Jan. 9, 1951 P. E. BISCH ET AL 2,537,393

TOY HELICOPTER

Filed July 27, 1946 2 Sheets-Sheet 1

Fig. 1

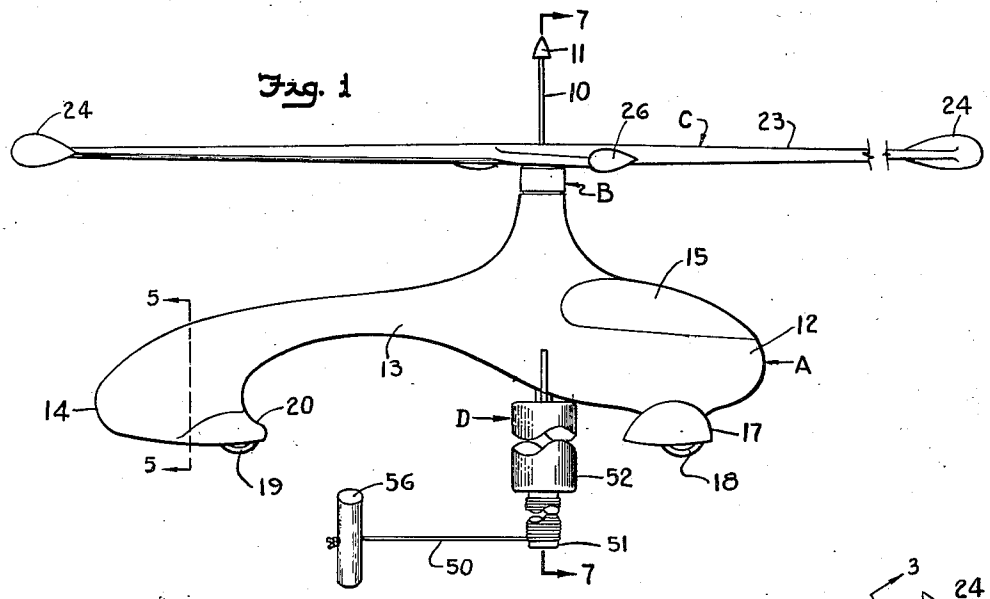


Fig. 4

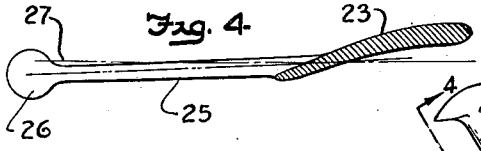


Fig. 2

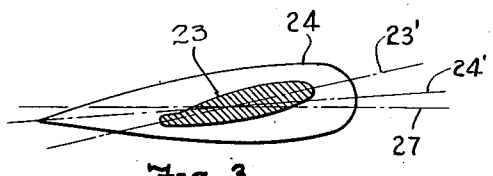


Fig. 3

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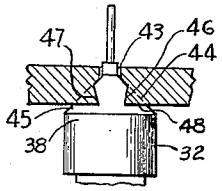


Fig. 10

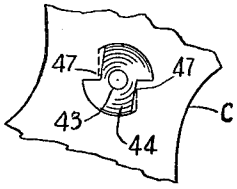


Fig. 8

Fig. 7

Fig. 11

Fig. 9

Fig. 5

Fig. 6

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TOY HELICOPTER

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3 Claims. (Cl. 46—75)

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This invention relates to toys and has as its general object to provide a toy helicopter that can be flown.

Helicopter-like toys including an air screw adapted to be set into spinning movement by a launching device including a draw string, are old and well known, and it has also been proposed to provide a flying helicopter toy embodying a fuselage and a sustaining rotor. However, the latter devices have not been definitely successful. The primary object of our invention is, therefore, to provide a toy helicopter including a fuselage and sustaining rotor adapted for successful flight, and landing.

Specific objects of the invention are: to provide a flying toy helicopter of relatively simple and inexpensive, yet sturdy and durable construction; to provide a toy helicopter embodying a rotor adapted for free spinning movement relative to the fuselage during flight; to provide a toy helicopter embodying a rotor having a universally pivotal connection with its fuselage, such that the fuselage may swing during flight without disturbing the axis of rotation of the rotor; to provide a toy helicopter in which the rotor is permitted to gain lifting momentum before applying lift to the fuselage, in order to facilitate overcoming the inertia of the fuselage in the take off; to provide a toy helicopter embodying a novel and simple launching device including a spindle adapted to pass substantially through the fuselage and engage a rotor spinner when spinning power is applied to the rotor, and to remain behind as the fuselage lifts away from the launching device; to provide a toy helicopter embodying a rotor adapted to become dissociated from its pylon during flight and to automatically center itself with relation to its pylon upon returning thereto; to provide a toy helicopter embodying landing gear adapted to land the toy in an upright position, so as to prevent damage thereto during landing; to provide a toy helicopter in which the center of gravity and the elastic center of the fuselage (with reference to the landing wheels) are both located at the axis of rotation of the rotor, whereby to assure proper balancing of the fuselage during flight and proper balancing of the entire toy during landing; to provide a toy helicopter embodying simple yet effective means for restraining the fuselage from rotation about the rotor axis both during launching and during flight; to provide a helicopter embodying a rotor having blades adapted to automatically change pitch during flight so as to achieve a combination of maximum lifting power during

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take-off and maximum distance of travel in the complete flight; and to provide a helicopter having a rotor embodying an automatic dynamic balancing mechanism.

Other objects will become apparent in the ensuing specifications and appended drawings in which:

Fig. 1 is a side elevation of a toy helicopter embodying my invention;

Fig. 2 is a plan view of the same;

Fig. 3 is a sectional view through a rotor blade taken on the line 3—3 of Fig. 2;

Fig. 4 is a sectional view through a rotor blade taken on the line 4—4 of Fig. 2;

Fig. 5 shows a tail section taken on the line 5—5 of Fig. 1;

Fig. 6 is a diagram illustrating the automatic rotor adjustment;

Fig. 7 is a vertical sectional view taken on the line 7—7 of Fig. 1, with the rotor blade shown extending transversely with reference to the fuselage;

Fig. 8 is a detail, inverted plan view of the central portion of the rotor;

Fig. 9 is a detail view of the upper end of the pylon;

Fig. 10 is a detail sectional view taken on the line 10—10 of Fig. 2; and

Fig. 11 is a side view of the upper end of the pylon.

As an example of one form in which our invention may be embodied, we have shown in the drawings a toy helicopter embodying generally a combined fuselage and landing gear unit A, a pylon assembly B, a rotor C, and a launching unit D. The pylon assembly B is adapted to receive spinning movement transmitted thereto from the launching unit D, and in turn, to transmit this spinning movement to the rotor C which, at the cessation of the applied spinning power, is adapted to free itself from the driving hub of the pylon assembly B, to rise upon the pylon shaft 10, to engage the head 11 thereof, and to thereupon lift the fuselage and landing gear unit A clear of the launching unit D.

The fuselage and landing gear unit A and rotor C are constructed of a material having a relatively high strength-weight ratio. I find that a molded plastic material, such as cellulose acetate, is well suited for the fuselage. The fuselage is hollow and extremely thin-walled; for example, the wall thickness may be as little as $\frac{1}{32}$'' for a fuselage measuring approximately $10\frac{1}{2}$''. The fuselage may be either an integral molded construction or may be fabricated from symmetrical

sections of pressed sheet material, cemented together.

The landing gear is molded of solid material, and is cemented to the fuselage. The rotor is likewise of integral, solid, molded construction. A suitable material for the blade and landing gear is cellulose butyrate.

The fuselage embodies a cabin portion 12 forming the forward part thereof, an intermediate slender body portion 13, and a tail portion 14. The fuselage is preferably constructed from a transparent material the majority of which is provided with an opaque coating which is omitted from the area designated 15 on the upper side of the nose portion of the cabin 12. This clear area 15 represents a window or windshield in the cabin, the opaque area representing the non-windowed wall portions of the fuselage.

The landing gear includes struts 16, wheel fairings 17, and projections 18 representing wheels. The landing gear also includes a wheel 19 in a wheel fairing 20 in the tail 14. The wheels 18 and 19 may be real wheels, mounted on an axle for rotation, or may be merely integral projections simulating a wheel, or may be universally pivoted supporting elements such as a socketed ball, or a caster. The rear wheel 19 is preferably of a non-skid characteristic (e. g. of soft rubber) to prevent lateral skidding while the front wheels are hard and smooth to facilitate lateral skidding.

The tail 14 functions to restrain rotation of the fuselage during flight of the craft. To this end, the rear end of the tail 14 is pitched downwardly and laterally (as shown in Fig. 5) in the direction of rotation of the rotor C. For example, where the rotor spins clockwise, as viewed from above, which is the case with the rotor shown in the drawings (as indicated by arrow 21 in Fig. 2) the tail 14 is pitched downwardly and clockwise as viewed from above. As the result of this pitch in the tail 14, the tail will develop a counter-thrust (indicated by the arrow 22) in the downwash of the rotor C, which counter-thrust is sufficient to counteract the tendency of the lightweight fuselage to rotate with the rotor C in response to the slight amount of frictional torque that is transmitted through the bearings connecting the rotor to the fuselage.

The landing wheels 18 are fairly widely spread apart and cooperate with the tail projection 19 to provide a three-point landing gear so related to the rotor axis as to place the center of elasticity of the fuselage and landing gear assembly at a point on the rotor axis. Consequently, when the toy makes a landing, its center of gravity (which is also located on the rotor axis so that the fuselage may be suspended in a balanced, horizontal condition during flight) will be substantially centered between the three landing wheels 18 and 19 so as to minimize any tendency of the craft to bounce forwardly or rearwardly or to either side. This is quite important, since it provides for maintaining the toy in an upright position during and after landing, and thereby avoids damage which would be likely to occur, especially to the rotor, as the result of overturning.

The rotor C embodies a pair of blades 23 each having at its tip a streamlined weight 24. The weights 24 have their longitudinal axes 24' disposed at an angle of incidence with reference to the plane of rotor rotation, indicated at 27 in Fig. 3, such that the weights will have a zero angle of attack relative to the air through which the rotor is moving, while the blades 23 will have a positive angle of attack (indicated between the lines 24' and 23').

The blades 23 have an approximately airfoil cross-section and an angle of attack gradually increasing to a maximum and then gradually diminishing from the rotor axis to the blade tips. A stable (non-tilting) plane of rotation of the rotor C is maintained by dynamic balancers comprised in arms 25 which project from the trailing edges of the blades 23, near the rotor axis, and terminate in weights 26. The weights 26 develop centrifugal forces tending to maintain the rotor in a non-tilting plane of rotation (indicated by the broken line 27 in Fig. 4).

The blade tip weights 24 have a dual function. They serve to store energy during launching, and to deliver up this energy to the rotor for sustained flight. They also serve to provide an automatic adjustment of the angle of attack of the blades in such a manner as to give a minimum angle of attack at maximum speeds (at starting) and a maximum angle of attack at minimum speeds (at end of flight). The action of the weights 24 in producing automatic adjustment is shown schematically in Fig. 6. The leading edge of the wing is indicated by the line 55. The maximum angle of attack is located adjacent the axis of a stabilizer arm 25 (indicated at the point 56). The leading edge 55 tapers toward the plane of rotation of the trailing edge (indicated at 57) both toward the blade tip and the rotor axis (indicated at 58). Consequently, the blade is arched from rotor axis to tip, and the centrifugal pull of the weight 24 (indicated at 59) will tend to reduce the arch and therefore to reduce the angle of attack. Consequently, at launching, the rotor blades will have a minimum angle of attack, with minimum drag and lift (resulting in maximum conservation of rotational speed and, therefore, of energy). As the rotor gradually loses speed during flight, the inherent resiliency of the blades will gradually increase the angle of attack, thus increasing the lift so as to compensate for loss in lift tending to result from decreasing rotor speed. Thus, at some sacrifice of height of flight, rotor speed and lift are maintained so as to minimize the fall of the toy to the earth in the landing stage.

The dynamic stabilizers 25, 26 have, in addition to their function of maintaining the rotor in a plane of rotation that is relatively non-tilting, another function, namely to assist in reducing the angle of attack of the rotor blades at high speeds. To this end, the arms 25 are disposed at an acute angle relative to the plane of rotation (indicated at 27 in Fig. 4) so as to twist the blades 23 toward a lesser angle of attack as the weights 26 tend to move into the plane 27 under the effect of centrifugal force. The resiliency of the reduced neck portions 60 of the blades 23 yieldingly opposes this twisting moment, and urges the blades toward maximum pitch as rotational speed lessens.

It is contemplated that this characteristic, in amplified form, may be utilized in full size helicopters, with a torsional spring connection between blade and hub taking the place of the yielding integral neck 60. In such a construction, the blade tip weights may be dispensed with and the weights 26 utilized as the sole means for pitch control.

Referring now to Figs. 5 to 8 inclusive, the fuselage is formed with an open-ended pylon neck 30 in which is fixed a bearing bushing 31. Jour-

nalled in the bearing bushing 31 is a pylon spinner 32 having an annular recess 33 receiving the bushing 31 and having a socket 34 adapted to receive the upper end of a launching spindle 35.

The bearing bushing 31 is initially shrunk into the groove 33 to form part of a pylon spinner assembly which is later pressed into the pylon neck 30. This causes the bearing bushing 31 to become fixed in the collar 30, leaving the spinner 32 freely rotatable in the bushing 31, and provides a relatively inexpensive and easy method of assembly. The lower end of the socket 34 is flared as at 36 to facilitate insertion of the spindle 35. The upper end of the spindle 35 has a clutch notch 36 adapted to receive a pin 37 which is mounted in the spinner 32 and extends transversely across the socket 34. The spinner 32 has a head 38 which is bored to receive a pylon shaft 39 extending upwardly from the center of the spinner. The lower end of the shaft 39 is provided with a head 40 to engage the head 38 in order that the helicopter may be suspended from the shaft. To the upper end of the shaft 39 is attached a retaining member 41 which receives support from the rotor C. For the sake of simplicity and cheapness, I prefer to employ, for the retaining member 41, a nipple of resilient material such as soft rubber or its equivalent, expanded over a roughened surface 42 at the upper end of the shaft 39 and secured by its contractile engagement with the surface 42. The surface 42 may be knurled or indented or threaded or otherwise roughened. The rotor C is provided, at its center, with an opening 43 through which the shaft 39 extends, with substantial clearance.

The underside of the rotor is formed with a generally conical recess 44 (Fig. 10) which is adapted to receive the generally conical upper surface 45 of the head 38 (Fig. 10) and to provide self-centering of the rotor C with reference to the spinner 32. The conical surface 45 is interrupted by undercut notches defining clutch jaw faces 46 that coact with undercut faces of projections 47 in the rotor C, with shoulders 48 to support the rotor C. The engagement of undercut surfaces makes it possible for the clutch jaw faces 46 to resist lifting action of the rotor until the transmission of power through the spinner ceases. At this point in the operation, when the rotor C tends to rotate ahead of the spinner 32, disengagement of the rotor from the spinner will be quickly effected. The rotor, thus disengaged from the spinner, will spin freely on the shaft 39 and thereafter rise by its air screw action.

The pylon spinner 32 has a pilot 49 that is receivable in the opening 43 in the rotor, for centering the rotor on the pylon. An important feature of the invention is the provision for universal freedom of movement between the rotor C and the shaft 39. This avoids interference with the gyroscopic orbit of the rotor by the fuselage and pylon, and thus provides stability in flight. Freedom of movement is provided for by the loose fit of the shaft 39 in the hole 43. Extra large diameter of the hole 43 also permits ample manufacturing tolerances for desired cheapness.

The launching unit D includes the spindle 35, a pulley 51 secured to its lower end, a combined handle and bearing sleeve 52 in which the spindle 35 is journalled, and a thrust ring 53 attached to the spindle 35 and engaging the upper end of the handle 52.

A pair of stay pins 54 are driven into the upper end of the handle 52 to form a yoke adapted to embrace the sides of the fuselage to hold the

fuselage and landing gear unit A against rotation during the launching operation.

In the operation of my improved toy helicopter, the spindle 35 is inserted through an opening 55 in the bottom of the fuselage and is passed upwardly through the center of the fuselage and into the socket 34 into engagement with the pin 37. A pull cord 50 having a handle 56 at one end, is then wound about the pulley 51, the handles 52 and 56 are grasped in the hands and the cord 50 is pulled with a steady, accelerating pull to spin the spindle 35 and with it the spinner 32 and rotor C. During the pull, the spindle 35 will freely rotate in the bearing sleeve 52 while side thrust is easily absorbed by the long bearing surface. The opening 55 and bushing 31 provide spaced bearings for the spindle 35, maintaining the fuselage in an upright position while the spindle rotates therein. At the end of the pull, the rotor C, the spinner 32 and the spindle 35 will be spinning in unison, but the slight frictional resistance existing within the bearings 32 and 52 will cause the spindle 35 and spinner 32 to tend to lag behind the rotor, resulting in the above described disengagement of the rotor from the spinner. As soon as the rotor has become thus disengaged, it will rise up the shaft 39 into engagement with the retaining member 41 and the momentum that it has thus attained will be utilized in overcoming the inertia of the fuselage landing gear unit A. Thus the unit A will be lifted from the spindle 35, the pin 37 automatically disengaging from the notch 36. The helicopter will then be in flight, the launching unit D remaining in the hands of the operator.

During flight, the down-wash of air acting against the pitched portion of the tail 14 will produce the counter torque 22 in the fuselage, sufficiently to counteract any torque transmitted to the fuselage from the rotor through the shaft 10, and thus the fuselage will maintain a substantially non-rotating position while the rotor C continues to rotate under the energy stored in the blades 23 and weight 24. However, friction between the rotor and the shaft 39 and washer 41, is negligible. Thus the toy closely simulates the action of a real helicopter, the effect being quite impressive.

At launching, the speed of the rotor C will be at a maximum and the above referred to action of the weights 24 will cause the blades 23 to assume a minimum angle of attack. As the rotor gradually loses momentum and speed, the inherent resiliency of the blades will cause them to return toward a normal unstressed angle of attack, thus maintaining lift. The reduction in angle of attack in the initial stage of flight provides for lower starting speed and less climbing. The maintenance of lift in the later stages of flight provides for prolonged sustentation during return of the toy to the earth, thus avoiding stalling, while the toy is still at a relatively high elevation. It is aimed to prolong the lift so that stalling will not occur until the toy has virtually reached a landing position, thus providing for a landing of maximum smoothness and safety. In landing, the toy will maintain an upright trim due to the centering of the center of gravity of the fuselage with reference to the axis of the pylon assembly B. When the craft alights, the shock will be centered between the landing points 18 and 19 due to the location of the center of elasticity of the fuselage, with reference to the landing points, and to the pylon axis, i. e. at the same point as the center of gravity. As a re-

sult the rebound force will be applied at the center of gravity and there will be a minimum tendency for the craft to overturn.

We claim as our invention:

1. In a toy helicopter, a fuselage, a pylon assembly rising from the upper side of said fuselage, said pylon assembly including a spinner journalled with reference to the fuselage and having at its upper end a clutch device, and a shaft rising therefrom, a rotor freely journaled on said shaft and having in its under side clutch means for coaction with said clutch device for receiving spinning movement from said spinner, said rotor being adapted, upon cessation of launching movement, to disengage from said clutch device and rise upon said shaft, said shaft having at its upper end abutment means adapted to be engaged by said rotor for transmitting lifting support from the rotor to the fuselage, and launching means adapted to be passed upwardly through the fuselage into driving connection with said spinner, said launching means and spinner including disengageable coupling means for effecting said driving connection.

2. In a toy helicopter, a fuselage, a pylon assembly including a spinner journalled substantially vertically with reference to the fuselage and having at its upper end a clutch device, a shaft rising from said spinner, a rotor freely journalled on said shaft and longitudinally slidable thereon, said rotor having clutch means for co-action with said clutch device for receiving rotation from said spinner, said rotor being adapted, upon cessation of launching movement, to disengage from said clutch device and rise upon said shaft, said shaft having at its upper end abutment means adapted to be engaged by said rotor for transmitting lifting support from the rotor to the fuselage.

3. In a toy helicopter, a fuselage, a pylon assembly including a spinner journalled substantially vertically with reference to the fuselage and having at its upper end a clutch device, a shaft rising from said spinner, a rotor freely journalled on said shaft and longitudinally slidable thereon, said rotor having clutch means for co-action with said clutch device for receiving rotation from said spinner, said rotor being adapted, upon cessation of launching movement, to disengage from said clutch device and rise upon said shaft, said shaft having at its upper end abutment means adapted to be engaged by said rotor for transmitting lifting support from the rotor to the fuselage, and launching means engageable with and adapted to transmit rotation to said spinner.

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