J. N. WILLIAMS.

FLYING MACHINE.

APPLICATION FILED JULY 14, 1910.

1,076,803.

Patented Oct. 28, 1913.

4 SHEETS—SHEET 1.

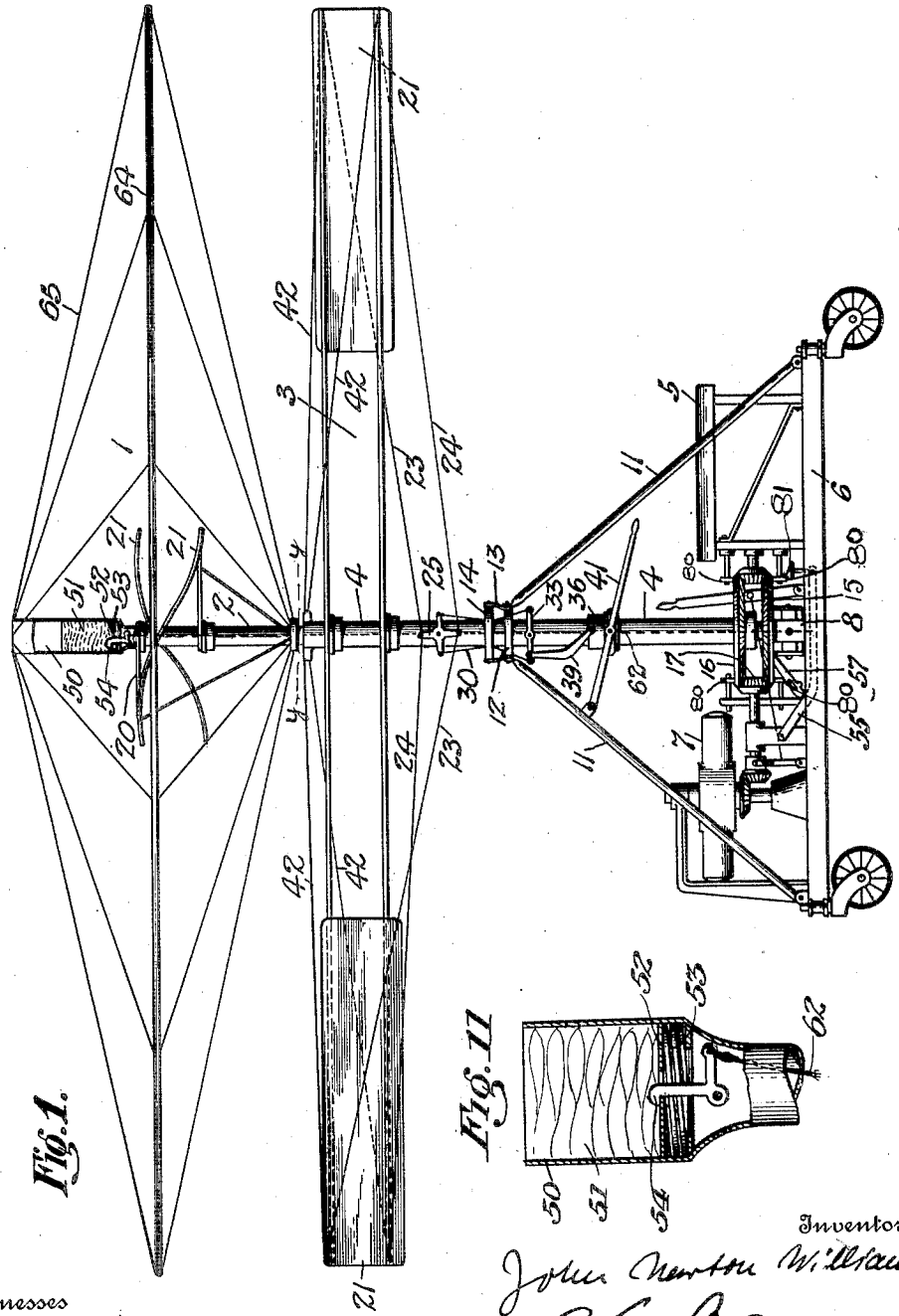


Fig. 1.

Fig. 11

Witnesses

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4 SHEETS—SHEET 2.

Fig. 2.

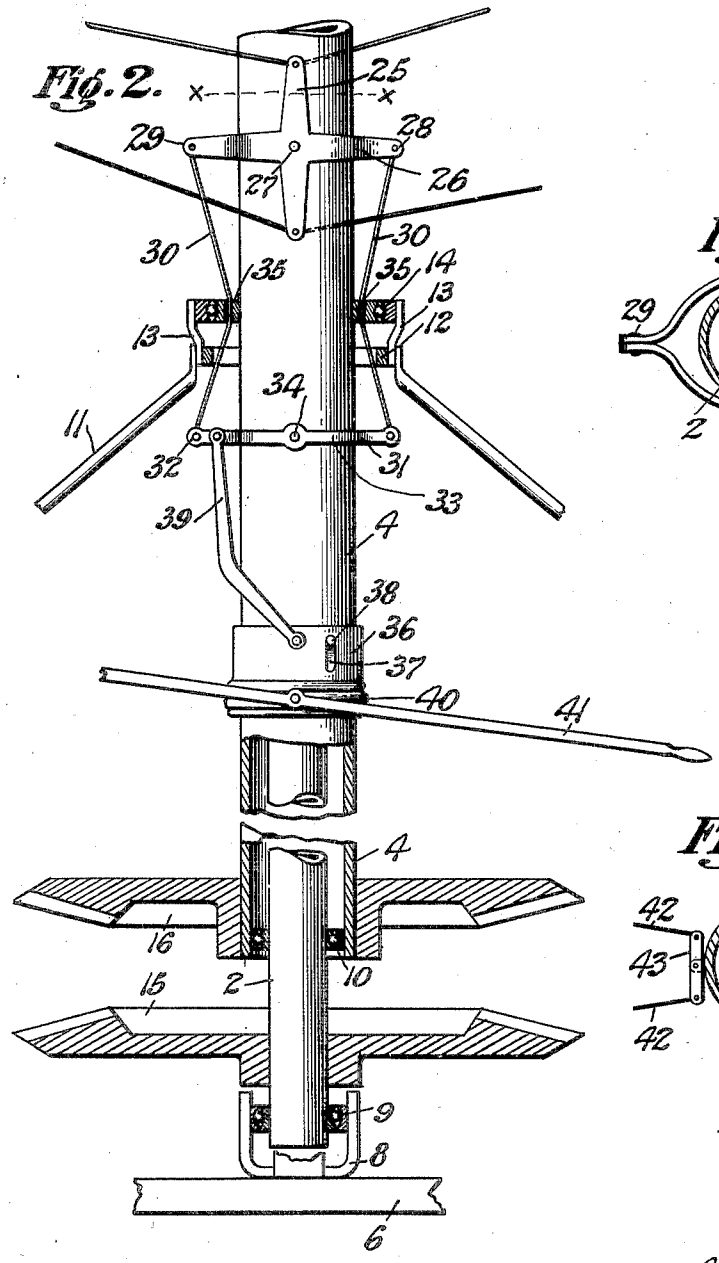


Fig. 3.

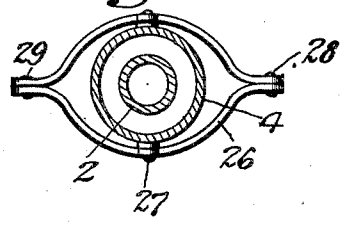
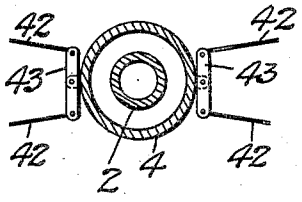


Fig. 4.



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4 SHEETS—SHEET 3.

Fig. 7.

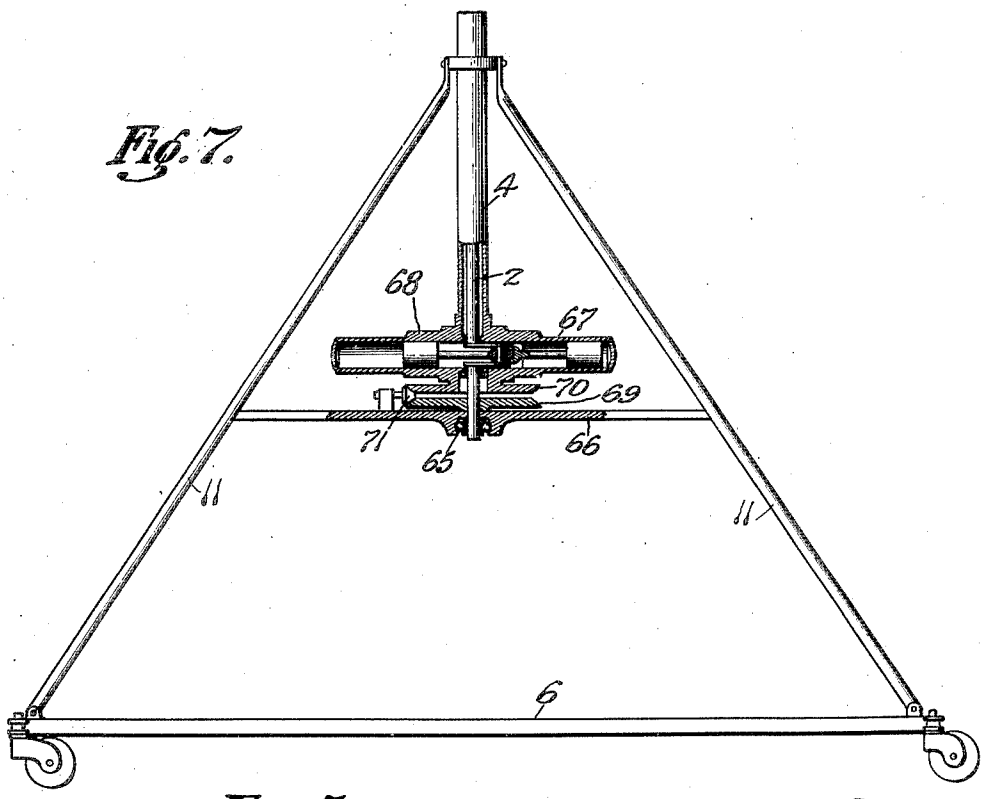


Fig. 5.

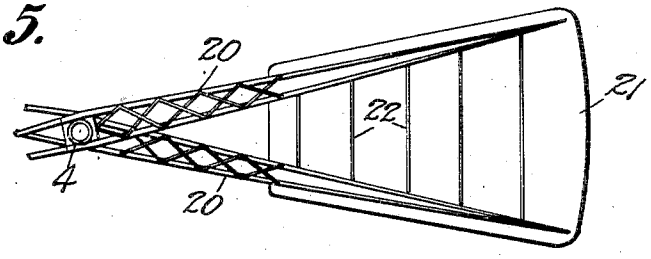
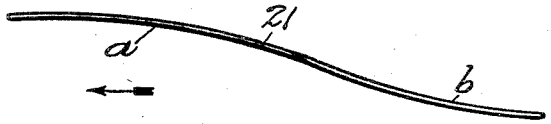


Fig. 6.



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4 SHEETS—SHEET 4.

Fig. 9.

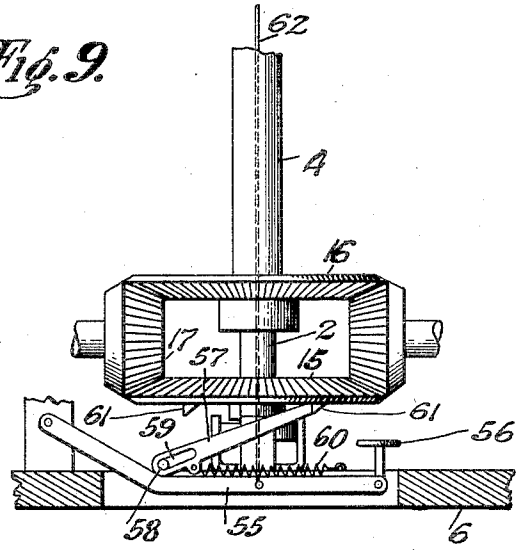


Fig. 10.

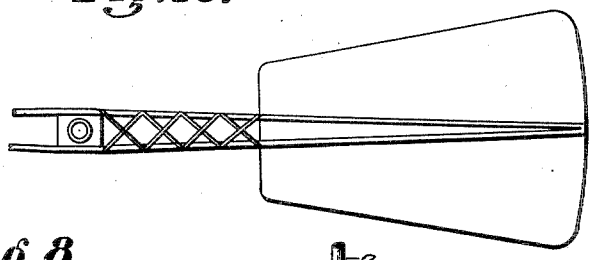
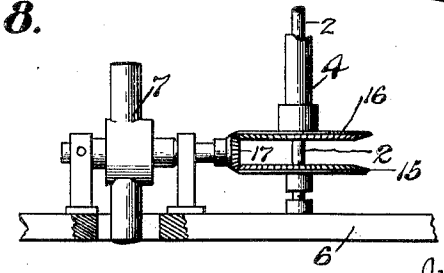


Fig. 8.



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FLYING-MACHINE.

1,076,803. Specification of Letters Patent. Patented Oct. 28, 1913.

Application filed July 14, 1910. Serial No. 571,948.

To all whom it may concern:

Be it known that I, JOHN NEWTON WILLIAMS, a citizen of the United States, and a resident of Derby, in the county of New Haven and State of Connecticut, have invented certain new and useful Improvements in Flying-Machines, of which the following is a specification, the particular novel features of my invention being more fully pointed out in the annexed claims.

The subject matter of the present application relates in particular to improvements in flying machines of the character described and shown in my copending application, Serial No. 354,877, filed January 30th, 1907 and I shall hereinafter only briefly refer to the principal features involved in the aforesaid application.

The particular novel features covered by the present application are the flexible arms of the propeller blades, and their support by adjustable guy wires by which the pitch of one propeller may be varied at will; the particular control of the pitch variations by means of guy wires; the shape of the propeller to develop a greater efficiency per unit of h. p.; a particular hanger construction so as to distribute the suspension strain of the platform uniformly over the upper rim of the ball race; and lastly an automatic arresting of the reverse movement of the propellers and simultaneous release of the parachute when the engine has stopped and the machine tends to descend against the will of the operator.

In the accompanying drawings Figure 1 represents a side elevation of the whole flying machine. Fig. 2 is a detail illustration of the middle portion of the two propeller shafts to larger scale, showing the improved hanger construction and the manner in which the guy wires for changing the pitch of the propeller blades are operated. Fig. 3 is a plan view of the shaft shown in Fig. 2 on a section line x—x in that figure. Fig. 4 is a transverse section through the shafts on the line y—y in Fig. 1 to larger scale. Fig. 5 is a detail illustration of the upper side of one of the propeller blades. Fig. 6 is an end view of a blade to larger scale showing its peculiar curvature. Fig. 7 is a side elevation of the lower portion of the machine illustrated in Fig. 1, showing a modified arrangement of the driving motor for the two shafts. Fig. 8 is another modification of the system of driving the two propeller shafts. Fig. 9 is a detail illustration to larger scale, of the central lower portion of the machine showing the automatic release of the parachute and the locking of the propeller shafts against reverse movement when the engine stops and the machine tends to descend. Fig. 10 represents a modified form of the propeller shown in Fig. 5. Fig. 11 is an enlarged detail view.

The machine as illustrated in Fig. 1 and described in the aforesaid application is of the helicopter type in which two propellers are used for lifting the machine, the propellers revolving in opposite direction so as to mutually counteract the reaction of their torque and prevent revolving of the operator's platform against his will when the machine is suspended in the air. The propeller shafts are arranged one within the other so that the two propellers are in axial alinement with each other and both shafts are driven from one source of power. In Fig. 1 the upper propeller may be seen at 1 and its shaft at 2, and the lower propeller at 3 and its shaft at 4, shaft 2 being disposed within the hollow shaft 4 with suitable ball bearings interposed at the proper places as illustrated in detail in the aforesaid application. The platform 6 which supports the operator whose seat is at 5, supports oppositely to the operator's seat a motor 7. The lower ends of the shafts 2 and 4 are supported as shown in detail in Fig. 2. From this figure it will be seen that in the center of platform 6 is mounted a four armed bracket 8 with its four arms bent upward so as to hold the outer ball race of thrust ball bearing 9, the inner ball race of which is suitably fastened to the lower end of inner shaft 2. The lower end of the outer shaft 4 has fastened to its inside the outer ball race of thrust ball bearing 10 the inner race of which is mounted on shaft 2. To the four corners of platform 6 are pivoted truss rods 11 which incline toward outer shaft 4 to which they are attached in the manner clearly shown in Fig. 1. As will be seen from this figure, truss rods 11 are united by and fixed to ring 12 to which are also attached a suitable number of upward extensions 13 the upper ends of which are in turn attached to the outer race of thrust ball bearing 14, the inner ball race of which is suitably fixed on outer shaft 4.

By first uniting trusses 11 by a ring and suspending this ring from the outer ball race

by hangers as shown, which are uniformly distributed in suitable number over the whole circumference of the whole outer ball race of ball bearing 14, I obtain a uniform distribution of the suspension or thrust strain of each single truss-rod on this bearing. By the whole arrangement of the support of platform 6 by the shafts 2 and 4 and the thrust ball bearings 9, 10 and 14, I obtain a suspension of platform 6 as well at its four corners as also at its center in such manner that the suspension strain is uniformly distributed over the two shafts so that both propellers uniformly contribute to the support of the platform when the machine is suspended in the air, and so that the whole combination forms a rigidly trussed construction. Each shaft 2 and 4 has fixed to its lower end a bevel gear wheel 15 and 16 respectively, which are of uniform size and driven directly from the engine shaft by bevel pinion 17 so that both shafts must revolve at uniform speed, but in opposite directions. To prevent one sided strain on bevel wheels 15 and 16 I provide an idle pinion 81 in axial alinement with and opposite to pinion 17 between the two wheels. Also, in order to prevent disengagement of these wheels from their pinions should the entire frame structure slightly yield owing to its more or less flexible nature, I also provide idle rollers 80 which travel over the outside of the bevel wheels 15 and 16 opposite each pinion. By shifting his position on seat 5 toward the center of the platform the operator may tilt the machine out of the vertical position when it is suspended in the air and thus obtain forward movement of the machine.

In my aforesaid application I have described various arrangements for turning the platform in the compass direction with the machine suspended in the air so as to enable the operator to travel in these different directions at will. According to these arrangements either the relative speed of one of the propeller shafts was increased or decreased or the relative effective areas of one of the two lifting propellers was changed by either decreasing or increasing its surface area, or also by employing supplemental resistance wings or vanes shiftable at will. In practice I have found that among the most effective manners of producing a difference in torque reaction of the two shafts upon the platform the slight change of pitch of the blades of one of the two propellers is the simplest and most effective, and in turn that the change of the pitch of the blades is most effectively produced by twisting the flexible arms and blades by means of adjustable guy wires, by the operator while the machine is suspended or moving in the air.

While of course the blades of both propellers may be twisted for the purpose described, I prefer in practice to only twist the blades of the lower, most accessible propeller in either direction, so as to produce the desired difference in torque reaction. In order that the propeller arms and blades may readily yield to such twisting, I have constructed the arms in such manner that they form a truss in the direction of their plane of rotation so as to offer greatest driving strength with least head resistance, while their lifting strength or thrust is reinforced by guy wires. In my present construction each front and rear edge of a blade is supported by arms 20 (Fig. 5) these two arms of each blade crossing each other at the shaft to which they are attached, as for instance shaft 4. The arm 20 which supports the front edge of a propeller blade 21, preferably extends beyond the center of its shaft toward the opposite direction where it supports simultaneously the front edge of the oppositely disposed blade 21 of this same propeller. The front and rear edge arm 20 in each blade are connected with each other at the upper side of each blade 21 by ribs 22 as shown in Fig. 6 so that thereby a skeleton is formed upon which the blade 21, which may be of any suitable material, is mounted. To the front and rear margin of each blade 21 of the lower propeller are attached guy wires 23 and 24, guy wires 23 of each blade being attached to the front edge and guy wires 24 of each blade being attached to the rear edge of the blade. Of course a propeller blade may be constructed with a single supporting arm as shown in Fig. 10, or, as is customary in the ordinary type of propeller blade, with a continuous flexible blade extending from the propeller shaft, and its outer portion supported by rigid or adjustable guy wires. The inner ends of guy wires 23 and 24 are attached to a vertical double armed lever 25 in the manner shown in Figs. 1 and 3 in such manner that guy wire 23 of one blade and wire 24 of the other blade are attached to the upper end of the lever and wire 23 of the other blade and wire 24 of the second blade to the lower end of the lever. This lever may be rocked by a yoke 26 with which it is integral, the yoke being pivoted on shaft 4 at 27.

The ends 28 and 29 of yoke 26 are attached by cables 20 to the two ends 31 and 32 respectively of a yoke 33 pivoted at 34 to shaft 4, whereby cables 30 pass through suitable openings 35 provided in inner ball race of thrust ball bearing 14 as shown in detail in Fig. 2. A plan view of yoke 26 is shown in Fig. 3. Below lever 33 a sleeve 36 is disposed on shaft 4 which has a vertical movement thereon limited by the length of its slot 37 and by means of pin 38 disposed therein and fixed on shaft 4. Sleeve 36 is connected with yoke 33 by means of

fork 39 pivotally attached to these two members as shown and sleeve 36 may be shifted vertically within the limits described by means of collar 40 to which is attached a hand lever 41. It will be seen that if hand lever 41 is moved upward or downward and through the lever connection described hereinbefore, the double armed lever 25 will be rocked in either direction and either guy wires 23 of the front edge of the two blades tightened and simultaneously the guy wires 24 of the two rear edges slackened, or vice versa, so that thereby either the front edge of each blade will be sprung down and its rear edge sprung up, thereby the pitch of the two blades being lessened, or the front edge will be sprung up and the rear edge of the blade sprung down, whereby the pitch of the two blades is increased. The outer corners of each blade of the lower propeller are also supported by guy wires 42 in such manner that the outer ends of these guy wires of each blade are attached to the opposite ends of a double armed lever 43 which is at its pivot point attached to shaft 4 above the horizontal axis of the two blades 21. Thus it will be seen that while these upper guy wires 42 of each blade prevent the drooping down of the outer end of the blade these wires still permit the twisting of the blade edges as just described, owing to their attachment to the levers 43. Hand lever 41 being arranged near the operator's seat 5, he may thus vary the pitch of the lower propeller which is attached to shaft 4 and thereby produce a desired difference in torque reaction of the two propellers upon the platform and thus turn the platform into any compass direction when the machine is suspended in the air by the revolving fans. Other well known mechanical means may be employed to adjust and control the guy wires for regulating the pitch of propellers without departing from the spirit of my invention.

While a flying machine may be operated by propellers of any suitable shape I have discovered that greater efficiency is obtained by shaping the blades 21 of each propeller in the manner shown in Fig. 6 which represents an end view of such a blade. From this view it will be noted that the blade has the greater portion of its working surface or face *a* concaved, but has a slight convex reverse curve near the rear edge *b* of the blade, so as to permit easier escape of air.

It is true that a proper concavity for the entire working surface of a propeller blade will give a greater thrust for a given revolution speed, but tests have demonstrated that it is also true that while a slight convexity or reversal of the curve at the rear portion of the blade will diminish that thrust, it will also diminish the amount of power consumed in driving it, in a still greater ratio, therefore giving a greater thrust per unit of horse-power, which in a heavier-than-air flying machine, is greater resultant efficiency.

In my aforesaid application I have illustrated on top of the upper propeller and rigidly connected with the upper end of its shaft a tubular upward extension which contains a parachute folded therein and connected by means of suspension cords to a rim encircling the tips of the blades of the upper propeller, and I have also illustrated in said application a device which may be operated by the foot or hand of the operator in case of emergency by means of which this parachute may be expelled from this cylinder when the machine tends to drop against the will of the operator, so as to lessen the impact with the ground. In the present application I have devised means by which this parachute may be automatically released as soon as the two propellers stop and by the unintentional descent of the machine tend to move in reverse direction by the pressure of air bearing against the underside of the blades. Similar to the manner illustrated in said application, I have illustrated in the present Fig. 1 a tubular upward extension 50 mounted on top of shaft 2 carrying the upper propeller which tube contains the parachute 51 only diagrammatically indicated, and which also contains a spring bottom or disk 52 on which the parachute rests.

Beneath disk 52 is disposed a compression spring 53 which tends to throw disk 52 upward and thus parachute 51 out of cylinder 50. The disk 52 is held in the position shown, with spring 53, pressed by latch 54 suitably pivoted in the bottom of the cylinder so that it may be disengaged from disk 52 by means of a cable or rope passing through the hollow center of shaft 2 to the bottom of platform 6. This cable is also shown in said application and is attached to a foot or hand lever 55 pivoted on a suitable block on the platform. In order to operate this foot lever automatically as soon as the propellers tend to revolve in the reverse direction, I provide a folding pawl 57 which is pivoted on a pin 58 fastened on the platform, however, in such manner that the pawl can slide on its pivot axially of slot 59 in which pivot 58 is disposed. At a point on pawl 57 lateral to its longitudinal axis a tension spring 60 is fastened, the other end of which spring is fastened to a fixed point on the platform. The lower side of gear wheel 15 which operates shaft 2 is provided with four ratchet teeth 61 in the path of which the end of pawl 57 is arranged. So long as gear wheel 15 revolves in the direction of revolution of the propeller at which it lifts the machine, pawl 57 will glide over teeth 61. When gear wheel 15 tends to re-

volve in the opposite direction, one of the teeth 61 will come into engagement with pawl 57 and move it in the opposite direction so that the rear end of pawl 57 abuts against foot lever 55 which will be thrown downward thereby and thus pull cable 62 which releases latch 54 of the parachute device so that the latter is released and the parachute expelled from the cylinder 50. Four of such teeth 61 as previously stated are provided in this particular case of two-bladed propellers and are set at 90° to each other on the circumference of wheel 15 so that the two propellers are always arrested standing at right angles to each other to aid as supporting surface when the machine descends with the engine at rest. In Fig. 9 only two consecutive teeth are visible, the other two being located corresponding therewith at the other side of the center. As in the illustration shown in my aforesaid application, the tips of the blades of the upper propeller are encircled and connected to a ring 64 to which the parachute suspension cords 65 are fastened as shown in Fig. 1. Thus the parachute is expelled when the machine tends to descend without the action of the operator, though of course he is at any time able to expel the parachute from the cylinder by operating the foot lever 55 by means of foot pedal 56 which is disposed near the seat 5.

In Figs. 7 and 8 I have represented two modifications of the manner in which the propeller shafts may be driven. The modification in Fig. 7 shows a hydrocarbon motor of the so called revolving cylinder type which is directly coupled with the two propeller shafts. In this case the inner propeller shaft 2 is connected direct to the motor crank shaft, while the outer propeller shaft is connected direct to the center chamber or hub of the revolving cylinders.

The lower end of the motor crank shaft is connected by thrust ball bearings 65 to a cross bar 66 on the frame of the machine and mounted upon it is bevel gear wheel 69 and a downward projecting sleeve of the motor hub has a corresponding gear wheel 70 just above it and an idle pinion 71 disposed between the two gear wheels and engaging them both, is mounted on the said crossbar 66 of the frame to insure the propellers running in opposite directions at the same revolution speed relatively to the platform or frame. By this arrangement a very simple and direct power transmission is obtained.

The power transmission shown in Fig. 8 comprises the two bevel gear wheels 15 and 16 which are rigidly connected to the inner and outer shafts 2 and 4 respectively similarly to the manner as shown in Fig. 2, and which are connected by bevel pinion 17. Pinion 17, however, is connected to the casing 72 of a revolving cylinder hydrocarbon engine which rotates in a vertical plane contrary to the motor illustrated in Fig. 7 which rotates in a horizontal plane. Also in this case the power transmission is very effective and direct.

While it has been suggested in the art to change the pitch and thereby the resistance of one propeller relatively to the other in the helicopter type of machine, the method employed of pivoting and rocking a blade upon its radial arm, or connecting it rigidly to an arm which is arranged to rock upon its radial axis, has involved complicated and heavy construction, while the light flexible arm and blade supported and controlled by guy-wires is a much lighter and stronger construction which is most essential in a heavier-than-air machine. Manifestly a heavy construction is highly undesirable for machines of the character described in this application, where every ounce of weight should be eliminated. On the other hand it will be obvious that with my construction of the propellers with light elastic arms supported by guy wires and in which the pitch is changed by springing the arm and blade, a heavy construction at the point where the blades join the hub is unnecessary since there are no moving parts at this point.

I claim:

1. In a machine of the character described, a propeller having a shaft, flexible arms and blades supported by adjustable guy wires fastened to the front and rear edge of each blade and pivoted levers fastened to the shaft to which levers the other ends of said guy wires are attached, means for operating the levers to control the pitch of said blades while the propeller revolves, and a platform supported by said propeller shaft, said lever-operating means being controlled from said platform while the machine is suspended in the air.

2. In a machine of the character described, the combination of two propellers revolving in opposite direction, at least one of said propellers having flexible arms and blades supported by adjustable guy wires fastened to the front and rear edge of each blade, pivoted levers fastened to the propeller shaft, to which levers the other ends of the said guy wires are attached and means for operating the levers to control the pitch of said blades to increase or diminish their air resistance and thereby the revolution speed of said propeller while the machine is suspended in the air by said two propellers.

3. In a machine of the character described, the combination with two propellers revolving in opposite direction at least one of said propellers having flexible arms and blades supported by adjustable guy wires fastened to the front and rear edge of each blade, pivoted levers fastened to the propeller

shaft, to which levers the other ends of the said guy wires are attached and means for operating the levers to control the pitch of said blades to increase or diminish their air resistance and thereby the revolution speed of said propeller, while the machine is suspended in the air by said two propellers, and to change the compass direction in which the machine travels.

4. In a flying machine, a propeller having a shaft, flexible arms and blades supported by guy wires fastened to the front and rear edge of each blade and a pivoted lever fastened to the shaft to which lever the other ends of said guy wires are attached, a sleeve slidingly disposed on said shaft and operatively connected to said lever and having a collar, a hand lever with a ring disposed on said sleeve and held in position by said collar for moving said sleeve to adjust the pitch of said blades, substantially as and for the purpose described.

5. In a machine of the character described, a propeller having a shaft and flexible arms and blades, adjustable guy wires for each blade for flexing the blades to change the pitch thereof, and supporting guy wires attached at one end to the front and rear edge of the blade, the other ends of the supporting wires being fastened to the two ends respectively of a double armed lever pivoted above the blade to the shaft for compensating the length of the supporting guy wires when said flexing guy wires twist the blade.

6. In a machine of the character described, the combination with the propeller shafts and a platform supported thereby, of guy rods extending from the outer portion of the platform toward said shafts and a ball bearing collar on said shafts between the platform and the propellers, having a supplemental collar attached to it below the main collar to which supplemental collar the upper ends of the guy rods are attached to bring their line of strain in line with the center of said ball bearing collar and equalizing the thrust and pull of the rods on the ball bearing.

7. In a machine of the character described, having concentrically disposed propeller shafts with bevel gear wheels at their lower ends, a motor having on its shaft a bevel pinion which is in mesh with said gear wheels for driving said wheels in opposite direction, an idle bevel pinion suitably secured on the machine frame and also in mesh with said gear wheels but disposed oppositely to said driving pinion for relieving the lateral strain upon the propeller shaft bearings, and idle rollers mounted on the machine frame above and below each of said bevel pinions and bearing upon the rim of said gear wheels to hold them in mesh with said pinions.

8. In a machine of the character described, the combination with a supporting frame, an internal combustion motor of the revolving cylinder type having a vertical axis and mounted on said frame, vertical concentric propeller shafts extending above the motor, the motor casing being fixed to the lower end of the outer of the two propeller shafts and having on its underside a bevel gear wheel integral with it, the inner of said two shafts being fixed to the motor crank shaft which has attached to its lower end outside of the casing a bevel gear wheel facing said other bevel gear wheel, an idle pinion in mesh with both of said wheels and mounted on a stud fixed to said frame to cause the propellers revolving in opposite direction to maintain the same revolution speed relatively to the frame.

9. A flying machine of the character described, having two superposed propellers mounted on vertical concentric shafts, a platform supported by said shafts when the machine is suspended in the air, the inner of said two shafts being connected intermediate its ends by thrust bearings to the outer shaft and at its lower end by a thrust bearing to the center of said platform, the outer shaft having a thrust bearing intermediate its ends which is connected by truss rods to the outer portion of said platform to distribute the lift of said platform over both shafts.

10. In a machine of the character described, having two superposed propellers with concentric shafts to support a platform, bevel gear wheels at the lower ends of said shafts and means for driving said wheels in opposite direction, one of said gear wheels having ratchet teeth, a pawl mounted on said platform to engage said teeth to prevent reverse movement of the wheel, said teeth being disposed on said wheel so that when it is arrested said propellers stand with their arms at right angles to each other.

11. In a machine of the character described, having two superposed propellers with concentric shafts to support a platform, bevel gear wheels at the lower ends of said shafts and means for driving said wheels in opposite direction, one of said gear wheels having ratchet teeth, a pawl for arresting the reverse movement of said toothed gear wheel and a parachute having a holder mounted on one of said shafts which holder is adapted to receive and hold the parachute, means for expelling the parachute out of said holder, said pawl being provided with a slotted bearing on its pivot pin to admit of endwise movement when engaging a ratchet tooth and suitable connections between said pawl and said parachute holder to expel the parachute automatically when the pawl arrests the propellers.

12. In a flying machine, a pawl for arresting the reverse movement of the propeller

having a yielding pivot to permit of its moving endwise when thrown into action, a parachute and a parachute receiver mounted on said machine, means for expelling said parachute from the receiver, a catch holding said expelling means in inoperative position, means for connecting said catch with said pawl, the endwise movement of said pawl releasing the catch and rendering operative the expelling means to expel the parachute.

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