an arrangement for the operation of the lever to automatically change the pitch angles of the blades of the rotors, and

Figure 2 is a fragmentary top plan view of the blade mounting.

Referring now more particularly to the drawing, the preferred embodiment is illustrated as embodied in helicopters wherein shafts 19 and 20 are rotatably mounted and carry the rotors having the upper blades 1 and lower blades 1', which are pivotally mounted on the shafts or spars 7 by means of ball or roller bearings 8. Secured to the upper blades 1 and to the lower blades 1', at their inner ends, are the arms 14, each arm terminating with an antifriction roller 15. The rollers 15 through the action of the springs 16, on the arms 14, aid in keeping the rollers 15 in physical contact with the blade pitch angle changing cones or cams 17 and 18. Thus,

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when rotating, the pitch angles or angles of incidence of the blades of the upper and lower rotors depend on the position of the cones 17 and 18, respectively.

In the drawing the arms 14 are provided with upright portions and horizontal portions. In Fig. 1 the horizontal portions of the arms, upper right and lower left, are broken off so as to depict clearly the cross section of the cones or cams 17 and 18. The other horizontal portions, upper left and lower right, have their terminals concealed back of the cone or cam construction. None of the terminal antifriction rollers 15 are disclosed in Fig. 1, but in Fig. 2 the upper antifriction rollers 15 are shown in contact with the cone or cam construction. Rotor blade pitch angle changing cones 17 and 18 are carried by the cylindrical support or tubular staff 48 and is slidably mounted on the neck portion of the tubular shaft or stud 49 of the eccentric bracket 36.

An intermediate steady bearing 32 is provided for shaft 20, and is mounted on frame member 35. Bearing 32 also serves to give additional support to the eccentric bracket 36.

The usual effect of raising the staff or support 48 is to simultaneously increase the pitch angles of the blades of the rotors and consequently to increase the lift or thrust of the rotors. Lowering the support 48 has the reverse effect. The eccentric bracket or support 36 is horizontally movable in any direction of the compass. For such a construction attention is called to my application Serial No. 471,492 filed January 6, 1943, for Variable Thrust Mechanism now Patent Number 2,434,276, granted to me January 13, 1948.

The lower end of the cylindrical support or staff 48 is carried by means of the pins 51 on the lever 52 which is pivotally mounted on the pin 53 between the brackets 54 secured to the eccentric bracket 36.

The lever 52 for simultaneously changing the pitch angles of the blades is not extended within reach of the pilot, instead—the lower end of the lever 52 engages the pivoted end 115 of the piston rod 116 secured to a piston 116A, which slides in the cylinder 117. Cylinder 117 is pivotally supported at one end by means of the pin 118 and the bracket 119 which is secured to the eccentric bracket 36.

Upper and lower limit stops 123 are provided for limiting the movement of the lever 52. A spring 124 creates a pull on lever 52 tending to bring the lever 52 in its lowest position and con-

sequently the smallest pitch angle setting for the blades of the rotor or rotors. Pivoted end of the cylinder 117 is open to the atmosphere through the vent 117', the other end of the cylinder 117 is connected by means of the flexible pipe 120 to a pump or compressor 125 of the centrifugal type. The pump 125 is connected by means of the shaft 126 and the bevel gears 127 to the drive shaft 24 of the engine or motor 25. An automatic declutching or free-wheeling device 33 of any suitable or preferred type is interposed between the engine or motor 25 and shafts 18 and 20, whereby these shafts and the rotors mounted thereon are free to rotate when the engine or motor is not functioning. An oil or other fluid reservoir 128 is connected to the intake of pump 125. Since the pump 125 is directly connected to the engine 25 the speed of the pump will vary as the speed of the engine or motor. A by-pass 129 connects the suction pipe of the pump to the flexible pipe 120. A relief valve 130 set at any predetermined relief pressure is inserted in the by-pass line 129.

The gears 127 on the shafts 24 and 126 are maintained in position by the inverted U-shaped bracket 127' which is secured to the floor of the frame 26. The tank 128 and its depending pipe are maintained in position by the bracket arm 128'. The brackets 127' and 128' together maintain the shaft 126 in a steady upright position.

Thus, as the engine or motor 25 rotates, pump 125 will also operate and create a pressure in the pipe 120, which pressure will actuate the piston 116A in the cylinder 117 and move the lever 52 which in turn will raise the support 48 to increase the pitch angles of the blades against the action of the spring 124. As the speed of the engine 25 is increased or decreased, the pressure created by the pump 125 will also be increased or decreased and as a result lever 52 will be raised or lowered and automatically increase or decrease the pitch angles of the blades. Since the speed of the engine 25 is controlled by its throttle the variation in the pitch angles of the blades will automatically vary with the setting of the throttle. And for any position of the throttle should the engine fail, the lever 52 will be automatically lowered to decrease the pitch angles of the blades for a safe descent of the craft.

Obviously, minor changes may be made in the preferred embodiment without departing from the essence of the invention or the scope of the appended claims. Thus, ball or roller bearings may be employed in place of the sleeve bearings disclosed. It is contemplated that other equivalent mechanical, hydraulic or electrical control movements might be substituted for the one shown without essentially departing from the scope of the invention as claimed.

Having fully disclosed my invention, what I claim is:

1. In a coaxial helicopter construction, an automatic blade pitch angle control mechanism, said mechanism comprising a support having an upright hollow stud thereon, a tubular supporting staff, blade pitch angle changing cones mounted on said staff, an upright bracket and a depending bracket on said support, a bellcrank lever, a piston, piston rod and cylinder, a pump and fluid reservoir or chamber, a prime mover, said lever being pivotally mounted in said upright bracket and having one end pivotally connected to said tubular staff and its other end pivotally connected to the free end of the piston rod, said cylinder being pivotally connected to the depending bracket, the piston rod end of said cylinder having flexible yieldable tubular fluid connection with said pump, said pump having operative mechanical connection with said prime mover whereby said pump may be operated, said chamber having tubular fluid connections with said pump, said staff being movably and telescopically connected to said hollow stud, the pivoted end of said cylinder having a vented portion, and means for moving said cones automatically to their lowest position, should the prime mover fail.

2. In a helicopter construction, a pressure operated means to automatically control the angular pitch of the rotor blades, said construction comprising a substantially horizontal support, a bell crank lever pivotally mounted on and above said horizontal support, a cylinder pivotally mounted on and below said horizontal support, a piston and piston rod operatively associated with said cylinder, in combination with fluid pressure means for actuating said piston, said last named means having fluid connection and communication with said cylinder, an upright hollow stud on and projecting upwardly from said horizontal support, an upright movable tubular support telescopically receiving said stud, blade pitch angle changing cones mounted on said tubular support, one end of said bell crank lever being pivotally connected to the free end of said piston rod and its other end pivotally connected to the upright support whereby said upright support may be moved upwardly and downwardly telescopically on said stud, and means for moving said cones automatically to their lowest position should said fluid pressure means fail.

3. In a helicopter construction, an automatic blade pitch angle control mechanism, said mechanism comprising a movable support having a hollow upright stud, a movable hollow supporting means telescopically receiving said stud, blade pitch angle changing cones mounted on said hollow supporting means, an upright bracket and a depending bracket on said first named support, a bell crank lever pivotally fulcrumed in said upright bracket, a cylinder pivotally connected at one end to the depending bracket and having a reciprocating piston therein, a pump, a fluid chamber, a motor, a tubular connection having a yieldable and flexible portion therein establishing fluid communication between the cylinder and said pump, operative connections between the motor and the pump for actuating the latter, one end of said bell crank lever being pivotally connected to the reciprocating piston, a tubular bypass connecting the fluid chamber and said tubular connection leading to the cylinder, said cylinder having a vented portion located in the pivoted end of the cylinder.

4. In a helicopter, a frame, counter-rotating shafts arranged vertically on said frame, a pair of rotors, each comprising a hub and a plurality of blades, said hubs being mounted on said counter-rotating vertical shafts, said blades being rotatable about their longitudinal axes, a pair of cones encircling said shafts and operatively connected to the blades, an engine operatively connected to said shafts, fluid pressure means powered by said engine, reciprocating means actuated by said fluid pressure means, linkage connecting said reciprocating means and said cones for automatically moving said cones up or down as the speed of the engine increases or decreases to simultaneously vary the pitch angles of

the blades of said rotors and moving said cones to their lowest position, should the engine fail, to reduce the pitch angle of said blades to that required for auto-rotation.

5. In a helicopter comprising coaxial rotors having blades, blade pitch angle changing cones operatively connected to the blades whereby the pitch angle of the blade may be varied, an engine operatively connected to said rotors, a fluid pump operatively connected to said engine, reciprocating means actuated by said fluid pump, linkage connecting said reciprocating means with said cones for automatically raising and lowering said cones for increasing and decreasing the pitch angle of said blades as the speed of said engine increases or decreases and lowering said cones thereby reducing the pitch angle of said blades should said engine become inoperative.

6. In a helicopter comprising a plurality of coaxial rotors, each having movable blades, the pitch angle of which may be varied, a pair of blade pitch angle changing cones operatively connected to the blades, an engine operatively connected to said rotors, a fluid pump operatively connected to said engine. a cylinder, a reciprocating piston operable therein, said fluid pump being

in communication with the cylinder to actuate the piston, spring actuated linkage operatively connected to said reciprocating piston and the cones for automatically varying the pitch angles of said blades simultaneously or collectively with variation in speed of said engine and to automatically lower said cones to reduce the pitch angle of said blades, to that required for autorotation, should the engine fail.

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