

April 5, 1960

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TOY HELICOPTER

2,931,132

Filed Nov. 26, 1957

2 Sheets-Sheet 1

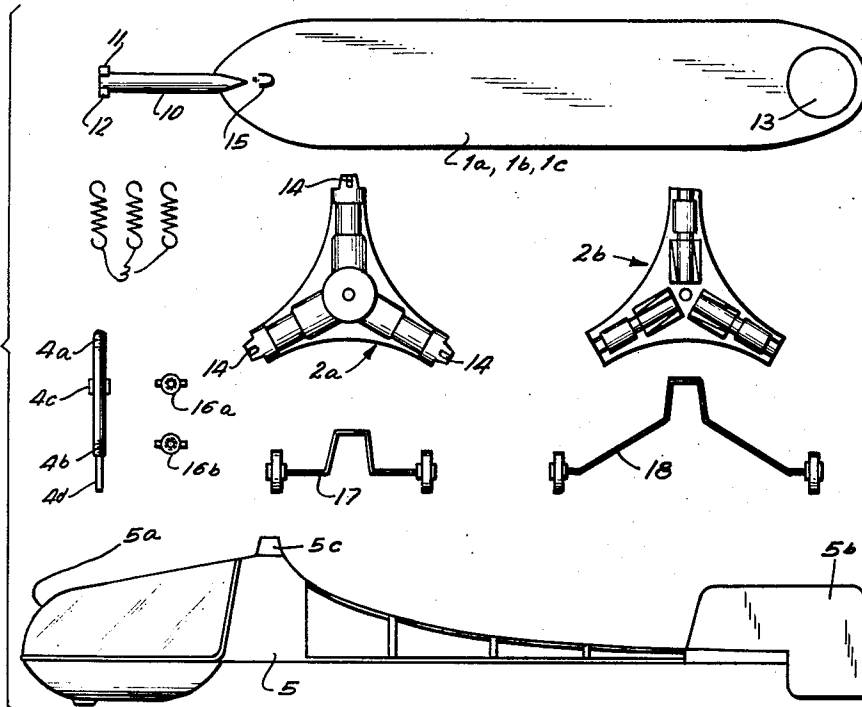


FIG. 1

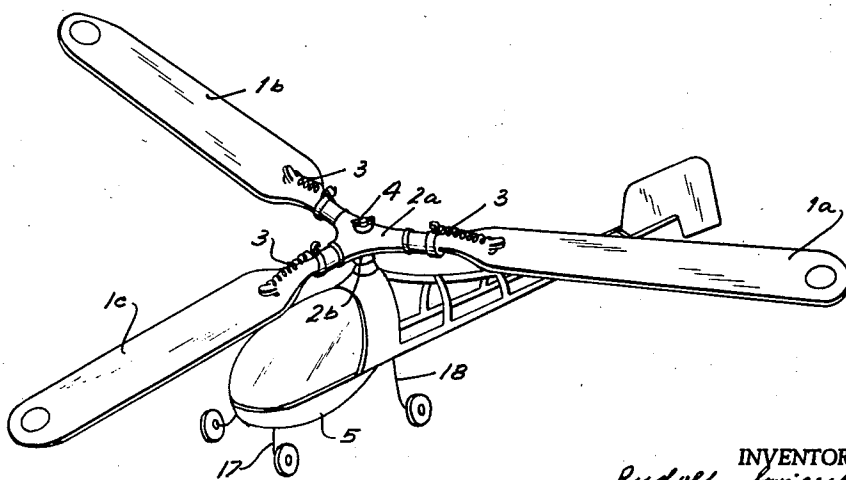


FIG. 2

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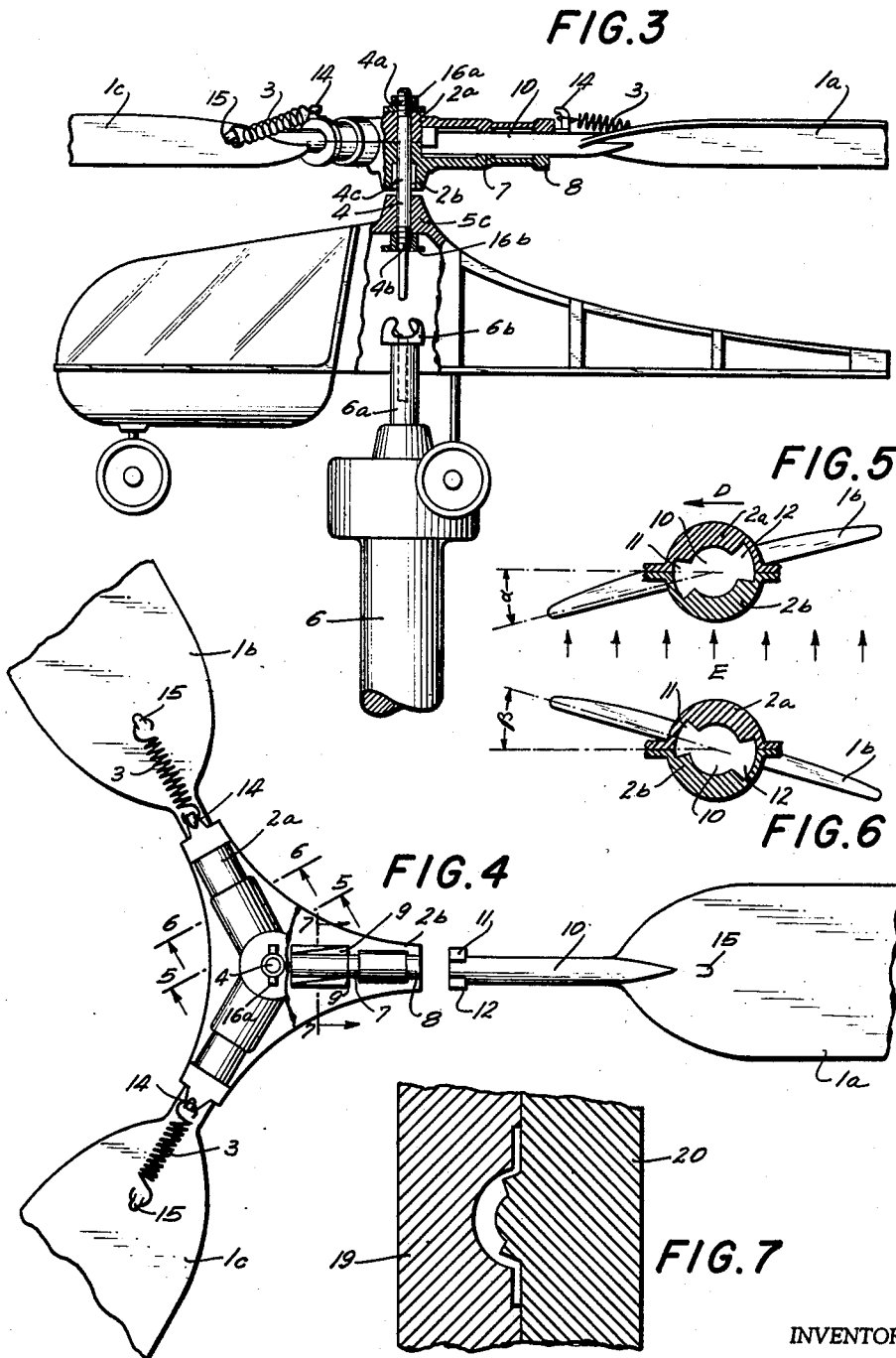
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Application November 26, 1957, Serial No. 699,041

Claims priority, application Germany February 25, 1955

8 Claims. (Cl. 46—75)

The present invention relates to toy helicopters.

This application is a continuation-in-part application of copending application Serial No. 564,064, filed February 7, 1956, now abandoned, and entitled "Toy Helicopter Having a Device for Automatic Regulation of the Helicopter Screw Blades."

One of the objects of the present invention is to provide a toy helicopter with a plurality of components which are of simple construction, which are small in number, and which can be very easily assembled.

Another object of the present invention is to provide a toy helicopter with a relatively simple and reliable structure which will automatically regulate the pitch of the blades of the propeller of the helicopter.

A further object of the present invention is to provide a toy helicopter with components which can be quickly and easily manufactured by die casting or injection molding, or the like.

With the above objects in view, the present invention includes in a toy helicopter a plurality of propeller blades and a hub means supporting the blades for movement to positions where they have a positive angle of pitch when the blades and hub means rotate at a speed above a predetermined value. The hub means supports the blades for movement to a position where they have a negative angle of pitch when the speed of rotation of the hub means and blades is less than this predetermined value, and the blades are moved to their position of positive pitch by centrifugal force. A spring means is provided to move the blades to their position of negative pitch angle when the force of the spring means overcomes the centrifugal force.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 illustrates the various components of a helicopter according to the present invention;

Fig. 2 is a perspective view of a helicopter according to the present invention made up of the assembled components of Fig. 1;

Fig. 3 is a partly sectional elevational view of the helicopter of the present invention showing the position which a starting device takes with respect to the propeller shaft of the helicopter and also showing the manner in which the blades are connected to the hub of the propeller;

Fig. 4 is a partly broken away top plan view of the hub and blades of the propeller of the toy helicopter of the present invention;

Fig. 5 is a sectional view taken along line 5—5 of Fig. 4 in the direction of the arrows;

Fig. 6 is a sectional view taken along line 6—6 of Fig. 4 in the direction of the arrows; and

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Fig. 7 is a fragmentary sectional view of a mold used for manufacturing the portion of the hub of Fig. 4 which is located at line 7—7.

Figs. 1 and 2 of the drawings show the toy helicopter of the present invention before and after assembly, respectively. The relatively small number of parts shown in Fig. 1 are all of the components of a top helicopter which is of the three-blade type and which very closely simulates the flight and appearance of a real helicopter.

The three blades 1a, 1b, and 1c are of identical construction so that only one blade is indicated in Fig. 1, but the three blades are shown in Fig. 2. Each of these propeller blades has an elongated free end portion 10 in the form of a cylindrical rod, and each of these free elongated end portions 10 fixedly carries at its left end, as viewed in Fig. 1, a pair of opposed radial projections 11 and 12 in the form of keys fixed to the portion 10. The entire propeller blade is molded in one piece, so that all of the above-described parts of each propeller blade are integral with each other. The hub of the propeller is composed of the two portions 2a and 2b shown in Fig. 1, Fig. 1 showing the top side of the upper portion 2a and the top face of the lower portion 2b against which the bottom face of the upper portion 2a is located. These two propeller parts 2a and 2b are substantially identical, and the faces of these hub parts which abut against each other are located in a plane which is normal to the axis of rotation of the hub. The hub, when its parts 2a and 2b are assembled, provides spokes distributed about and extending radially from the axis of rotation of the hub, and each of these spokes is formed with a bore extending radially with respect to the axis of rotation of the hub. Each of the hub parts 2a and 2b is formed with half of the several bores, and when the two hub parts are joined together they form the complete bores, these bores respectively receiving for slidable axial movement therein the free end portions 10 of the blades of the propeller. The blades are respectively connected to a plurality of springs 3 which are in turn connected to the hub and which serve as a spring means for urging the propeller blades inwardly toward the axis of rotation of the propeller to a rest position where the blades are automatically provided with a negative pitch angle, as will be apparent from the description below. Each of the springs 3 has hook portions at its opposite ends, and these hook portions respectively cooperate with hooks 14 of the upper hub part 2a and hooks 15 of the propeller blades. These hooks 14 are formed integrally with the hub part 2a, and the hooks 15 are formed integrally with the propeller blades, respectively, all of these elements being formed by injection molding, for example.

The hub parts 2a and 2b are formed with aligned bores extending along the axis of rotation of the hub and these bores cooperate together to form a continuous bore which receives the propeller shaft 4. This propeller shaft 4 is made of a high quality steel and is provided at its upper end portion with threads 4a and adjacent its lower end with threads 4b. Intermediate these threaded portions the propeller shaft 4 has a pair of opposed projections 4c extending radially from the propeller shaft and forming a key means, for a purpose described below. Beneath the threaded portion 4b, the shaft includes an elongated bottom end portion 4d of reduced cross section.

The threaded portions 4a and 4b of the propeller shaft 4 respectively receive the nuts 16a and 16b, and each of these nuts has a pair of opposed projections fixed to and extending radially therefrom. These nuts serve to hold the hub parts together and to connect the propeller shaft with the fuselage 5.

The fuselage 5 is preferably molded from an impact-resistant plastic material and is provided with a trans-

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parent windshield 5a and with a rudder 5b located at the tail end of the fuselage. At its top wall the fuselage has a thickened portion 5c formed with a bore or opening for receiving the propeller shaft 4, as indicated in Fig. 3. The fuselage 5 is furthermore formed with a pair of downwardly directed rectangular cavities spaced along the longitudinal axis of the fuselage, and these cavities receive the rectangular central portions of spring wires which form parts of the front and rear landing gear means 17 and 18 indicated in Figs. 1 and 2. These central springy wire portions of rectangular configuration fit into the cavities of the fuselage 5 and serve to resiliently fix to the latter the landing gear means 17 and 18. Each of these landing gear means is made up of a pair of wheels turnably connected to the free ends of the springy wire made of a highly resilient steel. The rectangular central portion of each of these springy wires has a substantially U-shaped configuration. The details of the assembly are illustrated in Fig. 3 from which it is evident that the parts of the toy helicopter of the present invention can be assembled very easily and very quickly. After the free end portions 10 of the several blades 1a—1c are located in the elongated radial bore portions of the lower half of the hub 2b, the upper half 2a is placed thereon so that in this way the free ends 10 of the several propeller blades are located in the bores of the hub, and then the propeller shaft is passed through the aligned bores of the hub 2a, 2b which extend along the axis of rotation thereof. The lower hub part 2b is formed with a pair of opposed grooves extending axially from the bottom face of the bottom hub part 2b and respectively receiving the key portions 4c of the propeller shaft 4, so that the hub 2a, 2b is in this way connected to the propeller shaft for rotation therewith, and the nut 16a is threaded onto the threaded portion 4a at the upper end of the propeller shaft 4, so as to fix the hub parts together with the free ends 10 of the propeller blades located in the bores of the hub. The pressure of the nut 16a presses the top ends of the axial grooves of the lower hub part 2b against the top end faces of the pair of keys 4c, so that in this way the nut 16a holds the hub parts together and the propeller blades in the bores of the hub. After the springs 3 are connected to the hooks 14 and 15 as described above and shown in Figs. 2—4, the assembly of the propeller of the toy helicopter is completed. Then the propeller assembly is joined with the fuselage by passing the lower portion of the propeller shaft 4 downwardly through the opening of the top wall portion 5c of the fuselage 5, and at this time with the bottom end portion of the shaft 4 extending into the interior of the fuselage the nut 16b is joined to the threaded portion 4b of the propeller shaft so as to connect the propeller assembly with the fuselage. The fuselage is substantially of a channel-shaped configuration and is open along its bottom side so that there is free access to the interior of the fuselage through the underside thereof. The top end face of the nut 16b limits the upward movement of the propeller assembly with respect to the fuselage, and the bottom end face of the central portion of the lower hub part 2b limits the downward axial movement of the propeller assembly with respect to the fuselage, and as is apparent from Fig. 3 there is a slight axial freedom along the axis of the propeller shaft between the propeller assembly and the fuselage.

The pair of opposed radial projections of the nut 16b cooperate with the starting device 6 indicated in Fig. 3 in a diagrammatic manner. This starting device 6 is of a well-known construction according to which a string wrapped around a pulley is pulled so as to turn the pulley at a high speed, and this pulley is connected with a spindle 6a which also rotates at a high speed. This spindle 6a is formed with an axial bore which receives the lower shaft portion 4d which is of reduced cross section, and the top end portion of the spindle 6a is

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provided with a pair of undercut claw teeth which cooperate with the radial projections of the nut 16b so as to turn the propeller assembly together with the spindle 6a until the speed of rotation of the latter becomes less than the speed of rotation of the propeller assembly which causes the helicopter to start flying and to automatically separate itself from the starting device.

The manner in which the hub means 2a, 2b supports the propeller blades 1a—1c for automatic movement between positions of positive and negative pitch angle is shown most clearly in Figs. 4—6. When the propeller assembly rotates at a relatively high speed which is above a predetermined value the centrifugal force of the propeller blades will automatically place them in a position where they assume a positive pitch angle while when the speed of rotation of the propeller assembly is below this predetermined value the force of the spring means 3 will automatically shift the propellers to a position where they assume a negative pitch angle.

In Fig. 4 part of the upper hub part 2a is broken away to clearly illustrate the structure therebeneath, and the blade 1a which cooperates with the right radial bore of the hub means illustrated in Fig. 4 is shown to one side of this hub means to better illustrate the cooperation between these elements, all of the blades cooperating with the hub means in exactly the same way. The bore portion of each of the spokes of the hub means has a pair of cylindrical sleeve parts 7 and 8 which slidably support the cylindrical rod portion 10 at the inner free end of each propeller blade for axial movement along the bore. Between the cylindrical sleeve portion 7 and the axis of rotation of the hub each bore is provided with a pair of opposed longitudinal grooves 9 which respectively extend along a helix. The grooves 9 are formed in part in the upper hub part 2a and in part in the lower hub part 2b, and when these parts are assembled they form a pair of opposed continuous grooves 9 along the length of the bore. The projections 11 and 12 of the free end portion 10 of the propeller blade are respectively located in the opposed grooves 9, and it is apparent that as the blade shifts axially toward and away from the axis of rotation of the propeller the projections or keys 11 and 12 will cooperate with the bores 9 to change the pitch of the propeller blade. The curvature of the grooves 9 is such that when the blades are located at their inner rest positions, to which they are urged by the spring means 3, the blades will have a negative pitch angle, while when the propeller blades are at their outer end positions, limited by engagement of the projections 11 and 12 with the outer ends of the grooves 9 located just inside of the sleeve portion 7, the blades will assume a positive pitch angle, so that in this way the hub means 2a, 2b supports the blades for movement between their positive and negative pitch angle positions. The sectional illustration illustrated in Fig. 5 shows how when the blades rotate in the direction of arrow D shown in Fig. 5 they will assume the negative pitch angle alpha, while when the blades rotate in the same direction at a high speed they will have the positive pitch angle beta indicated in Fig. 6, this pitch angle being positive when the blades rotate in the direction of arrow D of Fig. 5 and producing a lift as indicated by the direction of arrows E of Fig. 5. The pitch of the blade shown in Fig. 5 is negative with respect to the lifting force provided by the propeller assembly but is positive with respect to the upwardly moving air indicated by the arrows E of Fig. 5.

The propeller blades are moved outwardly to the positions where they assume the positive pitch angle of Fig. 6 as a result of the centrifugal force acting on the propeller blades, and this centrifugal force is augmented by suitable weights 13 (Fig. 1) mounted in the propellers adjacent their tips, respectively. The spring means 3 draws the blades inwardly to their inner end positions where they automatically assume the negative pitch angle of Fig. 5.

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The starting device 6 rotates the propeller assembly at a relatively high speed which automatically causes the blades to move by centrifugal force to their outer positions against the retracting force of the springs 3, and thus the blades automatically have the positive pitch angle indicated in Fig. 6, and when the helicopter automatically leaves the starting device 6 it rises to a relatively great altitude. As soon as the speed of rotation of the propeller assembly decreases upon expiration of the initial starting energy, the tension springs 3 start to move the propeller blades inwardly toward the axis of rotation of the propeller assembly, and eventually the springs locate the propeller blades at their inner end positions where they have the negative pitch angle indicated in Fig. 5. At this time the helicopter starts to descend, and the stream of air which moves upwardly with respect to the descending helicopter cooperates with the negative pitch angle of the blades thereof to accelerate the speed of rotation of the propeller and in this way a stable and safe landing of the toy helicopter is guaranteed. After the toy helicopter has reached its maximum altitude and has started to descend the acceleration of the speed of rotation of the propeller assembly due to the cooperation of the upwardly moving air stream (with respect to the downwardly moving aircraft) and the negative pitch angle of the propeller blades retards the descending speed and the toy helicopter closely simulates the maneuvers of a real helicopter when the pilot thereof is looking for a suitable landing area.

Thus, the upwardly moving air stream with respect to the descending aircraft accelerates the speed of rotation of the propeller, and during this time the rotational speed becomes sufficient momentarily to provide the centrifugal force necessary to overcome the force of the retracting springs 3, and thus the blades assume a positive pitch angle to retard the descending movement of the craft until the retracting force of the spring means 3 again overcomes the centrifugal force so as to cause the blades to automatically assume their negative pitch angles, respectively. This change in the pitch of the blades during the descent of the craft repeats itself several times.

This latter result is brought about by carefully relating the force of the springs and the centrifugal force of the rotating blades to each other in such a way that these forces counterbalance and are equal and opposed to each other approximately when the speed of rotation of the propeller assembly is at a value where the propeller blades have a slightly positive pitch angle which tends to lift the aircraft. If the centrifugal force of the propeller blades is too great with respect to the retracting force of the spring means 3, then the change in the pitch of the propeller blades from positive to negative would occur at a speed of rotation of the propeller assembly which would not appreciably retard the descent of the craft. On the other hand, if the force of the spring means 3 were too great with respect to the centrifugal force, then the toy helicopter would not reach its possible maximum altitude. Furthermore, where the spring force is too strong, with respect to the centrifugal force of the propeller blades, in spite of the acceleration of the speed of rotation of the propeller assembly during descent of the aircraft the speed of rotation would never be sufficient to provide a centrifugal force capable of overcoming the spring force to provide the change of pitch from negative to positive momentarily during descent of the aircraft.

It will be noted that the automatic pitch regulation of the propeller blades is provided with an exceedingly simple structure which cannot fail to operate properly. The sleeve portions 7 and 8, the helical grooves 9, and even the hooks 14 for the springs are all integral with the hub parts 2a and 2b. The cylindrical rod portions 10 as well as the keys 11 and 12 connected thereto and the hooks 15 are integral with the propeller blades. These blades and the hub parts are all produced very

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easily, and inexpensively, by injection molding, for example, and all of these parts have very simple molding shapes. The division of the hub means into substantially identical upper and lower halves in a horizontal plane permits molding according to mass production methods.

Fig. 7 illustrates the cooperation between mold parts 19 and 20 which define the portion of the mold interior which provides the lower hub part 2b at the section line 7-7 of Fig. 4. At this part the helical grooves 9 have a zero pitch. As is apparent from Fig. 7 the shape of the mold cavity does not have any undercuts and ejection of the molded part is carried out very simply by a linear to and fro movement of the mold parts 19 and 20. Figs. 5 and 6 illustrate the manner in which the opposite grooves 9 of each bore curve, these figures showing the positions of the grooves at their opposite ends, and it is apparent from Figs. 5 and 6 that nowhere along the length of the grooves are there any undercuts, so that the hub parts can be very easily molded. If the hub were molded in one piece then a very expensive mold together with a core and complicated movements of these parts would be required.

It should be noted that instead of locating the pair of grooves 9 of each bore on opposite sides of a vertical plane, it is possible to locate these grooves on opposite sides of a horizontal plane. In other words each of the hub parts may be provided with one complete groove 9, and in this latter case the grooves would be located above and below the faces of the hub parts which abut against each other to form the complete hub.

Of course, when the grooves 9 of each bore are located above and below a horizontal plane located at the junction between the upper and lower hub parts, respectively at the top and bottom surfaces of the end portion 14 of the inner end of each propeller blade are also located at the top and bottom surfaces of the end portion 10, respectively, rather than at opposed side surfaces thereof.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of toy helicopters differing from the types described above.

While the invention has been illustrated and described as embodied in toy helicopters with adjustable pitch, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a toy helicopter, in combination, an elongated fuselage portion having a longitudinal axis and provided with a pair of rectangular cavities which are directed downwardly from said longitudinal axis and which are spaced therealong, said fuselage also having a top wall portion formed with an opening passing therethrough along an axis substantially perpendicular to the longitudinal axis of the fuselage; a propeller shaft extending through the latter opening of said fuselage and being turnable therein, said propeller shaft having within said fuselage a means to be engaged by a starting device for rotating said propeller shaft to start the flight of the helicopter; individual front and rear landing gear units respectively each having a pair of landing wheels and having a wire structure having a U-shaped body portion with terminal axle portions carrying said wheels, said

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U-shaped body portion being received in said rectangular cavities and joined to said fuselage for connecting said front and rear landing gear means therewith; a hub located above said fuselage and fixed to said shaft for rotation therewith, said hub having a plurality of spokes extending radially from said shaft and respectively formed with bores distributed about said shaft and extending radially therefrom, each of said bores being formed in its interior with a pair of opposed longitudinal grooves each of which extends along a helix, said hub consisting of two parts in engagement with each other substantially in a plane normal to the axis of rotation of the hub and extending longitudinally through the axes of said bores; a plurality of blades respectively having elongated free end portions axially slidable in said bores and fixedly carrying a pair of projections respectively movable along the pair of opposed grooves of each bore, so that when said blades move outwardly away from said shaft due to centrifugal force when said shaft, hub, and blades rotate at a speed above a predetermined value said projections cooperate with said bores to change the pitch of said blades; and spring means connected with said blades and hub for urging said blades inwardly to a rest position where said projections cooperate with said grooves for providing a negative pitch on said blades, said spring means comprising a separate spring for each blade with one end of the spring attached externally to the respective blade and the opposite end attached externally to the hub.

2. A toy helicopter as recited in claim 1 and wherein said propeller shaft threadedly carries a nut engaging the interior of said fuselage at the bottom end of said opening in said top wall portion thereof and wherein said propeller shaft has a key means cooperating with said hub to connect the latter to said propeller shaft for rotation therewith, and said propeller shaft also having a top threaded portion carrying a nut and engaging said hub.

3. In a toy helicopter as recited in claim 2, said hub being made up of a pair of upper and lower parts which are substantially identical and which are held together by said key means and said nut on said upper end portion of said propeller shaft.

4. In a toy helicopter, in combination, a propeller hub having an axis of rotation and formed with a plurality of bores distributed about and extending radially with respect to said axis of rotation, said hub being formed in each of its bores with at least one groove extending along a helix about the axis of each bore and having a helical bottom, said hub consisting of two parts having abutment faces in engagement with each other substantially in a plane normal to the axis of rotation of said hub and extending through the axis of said bores, said plane intersecting with said bottom of said groove along the entire length of said groove, so that portions of said groove in said part of said hub have no undercuts, whereby casting of said hub parts is facilitated; a plurality of propeller blades having elongated end portions respectively extending into said bores for axial movement therein, each of said end portions having a lateral projection located in the respective helical groove so that during axial movement of said blades with respect to said bores the cooperation of said projection and respective grooves will change the pitch of said blades, said blades moving outwardly away from the axis of rotation of said hub due to centrifugal force incident to rotation of said hub; resilient means connected to said blades and hub for urging said blades toward said axis of rotation of the hub; and means for maintaining said two parts of the hub disconnectably connected with each other and operatively connected to said blades.

5. In a toy helicopter, the combination according to claim 4, wherein said resilient means comprise a separate spring for each blade with one end of the spring attached

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externally to the respective blade and the opposite end attached externally to the hub.

6. In a toy helicopter, in combination, a propeller hub having an axis of rotation and formed with a plurality of bores distributed about and extending radially with respect to said axis of rotation, said hub being formed in each of its bores with a pair of diametrically opposed grooves, each groove extending along a helix about the axis of each bore and having a helical bottom, said hub consisting of two parts having abutment faces in engagement with each other substantially in a plane normal to the axis of rotation of said hub and extending through the axis of said bores, said plane intersecting with said bottom of each of said grooves along the entire length of said groove, so that portions of each of said grooves in said parts of said hub have no undercuts, whereby casting of said hub is facilitated; a plurality of propeller blades having elongated end portions respectively extended into said bores for axial movement therein, each of said end portions having a lateral projection located in the respective helical groove so that during axial movement of said blades with respect to said bores the cooperation of said projection and respective grooves will change the pitch of said blades, said blades moving outwardly away from the axis of rotation of said hub due to centrifugal force incident to rotation of said hub; resilient means connected to said blades and hub for urging said blades toward said axis of rotation of the hub; and means for maintaining said two parts of the hub disconnectably connected with each other and operatively connected to said blades.

7. In a toy helicopter, in combination, a propeller hub having an axis of rotation and formed with a plurality of bores distributed about and extending radially with respect to said axis of rotation, said hub being formed in each of its bores with a pair of diametrically opposed undercut grooves, each groove extending along a helix about the axis of each bore and having a helical bottom, said hub consisting of two parts having abutment faces in engagement with each other substantially in a plane normal to the axis of rotation of said hub and extending through the axis of said bores, said plane intersecting with said bottom of each of said grooves along the entire length of said groove, so that portions of each of said grooves in said parts of said hub have no undercuts, whereby casting of said hub is facilitated; a plurality of propeller blades having elongated end portions respectively extending into said bores for axial movement therein, each of said end portions having a lateral projection located in the respective helical groove so that during axial movement of said blades with respect to said bores the cooperation of said projection and respective grooves will change the pitch of said blades, said blades moving outwardly away from the axis of rotation of said hub due to centrifugal force incident to rotation of said hub; resilient means connected to said blades and hub for urging said blades toward said axis of rotation of said hub; and means for maintaining said two parts of the hub disconnectably connected with each other and operatively connected to said blades.

8. In a toy helicopter, in combination, a propeller hub having an axis of rotation and formed with a plurality of bores distributed about and extending radially with respect to said axis of rotation, said hub being formed in each of its bores with at least one undercut groove extending along a helix about the axis of each bore and having a helical bottom, said hub consisting of two parts having abutment faces in engagement with each other substantially in a plane normal to the axis of rotation of said hub and extending through the axis of said bores, said plane intersecting with said bottom of said groove along the entire length of said groove, so that portions of said groove in said parts of said hub have no undercuts, whereby casting of said hub parts is facilitated; a plurality of propeller blades having elongated

gated end portions respectively extending into said bores for axial movement therein, each of said end portions having a lateral projection located in the respective helical groove so that during axial movement of said blades with respect to said bores the cooperation of said projection and respective grooves will change the pitch of said blades, said blades moving outwardly away from the axis of rotation of said hub due to centrifugal force incident to rotation of said hub; resilient means connected to said blades and hub for urging said blades toward said axis of rotation of the hub; and means for maintaining

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said two parts of the hub disconnectibly connected with each other and operatively connected to said blades.

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