J. N. HIGHLAND.

AIRSHIP.

APPLICATION FILED JULY 21, 1911.

1,055,533.

Patented Mar. 11, 1913.

3 SHEETS—SHEET 1.

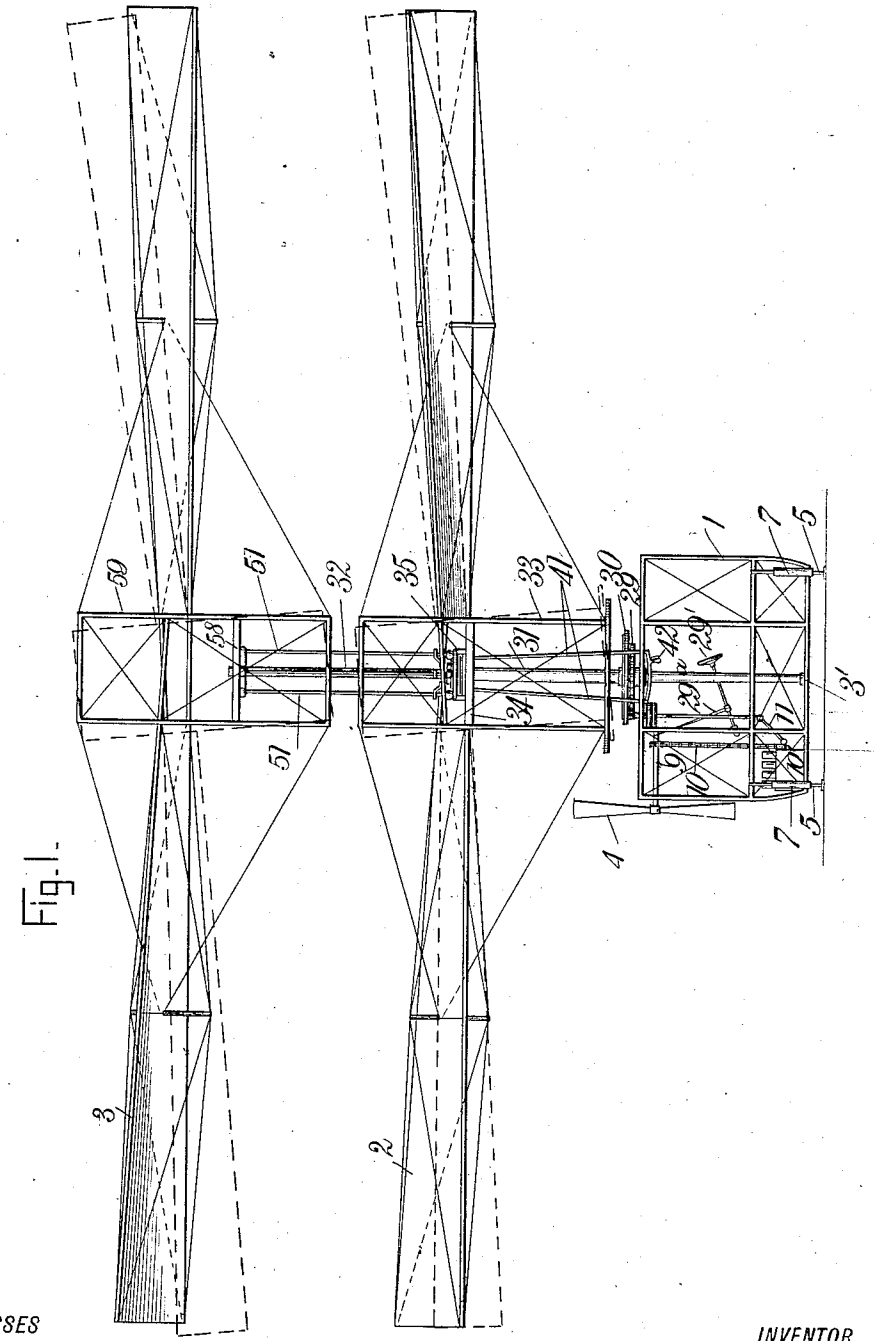

Fig. 1.

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3 SHEETS—SHEET 2.

Fig. 4.

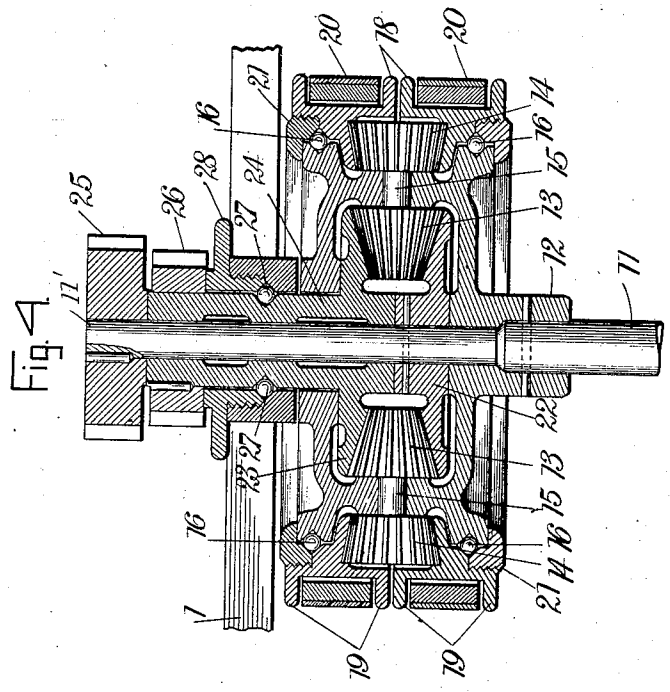


Fig. 3.

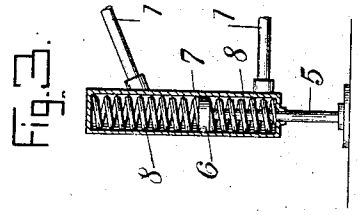
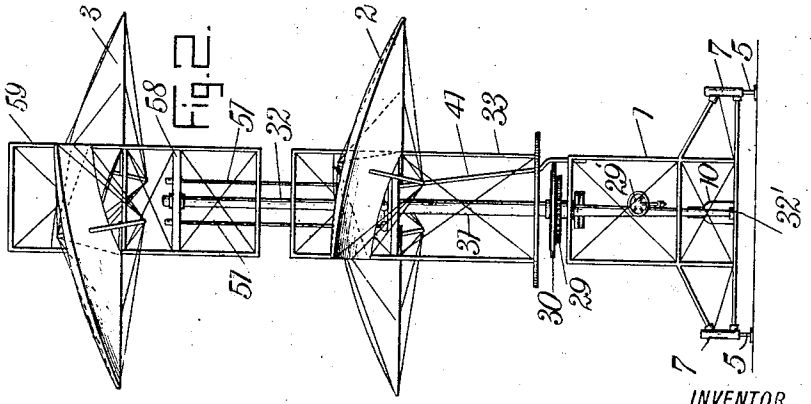


Fig. 2.



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3 SHEETS—SHEET 3.

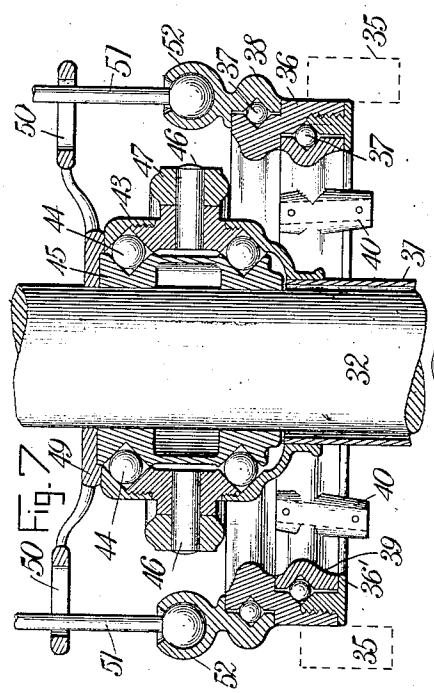

Fig. 7.

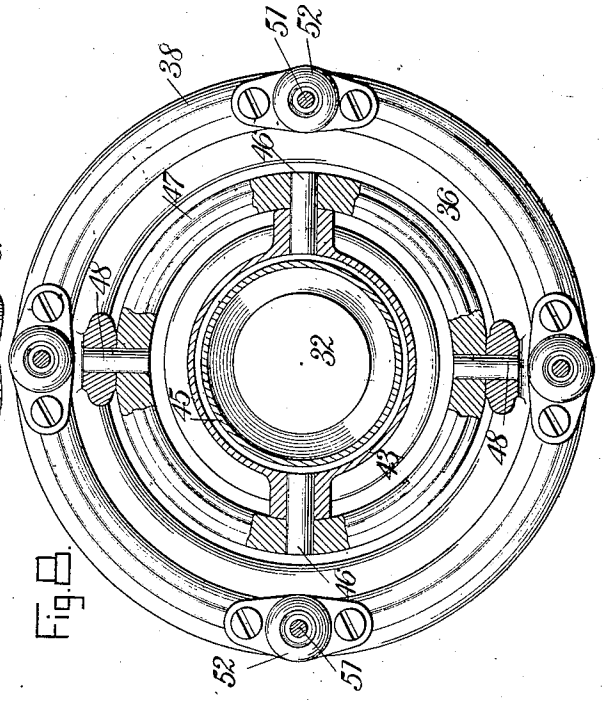

Fig. 8.

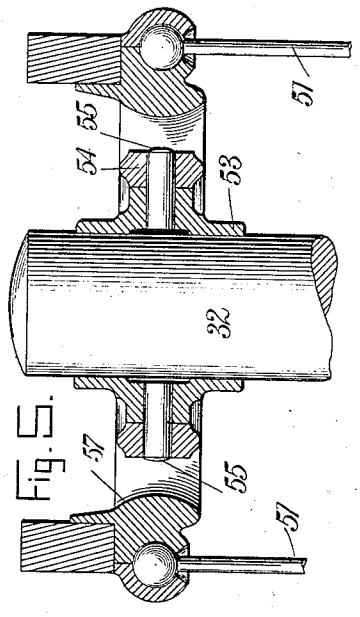

Fig. 5.

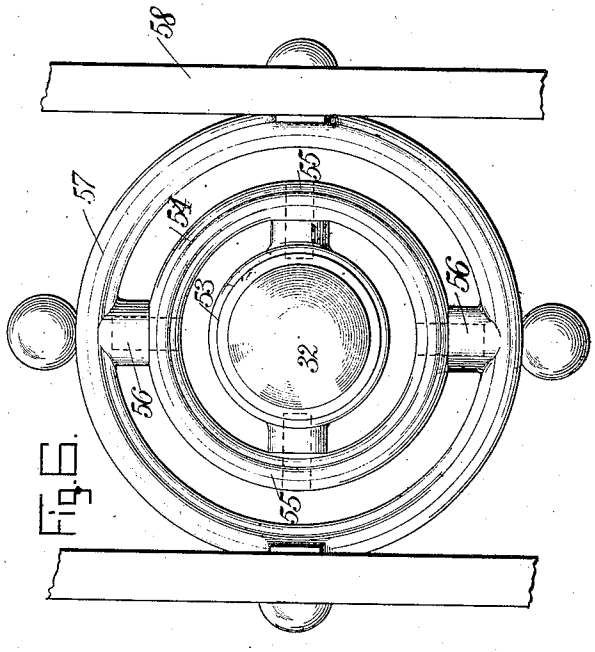

Fig. 6.

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UNITED STATES PATENT OFFICE.

JOHN N. HIGHLAND, OF DETROIT, MICHIGAN.

AIRSHIP.

1,055,533. Specification of Letters Patent. Patented Mar. 11, 1913.

Application filed July 21, 1911. Serial No. 639,732.

To all whom it may concern:

Be it known that I, JOHN N. HIGHLAND, a citizen of the United States, and a resident of Detroit, in the county of Wayne and State of Michigan, have invented a new and Improved Airship, of which the following is a full, clear, and exact description.

My invention relates to an improvement in airships of the helicopter type and it comprises a construction which includes preferably supporting means in the form of propeller wheels having extended blades which rotate in opposite directions.

The propellers are mounted one above the other, with their centers in vertical alinement with the center of gravity of the machine; and the driving shafts are connected up to mechanism which will permit these propellers to be driven at the same speed when it is desired to travel straight ahead, or at different speeds when it is desired to make a turn. Suitable mechanism is also provided for the purpose of permitting the planes of revolution of the supporting propellers to be tilted to the horizontal, to enable the car to move forward or backward, as conditions may require.

Other novel features of construction will appear in the accompanying description and be particularly pointed out in the claims appended thereto.

Reference is to be had to the accompanying drawings forming a part of this specification, in which the same characters of reference indicate the same parts in all the views.

Figure 1 is a side elevation of my improved airship as a whole; Fig. 2 is a rear elevation thereof; Fig. 3 is a vertical longitudinal section of one of the supporting posts or legs attached to the car of the airship; Fig. 4 is a vertical longitudinal section of the differential gearing by means of which the supporting propellers are caused to rotate at the same or different speeds; Fig. 5 is a vertical section of the driving connection for the upper propeller; Fig. 6 is a top plan thereof; Fig. 7 is a vertical longitudinal section of the driving connection for the lower propeller; and Fig. 8 is a top plan thereof, partly in section.

On the drawings I have shown my improved airship as being provided with a car or carriage 1; and above this car is the framework for the propellers 2 and 3, which support the car when the machine is in flight. These supporting propellers are each preferably in the form of a two-bladed propeller, and each of these propellers must rotate in opposite directions in order to balance each other, as shown on Fig. 2. In operation the blades of these propellers will be inclined in such a way that the thrust will be downward, as will be readily understood. A third or driving propeller 4 can be mounted in the upper part of the car 1 at the front end thereof if desired, or in any other suitable position.

The car 1 is provided at its corners with supporting legs or posts 5, having heads 6 on their upper ends which are inclosed in a tubular casing 7. Each of these tubular casings 7 contains springs 8 above and below the head 6, and this head, as well as the post 5, slides up and down, the post 5 passing out through a bearing in the bottom of the casing, as shown in Fig. 3. The casing 7 is connected rigidly to the framework of the car 1, and the posts 5, owing to the springs 8, form cushioned supports for the car when it comes to rest upon the ground.

The auxiliary driving propeller 4 is shown as mounted on a shaft 9 carried by the car 1; and this shaft 9 is driven by a sprocket chain 10, operated by a suitable motor 10'. This motor may be a gasolene engine of almost any type; and the crank shaft of this engine is connected to a universal shaft to transmit motion to suitable gearing by means of which the two supporting propellers 2 and 3 are rotated.

The section constituting the outer end of the universal shaft 11 is vertically supported in the car 1; and on the upper end of this section is rigidly mounted, so as to rotate therewith, a hollow cylindrical casing 12. In the opposite sides of this casing are formed suitable bearings for a pair of spindles 15, each of which carries a miter gear pinion 13 on its inner end inside of the casing 12, and another miter gear pinion 14 on its outer end outside of the casing 12. On the outer surface of this casing, adjacent the upper and lower edges, are formed annular grooves constituting raceways to receive a number of bearing balls 16, these bearing balls entering corresponding grooves or raceways formed on the internal surfaces of a pair of rings 18 which surround the casing 12, as shown on Fig. 4. The width of each of these rings is about equal to half the thickness of the casing 12, and each of the

rings 18 has an upper and lower flange 19, which flanges form in effect wide grooves on the outside surfaces of these rings to receive the straps of a pair of band brakes 20; and 21 indicates a pair of annular threaded washers having inwardly-projecting flanges to overlap the upper and lower surfaces of the casing 12 adjacent the outer edges of the same, these threaded washers having screw-threaded engagement with the insides of the upper and lower rings 18, to keep these rings in place on the casing.

Each of the rings 18 carries an integral gear on the inside of the same, the teeth of the gear on the upper ring 18 projecting downward, and the teeth of the gear on the lower ring projecting upward, as shown. These internal gears on the rings 18 are formed by means of inwardly-projecting flanges which extend into annular recesses in the outer surface of the casing 12, in such a position that the teeth on these gears will mesh with the outer miter gear pinions 14; and these gear-forming flanges coöperate with the retaining washers 21 in such a way as to keep each of the rings 18 supported in its proper place by engaging the end surface and the adjacent annular groove in the periphery of the casing, as will be readily understood.

Inside the casing 12 and bolted to a shaft 11′ is a miter gear 22, this miter gear engaging each of the inner pinions 13. A similar miter gear 23 is located inside the casing 12, this miter gear also engaging the pinions 13 on opposite sides, and being loosely mounted on the shaft 11′ for a purpose which will appear later. The miter gear 23 has an integral hub 24 which projects upward and is mounted in a suitable bearing carried by the framework of the car 1. This hub is perforated to permit the shaft 11′ to pass through it; and this shaft carries on its upper end, beyond the hub 24, a gear wheel 25, which is keyed thereon. 26 is a similar gear wheel keyed to the outer end of the hub 24; and this hub also has an annular groove which acts as a raceway for bearing balls 27 carried by means of a sectional ring bearing 28 supported by the framework of the car.

From the above description it will be clear that the gearing shown and described is similar to an ordinary form of differential gearing such as is commonly employed on automobiles, the shaft 11′ being loose in the casing 12, and mounted in alinement with the shaft 11. Motion will be transmitted through the shaft 11 to the gear 22 and gear 25, and to the gear 23 and gear 26; and so long as the brakes 20 are not applied, the gears 22 and 23 will rotate at the same speeds. Should the brakes to the upper or lower ring be applied, one of the gears 25 or 26 will rotate faster than the other one, as will be understood by those skilled in this art. The gear 26 meshes with an external gear 29, and the gear 25 meshes with an internal gear 30. The internal gear 30 is mounted on a hollow shaft 31, which rotates the lower propeller 2; and the external gear 29 is rigid with the main supporting shaft 32, which rotates the upper propeller 3. This shaft 32 is supported in an end bearing 32′ in the car 1; and the hollow shaft 31 surrounds this shaft 32 and is concentric therewith. A controlling wheel 29′ is carried by the car 1; and this controlling wheel is connected to suitable actuating rods 29ª, so that, by turning the wheel to the right or left, one or the other of the band brakes 20 can be applied to the rings 18, as desired.

The numeral 33 indicates a revolving frame to which the lower propeller 2 is fixed; and this frame has a cross-brace 34 midway of its length, carrying a pair of supporting blocks 35. These supporting blocks 35 are fastened to a ring 36 which has grooves on its inner and outer faces, forming raceways for bearing balls 37. The upper balls 37 form a suitable anti-friction bearing for an outside ring 38, which has an inwardly-extending flange resting upon the top of the ring 36; and the lower balls 37 form an anti-friction bearing for an inner ring 39. This inner ring is supported in the ring 36 by means of a flange 36′ extending inward from a suitable annulus which has screw-threaded engagement with the ring 36 from below; and this annulus serves also to retain the lower balls 37 in their places. The lower ring 39 has a pair of projections 40 which are hollow, and in these projections are secured the ends of a suitable shifting lever 41 having an operating handle 42.

The hollow shaft 31 is concentric with the solid shaft 32, as above stated, and it carries on its upper end a hollow head 43, which has ball-bearing engagement shown at 44, with a suitable collar 45, fixed to the shaft 32. The head 43 carries a couple of pivots 46, as shown, these pivots projecting outward at opposite ends of a diameter, and entering bearings in a ring 47. This ring 47 is connected by means of diametrically opposite pivot pins 48, to the ring 36, so that, as the shaft 31 rotates, motion will be transmitted therefrom to the head 43, the ring 47, the rings 36 and the frame 33.

Resting upon the upper surface of the collar 45 is a perforated plate 49, through which the shaft 32 passes. This perforated plate has four radial arms 50 projecting therefrom; and the outer ends of these radial arms have a large opening therein to give passage to supporting rods 51. The lower ends of these supporting rods 51 have balls formed thereon, and these balls are in-

closed by suitable sockets 52, integral with the ring 38. The upper ends of these rods 51 have similar ball and socket connection with a ring 57, this ring 57 having pivotal connection by means of diametrically opposite bolts or pins 56, with an inner ring 54, and this inner ring 54 has pivotal connection by means of similar diametrically opposite bolts 55, with a collar 53, rigidly secured to the shaft 32 at its upper end. The ring 57 is secured to blocks similar to the supporting blocks 35, and these blocks are fastened to a cross-beam 58, which supports a frame 59 for the upper propellers 3. It will be observed that the pivot pins 55 and the pivot pins 56 are spaced ninety degrees apart; and the same is true of the pivots 46 and 48 for the lower frame 33.

In the operation of the device the engine will transmit motion to the gears 25 and 26 and to the shafts 31 and 32. This will rotate the propellers 2 and 3 and lift the car 1 above the ground. The gear 25 being in mesh with the internal gear 30, and the gear 26 in mesh with the external gear 29, the shafts 31 and 32 will rotate in opposite directions. This will rotate the propeller frames 33 and 59 in opposite directions, causing both the propellers to exert a thrust downward, so as to lift the car; and the rotation of one of these propellers will balance the effects of the rotation of the other, so that, as long as the propellers 2 and 3 rotate at the same speed, the car 1 will be held steady and will not swing around the shaft 31 as a pivot. The lower frame 33 will be supported by the collar 45 on the shaft 32 and the hollow head 43 on the upper end of the hollow shaft 31. As the shaft 31 rotates, the head 43 will rotate with it, and motion will be transmitted therefrom to the ring 47, and through the pivots 48 to the ring 36. This ring will carry the frame 33 and the propeller 2 around with it. In the same manner the solid shaft 32 will rotate the ring 54 and the ring 57, causing the upper frame 59 to revolve, but in the opposite direction, as stated above. The upper frame 59 will be supported by means of the rods 51; and as these rods 51 have ball and socket connection with the ring 38, which has a ball-bearing connection with the ring 36, the upper frame, together with the rods 51, will be free to rotate in the manner required. The rings 36 and 38 move around in opposite directions, owing to the ball-bearing connection shown at 37. The adjusting lever frame 41 is so mounted that it can be swung to the front or rear of the car; and since the upper ends of this lever frame are mounted in the sockets 40 on the ring 39, the swinging of the lever frame to the rear will tilt the front edge of the ring 39 forward. As a result, the ring 36 and the frame 33 will be correspondingly tilted, and so will the upper frame 59, owing to the connection between the upper and lower frames by the rods 51. As a result, the planes of revolution of the lower and upper propellers 2 and 3 will be inclined, as shown in dotted lines in Fig. 1. This will cause the two propellers to exert a thrust downward in a slanting direction, and the horizontal component of this thrust will drive the car 1 forward. The propeller 4 can be used to assist the main propellers 2 and 3, if desired, or it can be dispensed with. Swinging the lever frame 41 in the opposite direction will of course stop the car or drive it backward. The propellers 2 and 3 can be likewise tilted in a direction that is transverse or diagonal with respect to the direction of travel of the airship, by swinging the lever frame in a transverse or diagonal direction. These adjustments are permitted by reason of the fact that the ring 39 to which the lever frame 41 is connected, can rotate on account of its ball-bearing connection with the ring 36. Consequently, if the operator grasps the lever frame 41 and causes it to revolve from the position shown in Figs. 1 and 2 to a position ninety degrees removed therefrom, that is to say, if he swings the lever frame 41 until it occupies a position either in front or in the rear of the shaft 31, the ring 39 rotating inside the ring 36, the lever frame can be operated to cause the plane of revolution of the propellers 2 and 3 to be tilted to one side or the other, and the tilting diagonally can be effected when the lever frame occupies positions intermediate with respect to the position which it is shown as occupying in Figs. 1 and 2 and the points named.

So long as the brake bands 20 are not applied, the shaft 11 will transmit motion through the pinions 13 to the miter gear 22, and to the miter gear 23, which is loose on the shaft 11', so as to cause the miter gears 22 and 23 to rotate at the same speed. This will cause the propellers 2 and 3 to rotate at the same speed, and the reaction due to the turning force of each will be equal. In consequence, the car 1 will not swing around the lower end of the shaft 1 as an axis. If it is desired to turn, one of the brake bands 20 must be tightened to retard the corresponding ring 18. Suppose, for example, the shaft 11 rotate in a clockwise direction, that is, from left to right, on Fig. 4, and the lower band 20 be tightened around the lower ring. This would cause each of the pinions 14 to turn in a clockwise direction, viewing them from the outside, and this motion would be transmitted through the inner pinions 13 to the gears 22 and 23. As a result, the gear 26 would rotate faster and the gear 25 slower, and the lower propeller 2 would revolve faster than the upper propeller 3. The car 1 would tend to swing around the lower end of the shaft 1 as an axis in the

direction of rotation of the upper propeller planes 3, in this instance, owing to the reaction due to the unbalanced rotary effect of the lower propellers. The car could be turned to the desired extent and then the brake band could be released. Tightening the other brake band would give the opposite effect and cause the car to swing in the other direction.

By means of the above construction an aviator can ascend at once directly from any point where the machine may be located, and the airship will be under complete control at all times. It can be made to go forward or back, to the right or to the left, almost instantly; and in case the engine should get out of order, so that the propellers planes would no longer revolve, the machine would simply descend as a parachute, easily to the ground, owing to the fact that the blades of the upper and lower propellers are reversely arranged, as above described.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. An airship comprising a car, a pair of upright shafts carried by said car and mounted in bearings which are fixed with respect to the framework of the airship, lifting propellers mounted upon each of said shafts, motor means carried by the car, transmission means for each of said shafts, to rotate the same in opposite directions, means for connecting each of said lifting propellers to one of said shafts to permit said lifting propellers to be tilted in any direction, each of said shafts passing centrally through each of said tiltable-connecting means, and means connected to each of said tiltable-connecting means to control the same.

2. An airship comprising a car, a pair of upright shafts carried by said car and mounted in bearings fixed with relation to the framework of the airship, motor means carried by the car, transmission means for driving each of said shafts from said motor means in opposite directions, a lifting propeller mounted upon each of said shafts, means for connecting each of said propellers to its shaft to permit each of said propellers to be tilted in any direction, said shafts passing through the center of said tiltable-connecting means, means joining said tiltable connecting means together to permit the propellers to be tilted in unison, and means connected to said tiltable means to control the same.

3. An airship comprising a rotating propeller forming supporting means, mounting means for said propeller, a ring secured to said mounting means, a second ring having pivotal connection with the first ring to enable the first ring to be adjusted with respect to the second driving means, means for pivotally securing said second ring to the driving means at points between the points of pivotal connection of said second ring with the first ring, a plurality of supporting rods having pivotal connection at their upper ends with the first-named ring, a ring pivotally connected to the lower ends of said rods, and a tiltable support comprising a pair of rings likewise mounted to be adjustable with respect to each other, the ring connected to the lower ends of said rods being rotatably mounted on said tiltable support, whereby when the support is moved the propeller can be tilted.

4. An airship comprising a pair of supporting propellers, mounting means for each propeller, a member rigidly connected to each of said mounting means, a second member pivotally connected to each of the first members to enable the first members and propellers to be adjusted, means for pivotally connecting each of said second-named members to a driving shaft to rotate said propellers, means for connecting the mounting means for the two propellers rotatably together, and means connected to the mounting means of one of said propellers to control the same to adjust said propellers simultaneously.

5. An airship comprising a propeller forming a supporting means, a hollow shaft for rotating said propeller, a head on the upper end of the hollow shaft, a ball-bearing support for said head, a ring having pivotal connection at diametrically opposite points with said head, a second ring having pivotal connection at diametrically opposite points with the first ring midway between the points of pivotal connection between the said first ring and said head, a framework connected to the second ring to support the propeller, and means for tilting the said propeller to shift the plane of revolution of the propeller.

6. An airship comprising a rotating propeller forming supporting means, a framework forming a base for the blades of said propeller, a shaft for rotating said framework having a head thereon, a ring having pivotal connection with said head at diametrically opposite points, a second ring having pivotal connection with the first ring at diametrically opposite points midway between the connecting points of the first ring with said head, said second-named ring being rigidly connected to said frame, a plurality of supporting rods having pivotal connection at their upper ends with said second-named ring, a ring pivotally connected to the lower ends of said rods, and a tiltable support on which said last-named ring rotates, whereby, when the said propeller is rotated by said shaft, the plane of revolution of said propeller can be tilted.

7. An airship comprising a propeller,

mounting means for said propeller, a ring secured to said mounting means, a second ring having pivotal connection with the first ring at diametrically opposite points, driving means, means for pivotally connecting the second-named ring at diametrically opposite points to the driving means, a plurality of rods having pivotal connection at their ends with the first ring, a ring pivotally connected to the other ends of the rods, and a tiltable support comprising a pair of rings likewise mounted to be adjustable, the ring connected to the other ends of said rods being rotatably mounted on the tiltable support, whereby when the support is moved the propeller can be tilted.

8. An airship comprising a pair of propellers, mounting means for each propeller, a member connected to each of said mounting means, a second member pivotally connected to each of the first members to enable the first members and the propellers to be adjusted, a driving shaft for each of said second members, means for pivotally connecting said second members to said driving shafts, means for connecting the mounting means for the two propellers rotatably together, and means connected to the mounting means of one of said propellers to control said propellers simultaneously.

9. An airship comprising a propeller, a hollow shaft for rotating said propeller, a head on the upper end of said hollow shaft, a ball-bearing support for said head, a ring having pivotal connection at diametrically opposite points with said head, a second ring having pivotal connection at diametrically opposite points with the first ring between the points of connection of the first ring and the head, a framework connected to the second ring to support the propeller, and means for tilting the propeller to shift the plane of revolution of the propeller.

10. An airship comprising a propeller, a framework forming a base for the blades of the propeller, a shaft for rotating the framework having a head thereon, a ring having pivotal connection with the head at diametrically opposite points, a second ring having pivotal connection with the first ring at diametrically opposite points between the points of connection of the first ring with the head, said second-named ring being rigidly connected to the framework, a plurality of rods having pivotal connection at their ends with the second ring, a ring pivotally connected to the other ends of said rods, and a tiltable support on which the last-named ring rotates, whereby when the propeller is rotated, the plane of revolution thereof can be tilted.

11. An airship comprising a car, a pair of shafts carried by said car, lifting propellers mounted on each of said shafts, motor means carried by the car, transmission means for each of said shafts to rotate the same in opposite directions, means for connecting each of said lifting propellers to one of said shafts to permit said lifting propellers to be tilted in any direction, each of said shafts passing centrally through each of said tiltable connecting means, and means connected to each of said tiltable connecting means to control the same.

12. An airship comprising a car, a pair of shafts carried by said car, motor means carried by said car, transmission means for driving each of said shafts from said motor means in opposite directions, a lifting propeller mounted on each of said shafts, means for connecting each of said propellers to its shaft to permit each of said propellers to be tilted in opposite directions, said shafts passing through the center of said tiltable connecting means, means joining said tiltable connecting means together to permit the propellers to be tilted in unison, and means connected to said tiltable means to control the same.

13. An airship comprising a car, an operating shaft rotatably mounted within bearings carried by the car, a ring pivotally secured at diametrically opposite points to said shaft, a second ring pivotally secured at diametrically opposite points to the first ring, said last-named points lying between the first-named points, a propeller secured to said second ring, and means secured to the second ring and extending longitudinally of said shaft for enabling said propeller to be tilted in any direction.

14. An airship comprising a car, an operating shaft rotatably mounted within bearings carried by the car, a ring pivotally secured at diametrically opposite points to said shaft, a second ring pivotally secured at diametrically opposite points to the first ring, said last-named points lying between the first-named points, a propeller secured to said second ring, a plurality of rods connected to the second ring at one end, and means rotatably connected to the other ends of said rods for enabling said propeller to be tilted in any direction.

15. An airship comprising a car, an operating shaft rotatably mounted within bearings which are fixed with respect to the framework of the car, a propeller mounted upon said operating shaft, means connecting said propeller to said shaft for permitting the propeller to be tilted in any direction, said shaft passing through the center of said tiltable connecting means, and means connected to said tilting means to move the same in any direction to tilt the propeller.

16. An airship comprising a car, an upright rotatable shaft carried by said car, and mounted in bearings which are fixed with respect to the framework of said airship,

a lifting propeller mounted upon said shaft, means for connecting said propeller to said shaft adapted to permit the propeller to be tilted in any direction, said shaft passing through the center of said tiltable connecting means, and means connected to the tiltable connecting means to move the same in any direction to tilt said propeller.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN N. HIGHLAND.

Witnesses:
GEO. D. MASON,
ALBERT C. MCDONALD.