

June 27, 1933.

J. W. HESS

1,915,855

AIRSHIP

Filed May 11, 1931

3 Sheets-Sheet 1

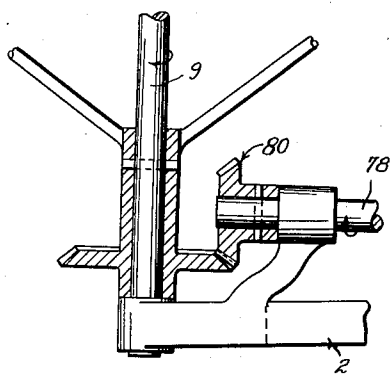
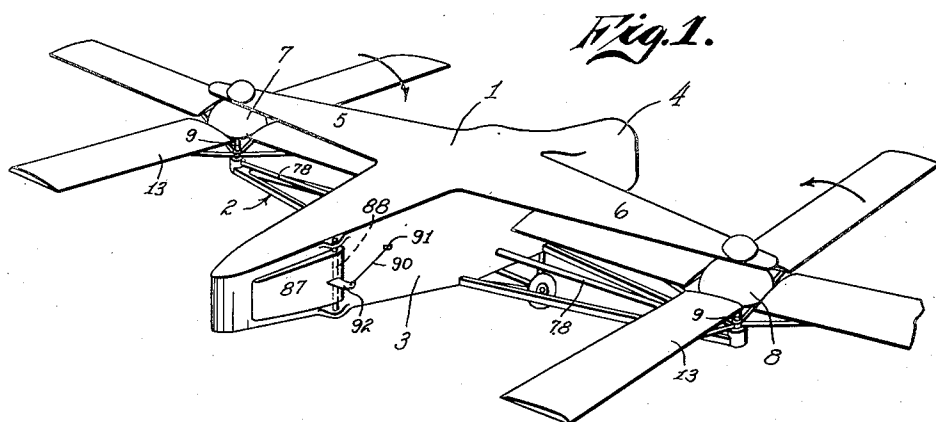


Fig. 8.

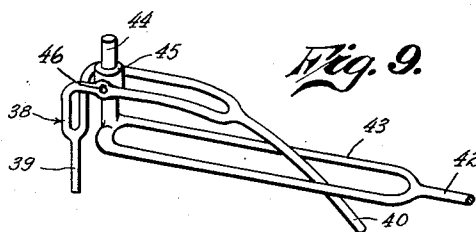


Fig. 9.

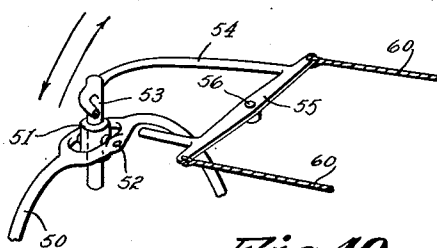


Fig. 10.

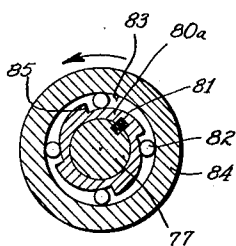


Fig. 11.

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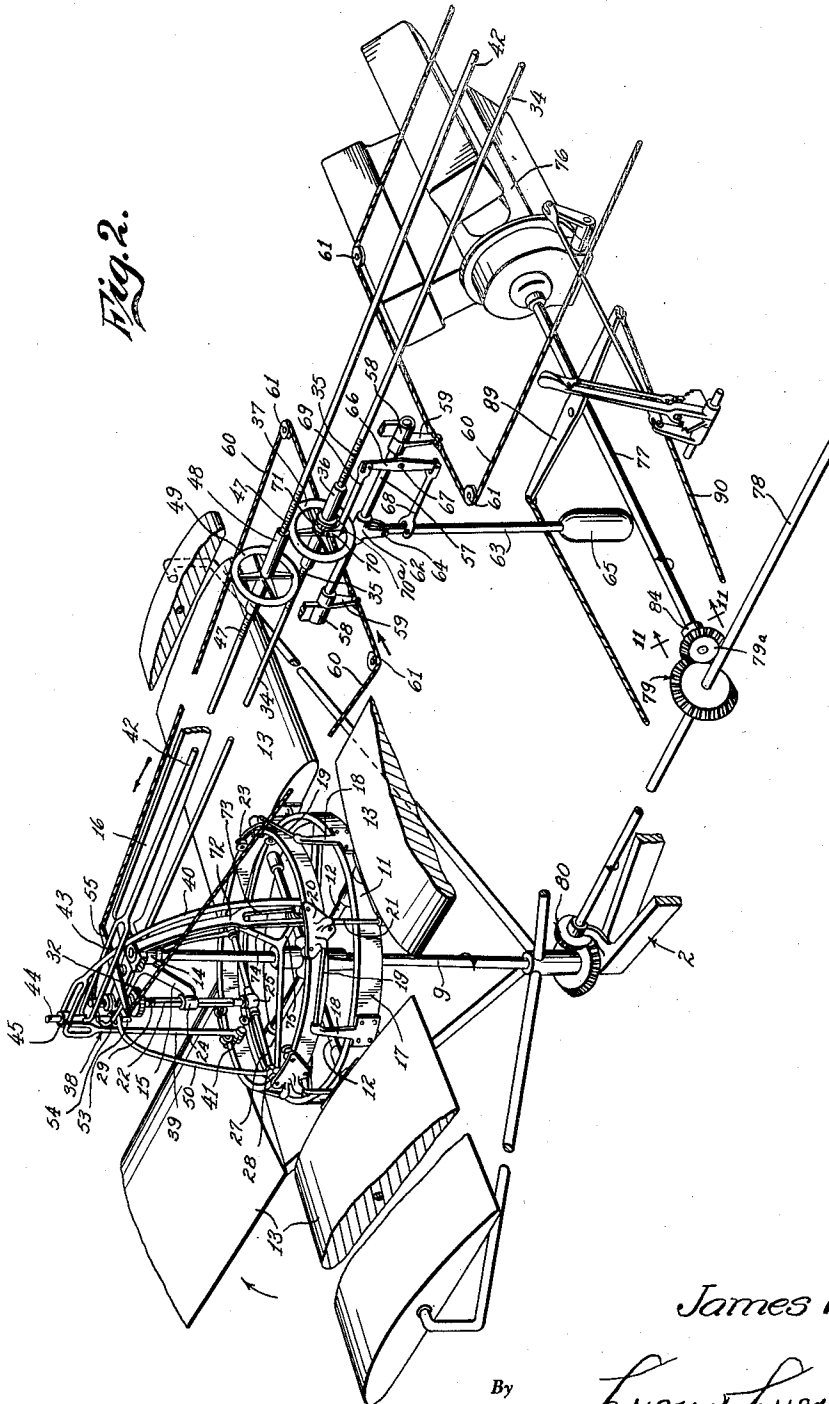
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3 Sheets-Sheet 2



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AIRSHIP

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3 Sheets-Sheet 3

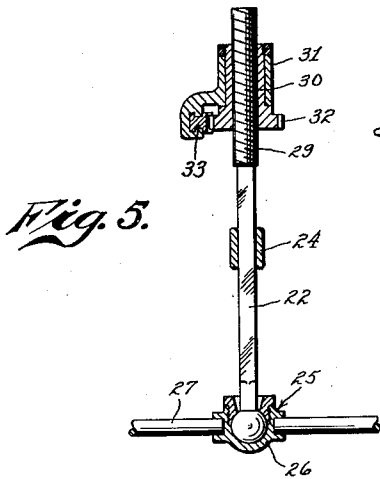


Fig. 5.

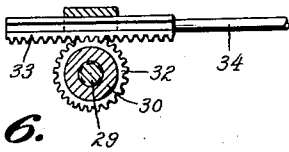


Fig. 6.

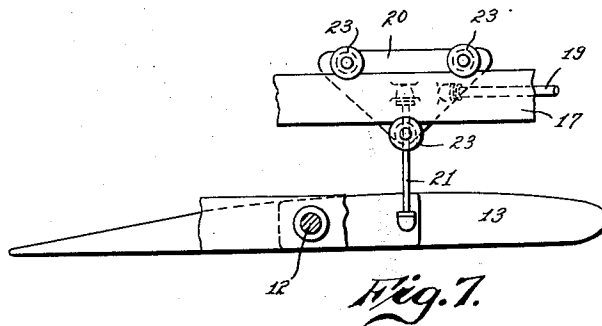


Fig. 7.

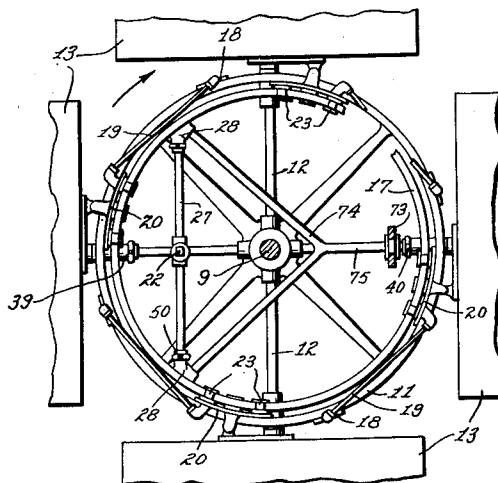


Fig. 4.

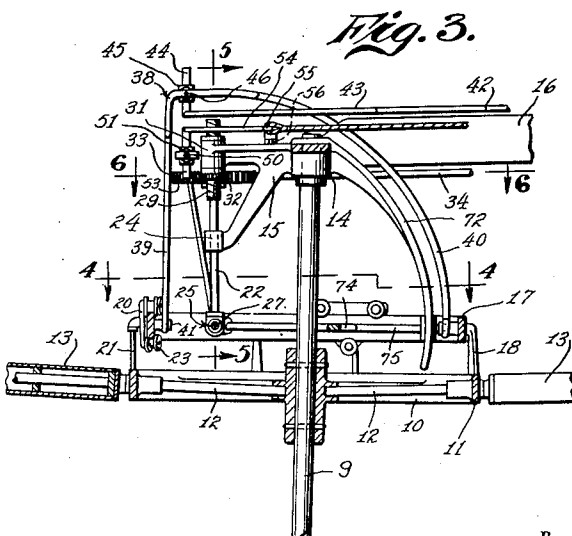


Fig. 3.

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UNITED STATES PATENT OFFICE

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AIRSHIP

Application filed May 11, 1931. Serial No. 536,451.

This invention relates to an airship, and, particularly, to the propelling mechanism for the same as applied to an airship of a rotary wing type having some of the characteristics of the helicopter. In its general construction, the airship to which I have applied my invention comprises two rotors disposed on opposite sides of the central fore-and-aft axis of the ship, and these rotors are mounted for rotation on a substantially vertical axis. A plurality of blades, or wings, are carried on each rotor, and these wings are preferably so located that a certain wing of one rotor is constantly in the same phase as the corresponding wing of the opposite rotor, and the rotors are driven in synchronism.

The general object of the invention is to provide an airship of this type with improved means for controlling the angle of incidence of the wings; also to provide a system of control for the wings operating in such a way that there is a correlated adjustment of the angles of incidence of the wings so as to obtain a substantial balance of the forces developed by the wings in their rotation, including the lifting effect of the wings and the driving forces that impel the airship forward.

A further object of the invention is to provide stabilizing mechanism for automatically maintaining the airship on an even keel as it progresses through the air, and controlling the wings in such a way that if the nose of the airship tends to dip too far in normal flight, an immediate automatic adjustment of the angle of incidence of the wings will take place, operating to raise the nose of the ship, and vice versa.

A further object of the invention is to provide means for automatically stabilizing the ship in a transverse direction, operating to control the angle of incidence of the blades in a correlated way so that if one side of the ship tends to become depressed, the wings of the airship are automatically adjusted as to their angle of incidence so as to raise the depressed side of the ship.

In the operation of the rotors, as the wings pass aft in their travel, their angle of incidence is controlled so as to develop a propel-

ling and lifting force on the airship; as the wings come forward their angle of incidence is decreased so as to reduce their resistance to the air.

A further object of the invention is to provide a construction for an airship which will be capable of developing a relatively high lift power, or a relatively high lifting force as may be desired by the aviator, and which will be capable of progressing through the air at a relatively low speed, when desired, and also capable of lighting and taking off at a relatively low speed.

A further object of the invention is to provide means whereby the airship can volplane to the ground with the wings rotating at a relatively higher velocity than corresponds to the motor, thereby enabling the rotors to rotate freely at a high speed independently of the motor and without necessitating the use of a regular clutch, which would have to be manually opened at such a time.

A further object of the invention is to provide a gravity controlled stabilizing device cooperating with the wings of the rotors to stabilize the airship in its flight by controlling the angle of incidence of the wings of the rotors.

Further objects of the invention will appear hereinafter.

The invention consists of novel parts and combinations of parts to be described hereinafter, all of which contribute to produce an efficient airship.

A preferred embodiment of the invention is described in the following specification, while the broad scope of the invention is pointed out in the appended claims.

In the drawings—

Figure 1 is a perspective of an airship embodying my invention, a portion of one of the wings being broken away;

Figure 2 is a perspective of a diagrammatic nature illustrating parts of the frame, and, particularly, illustrating the general arrangement of the airship and the rotors, with parts being broken away;

Figure 3 is a vertical section through the left rotor of the airship and looking in a

forward direction, certain parts being broken away;

Figure 4 is a horizontal plan section taken about on the line 4, 4 of Figure 3, the outer portion of the wings being broken away;

Figure 5 is a vertical section taken about on the line 5, 5 of Figure 3, and further illustrating the means for supporting and adjusting the controller rings that control the angle of incidence of the wings;

Figure 6 is a horizontal section taken about on the line 6, 6 of Figure 3, and further illustrating details of the supporting and adjusting means for supporting the controller rings;

Figure 7 is a detailed elevation in partial section, further illustrating the means for connecting the controller rings to the wings for regulating their angle of incidence;

Figure 8 is a vertical section in detail taken at the lower end of the driving shaft of one of the rotors and illustrating the driving means for the same, certain parts being broken away;

Figure 9 is a perspective showing the details of a control connection to the left controller ring for shifting its plane to elevate, or depress, its inboard edge, and correspondingly depress, or elevate, its outboard edge;

Figure 10 is a perspective illustrating the details of a controller connection for depressing, or elevating, the forward, or after, edges of the controller ring;

Figure 11 is a section taken about on the line 11, 11 of Figure 2, and, particularly, illustrating a driving connection which I employ for enabling the rotors at times to rotate at a faster speed than that corresponding to the rotation of the shaft of the motor.

Before proceeding to a detailed description of the invention, it should be stated that, in its general construction, I prefer to employ two oppositely disposed rotors located at equal distances from the central plane, or axis, of the airship. These rotors carry wings, each of which is movable for adjustment on its own corresponding, or individual, substantially horizontal axis. The rotors have the same number of wings, and the rotors are driven in synchronism so that the wings of one rotor are always in the same phase as the wings of the other, though in a reversed relation.

Corresponding to each rotor, I provide a controller ring which is mounted so that it is capable of being tilted into different planes, and each ring is connected with its corresponding wings so that the ring controls the angle of incidence of the wings throughout the entire 360° of their travel as they pass around the axis of the rotor. The construction is such that in normal flight, the angle of incidence of any wing of one rotor is the same as the corresponding wing of the opposite rotor, thereby insuring a normal balance

of the ship in flight. These angles of incidence are subject to automatic control through a stabilizer device to sustain the ship on a substantial even keel, and overcome any tendency to list to the right or left. These controls, however, are always subject to the manual control of the aviator so that manual control can be substituted at any instant for the automatic equilibrating controls.

Referring more particularly to the parts, and especially to Figures 1 and 2, 1 indicates the body of the ship that is mounted on a suitable frame 2. This body includes a fuselage 3, which may have a forwardly projecting nose, or head, 4, and comprises two laterally disposed arms 5 and 6, which are suitably trussed by the frame 2, and which support rotors 7 and 8.

Referring particularly to Figures 2 and 3, each of these rotors is preferably mounted on a central shaft 9, which, as indicated in Figure 3, is preferably not exactly vertical, but mounted so that its upper portion inclines toward the central plane of the airship. Each rotor comprises a wheel 10, including a hub secured to the rotary shaft and a concentric rim 11 connected to the hub by spokes 12 (see Figure 3), which are extended through the wings 13 of the rotor and constitute supporting shafts corresponding to each wing (see Figure 7). In this way, each wing has its own individual axis of rotation for adjustment on the extended spoke 12, and, furthermore, this axis of rotation for each wing is preferably located about on a line with the middle transverse axis of the wing, thereby substantially balancing the pressure forces on the under side of the wing as it moves through the air.

The upper end of each rotor shaft 9 is mounted in a bearing 14 carried in a bracket 15 that is attached to the upper truss 16 of the airship frame; from each bracket 15, a controller ring 17 is supported; each controller ring is supported from the bracket in such a way that it can be raised to change its elevation with respect to the wings 13.

Before describing this means, however, I shall describe the connections between the controller rings 17, and the wings 13 for regulating the angle of incidence of the wings as they travel around the axis of the rotor. Each controller ring, is, of course, substantially concentric with its corresponding rotor, and on the ring, means is provided that connects with the wings to tilt them up or down on their individual shafts 12. For this purpose, I provide each rotor with a plurality of brackets 18, which are connected by draw bars 19 respectively with small trolleys, or carriages, 20, that run on the ring, each trolley 20 being connected by an upright link 21 with the forward portion of a corresponding wing 13 (see Figure 2). The ends of the draw bars 19 are connected by flexible joints

(of the type illustrated at the bottom of Figure 5) to the brackets 18, and the carriages 20. The carriages 20 may have guide rollers 23 running on the upper and lower edges of the controller ring. With this construction, it will be evident that by altering the plane of the controller ring, the angle of incidence of the wings can be controlled throughout their complete revolution around the axis of the rotor. Means is provided for controlling the plane of the controller rings.

Referring again to Figures 2 and 3, each bracket 15 is provided with a hanger 22, which is preferably in the form of a slide bar guided to slide through a guide bearing 24 at the lower end of the bracket. The lower end of this slide bar is connected to the controller ring by a joint 25, which is preferably a universal, or ball and socket, joint (see Figure 5). The casing 26 for this joint is formed as a connection for a divided cross-bar 27, which extends as a chord across the ring, its ends being secured in the ring in suitable bosses 28 formed on the inner face of the ring (see Figure 4). Raising this bar 27, will, therefore, raise the entire ring, and vice versa. Suitable mechanism is associated with this hanger bar to raise it or lower it at the will of an aviator, and the construction is such that, if desired, one of the hanger bars 22 can be raised at one side of the airship while the other one is correspondingly depressed. Such movement would be effective for stabilizing purposes. For this purpose, the upper end of each hanger bar 22 is provided with a high pitch thread 29, which carries a nut 30 swiveled in a bearing 31 supported on the frame. This nut is formed at its lower end into a pinion 32, the teeth of which mesh with a rack 33 guided in the lower end of bearing 31. The thread 29 on one of these hanger bars 22 is of an opposite character from the corresponding thread 29 on the opposite hanger bar 22.

Each rack 33 is connected at its end to an operating rod 34, and these rods 34 extend to a point near the central part of the ship where they carry threads 35 of opposite character receiving a turn buckle 36, said turn buckle having a handle in the form of a wheel 37, which can be seized by the aviator and pushed to the right or to the left to shift the rods 34 toward either side of the ship. Such a shifting movement will cause rotation of the nuts 30, which will cause one of the draw bars 22 to rise and the other to descend. These hanger bars 22 are held non-rotatably in the guides 24.

With this construction, it will be evident that by leaving wheel 37 in its normal position, but by rotating it in one direction, or the other, the hanger bars 22 can be simultaneously raised, or simultaneously lowered, equal amounts.

The airship is also provided with means

for elevating, or lowering, the inboard sides of the controller rings 11 to tilt the plane of the rings, thereby raising the forward edges of the wings 13 as they pass in a rearward direction near the central fore-and-aft axis of the airship. In this connection, it should be understood that the left-hand rotor rotates in a clockwise direction, while the right-hand rotor rotates in an anti-clockwise direction (see the arrow in Figure 2). For this purpose, each ring is provided with a bail 38, which preferably has a substantially vertical arm 39 on its outboard side, and a curved arm 40 toward its inboard side. The lower ends of these arms 39 and 40 are attached to the inner sides of the controller ring, as indicated at 41 (see Figure 2). In order to produce a slight outward movement of the rings on their bars 27, I provide two push rods, or links, 42, each rod 42 being provided with a bifurcated head 43 provided with a slot in its end to clear the corresponding curved arm 40 of the bail 38. The end of this bifurcated head 43 carries an upwardly extending shank 44 that slides freely through a bearing ring 45, said bearing ring being mounted in the upper end of the curved arm 40 so as to rock on a horizontal pin 46, (see Figure 9). In order to receive this rocking ring 45, the upper end of the curved arm 40 is bifurcated as shown. With this construction, it will be evident that if either of the bars 42 is shifted in an outward direction, its corresponding controller ring 11 will be tilted upwardly at its inboard side, and slightly downwardly at its outboard side. In this connection, it should be noted that the bar 27 of each rotor is located on the outboard side of the ring and at a considerable distance from the axis of rotation of the rotor. This gives increased movement for the inboard edge of the controller ring and reduced movement for the outboard edge.

The bars 42 are connected by a construction similar to the turn buckle 36 already described, that is to say, each bar 42 extends over to a point near the center line of the airship where it is provided with threads 47 and the threads of one bar are of an opposite character to those of the other bar. These threads 47 are connected by a turn buckle 48 formed as the hub of a wheel 49.

This wheel operates as means for shifting the bars 42 simultaneously in either direction, for by rotating the hand wheel 49, the bars 42 can be drawn toward each other, or moved further apart, at their inner ends, which will have the effect of giving the controller rings an equal adjustment of the same character, raising or lowering the inboard edge of the controller rings as may be desired.

In order to enable the controller rings to be tilted up or down at their forward edges,

or aft edges, I provide each controller ring with a bail 50, the ends of which may be attached at the ends of the bar 27. The upper end of this bail is bifurcated (see Figure 10) to receive a rocking bearing 51, said bearing being mounted to rock on a horizontal pin 52. Through this bearing 51, a shank 53 extends downwardly from the outer end of a rocker 54, said rocker having a cross-bar 55 formed at its inner end and mounted for slight swinging movements on a rocking pin 56.

When the rocker 54 is swung forwardly at its outer end, the shank 53 would, of course, rock the bail 50 in a corresponding direction, thereby depressing the forward side of the controller ring and elevating the rear side. The cross-heads 55 are connected for complementary movement and are preferably connected with a stabilizer device controlled by gravity, which also connects up with the rods 34 already described. For this purpose, I provide a stabilizer device that is capable of swinging on a transverse axis of the airship, and also on an axis extending longitudinally with the fore-and-aft axis, and I utilize the relative movements of the stabilizer plumb-bob, or similar means, for effecting automatic adjustments in the controller rings. The stabilizer which I have illustrated comprises a transverse substantially horizontal shaft 57 mounted at its ends to rock in fixed bearings 58. This rocking shaft has two downwardly extending rigid arms 59 which connect to cords 60 that extend from it in different directions, and pass around guide pulleys 61 so that their outer ends can be attached to the ends of the cross-head 55. This construction, like the others described, is duplicated at both sides of the airship. Near the middle point of the bar 57, there is provided a rigidly attached sleeve 62 and on this sleeve a pendulum 63 is mounted to swing on a pin 64, the axis of which extends in a fore-and-aft direction. The lower end of the pendulum carries a plumb-bob 65.

With this arrangement, it will be evident that if the airship becomes depressed at its forward end, the pendulum 63 will swing relatively in a forward direction and this will move the cords 61 in the direction of the arrow (as indicated in Figure 2), thereby pulling in the rear cords and paying out the forward cords. This will produce an upward adjustment of the forward ends of the controller rings and a corresponding depression of their rear sides. This adjustment movement takes place on the universal joints, or ball and socket joints, 25, which support the bars 27 on the hanger bars 22. An opposite movement of the arms 59, will, of course, produce an opposite tilting effect at the controller rings. This gives a fore-and-aft stabilizing effect by reason of the fact that the raising of the forward sides of the

controller rings will increase the angle of incidence of the wings that are passing across the forward side of the airship, and this will increase their lifting power. I utilize the lateral swinging movements of the pendulum to shift the rods 34. For this purpose, on the rock bar 57, I mount a lever 66 on a horizontal pivot pin 67 so that this lever can swing in a transverse plane. The lower end of this lever is connected by a link 68 to the pendulum 63 and the upper end is attached by a link 69 to a yoke 70 that hangs on a grooved collar 71 near the hub of the wheel 37 already described. The yoke 70 is connected to the link 69 by a vertical pivot pin 70a. By reason of this lever 66 and its connections, it will be evident that if the airship becomes greatly depressed at its right or starboard side, the pendulum 63 will swing relatively toward the right, and this will shift the rods 34 toward the left. This will rotate the nuts 30 in a direction to depress the hanger bar 22 at the left or port side of the airship and will raise the outboard side of the starboard controller ring which will have the effect of increasing the angle of incidence of the wings as they pass forwardly at the right side of the ship, thereby increasing the lift on this side.

In order to guide the inboard sides of the controller rings as they are raised and lowered, the bracket 15 is provided with a long curved guide 72. This guide is bifurcated at its lower end so as to form a long guide slot 73 and each controller ring is provided with a Y-shaped brace 74, the shank 75 of which passes through this slot 73. This guide, therefore, keeps the inboard edges of the controller rings from moving in a fore-and-aft direction, and also permits the front or rear sides of the rings to be tilted up or down when the rings are being adjusted, or controlled, by the bails 50.

The airship may be driven by any suitable motor but preferably by a motor 76 mounted on the central axis of the airship (see Figure 2) so that the motor shaft 77 extends rearwardly so as to drive a cross-shaft 78 through bevel gears 79, the ends of the cross-shaft being provided with bevel gears 80 that drive the shafts 9 of the rotors. These gears should be proportioned so that the rotors will be driven at about one tenth the revolutions per minute of the engine, assuming an engine speed of about 12 or 14 hundred revolutions per minute.

At some point in the drive shaft 77, I provide a one-way drive connection, such as indicated in Figures 11 and 1, and, if desired, this one-way drive connection can be incorporated in the hub of the pinion 79a that forms part of the bevel gears 79. This construction may include a sleeve 80a rigidly mounted on the drive shaft 77, and having a plurality of cam faces 81 that cooperate with balls, or rollers,

82, so as to jam them against the inner face of a cylindrical chamber 83 formed within the hub 84 of the pinion 79a. A drive connection, constructed as described, will enable the engine to drive the rotors in a forward direction, but if the rotors should be rotated at a higher speed than the engine can drive them, then they will rotate freely because the balls, or rollers, will move up against the shoulders 85 at which point they will not be jammed in the chamber 83. This attains a "free wheeling" effect for the rotors, which is useful when the airship descends; the air stream that passes upwardly as the airship descends will cause rotation of the rotors in a forward direction. In order to permit this, of course it is necessary for the aviator to set the controller rings so that both the controller rings are in the same relation to the wings which they control. By setting the controller rings so that the forward edge of each wing (with respect to their rotation by the rotor) is depressed, the air stream will cause the rotors to rotate in a forward direction. This will, of course, develop a considerable resistance to the dropping of the airship through the air.

In order to steer the ship in a horizontal direction, I prefer to provide the tail of the fuselage with a rudder, or vane, 87, located on each side and normally lying close against the side of the ship. Each of these rudders has its own pivot pin 88 (see Figure 1), which is located in a substantially vertical plane, and the rudders can be controlled by a double steering lever 89 within the fuselage, each arm being connected by a steering cord 90 to its corresponding rudder. These cords can pass out through guide openings 91 in the side of the fuselage, and connect to an arm 92 on the side of the rudder. If desired, a light spring may be used on the inner side of each rudder to hold it normally against the side of the fuselage.

The general mode of operation of the airship will now be briefly described:

The two rotors rotate in opposite direction from each other, the left-hand rotor being rotated in a clock-wise direction, and the right-hand rotor in an anti-clockwise direction. The wings of the rotors are in the same phase and the rotors are driven in synchronism so that when any wing is passing rearwardly near the central fore-and-aft axis of the ship, a corresponding wing on the other side of the fore-and-aft axis is also passing rearwardly.

The wings that pass rearwardly near the center line of the ship produce most of the propelling effect and most of the lifting effect. At this point, the wings have the greatest angle of incidence and for this reason have the greatest lifting and propelling effect. As the wings pass outwardly toward the rear side of the ship, their angle of incidence de-

creases and they have a very small angle of incidence or none at all as they move forwardly at the outboard sides of the rotors. By rotating hand wheel 49 in one direction, the outboard sides of the controller rings 11 can be raised, and this will increase the angle of incidence of the wings as they come forwardly on the outboard side; an opposite rotation of the wheel 49 will produce an opposite effect. By rotating the wheel 37, the controller rings can be raised or lowered simultaneously, thereby increasing, or decreasing, the angle of incidence of all of the wings of the ship simultaneously. By swinging the pendulum 63 forward or back, the cross-heads 55 (see Figure 10) can be rocked in either direction. If rocked in the direction to carry the shank 53 forwardly, the forward sides of the controller rings will be depressed, thereby reducing the angle of incidence of the wings as they pass across the ship at the forward side. If the shank 53 is moved rearwardly, the angle of incidence of the wings on the forward side of the ship will be increased and the elevation of the rings at the rear side will be decreased, thereby reducing the angle of incidence of the wings on the aft sides of the rotors. By swinging relatively forward, or back, the plumb-bob will make similar adjustments automatically.

The plumb-bob 65 also automatically controls the shifting of the rods 34 by swinging relatively laterally to raise or lower the controller rings at their points of support on the hanger bars 32. The plumb-bob may be moved by hand toward either side for the same purpose.

By reason of the one-way drive connection in the drive shaft 77, it is possible for the engine to idle while the ship is in the air and this will cause the ship to descend; such descent, however, would be regulated by the resistance of the rotors which will be rotated by the relative upward air stream caused by the descent of the ship. By reason of the one-way drive, the engine does not operate as a drag on the rotors. In other words, the rotors rotate with a free wheeling effect. The upper ends of the shafts are inclined inwardly so as to increase the general stability of the ship.

It is understood that the embodiment of the invention described herein is only one of the many embodiments this invention may take, and I do not wish to be limited in the practice of the invention, to the particular embodiment set forth.

What I claim is:

1. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly

adjacent the central fore-and-aft axis of the ship, means for adjusting all the wings on their axes to regulate the angle of incidence of all of the wings simultaneously, and means
 5 for controlling the angle of incidence in a complementary manner of the wings on opposite sides of the ship as they pass forwardly remote from the fore-and-aft axis of the ship so that when the angle of incidence of
 10 a wing passing forwardly on one side of the ship is increased, the angle of incidence of the corresponding wing on the other side of the ship will be decreased.

2. In an airship, the combination of a
 15 frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the
 20 rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, means for adjusting all the wings on their axes to regulate the angle of incidence of all of the wings simultaneously, and means
 25 for controlling the angle of incidence in a complementary manner of the wings on opposite sides of the ship as they pass rearwardly adjacent to the fore-and-aft axis of the ship, so that when the angle of incidence of a wing
 30 passing rearwardly on one side of the ship is increased, the angle of incidence of the corresponding wing on the other side of the ship will be decreased.

3. In an airship, the combination of a
 35 frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating
 40 the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each rotor, means for supporting said ring for adjustment on a substantially horizontal fore-
 45 and-aft axis, means running on said ring and connected with the wings respectively for tilting the same on their axes, and means for controlling the position of the ring to control the angle of incidence of the wings.

4. In an airship, the combination of a
 50 frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the
 55 rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each rotor and mounted so that it is capable of tilting on a front and rear axis and on a transverse axis, means running on the ring and connected with the wings respectively for
 60 tilting the same on their axes, and means for regulating the position of the controller ring.

5. In an airship, the combination of a

frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the
 70 rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring concentric with each rotor, means corresponding to each wing, running on the controller ring and connected
 75 with the corresponding wing to tilt the same on its axis, means for supporting said controller ring enabling the same to tilt in different directions, and means for controlling the tilt of the controller ring to regulate
 80 the angle of incidence of the wings.

6. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the
 85 rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each rotor, and mounted substantially concentric therewith, a carriage corresponding to
 90 each wing and running on the controller ring, means connecting each carriage with each wing for tilting the wings on their axes to vary the angle of incidence, means for supporting the controller ring to enable the same to tilt in different directions, and means connected with the ring for tilting the same in
 95 different directions to control the angle of incidence of the wings.

7. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the
 105 rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each rotor, and mounted substantially concentric therewith, means for supporting each controller ring for adjustment on a substantially horizontal front and rear axis, a carriage corresponding to each wing and guided on the
 110 controller ring, means connecting each carriage with its corresponding wing for adjusting the angle of incidence of the wing, means for supporting each ring to enable the same to be adjusted downwardly or upwardly at the front and rear of the ring, and means for controlling the tilting of the ring at its front and rear.

8. In an airship, the combination of a
 115 frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the
 120 rotors so that the wings pass rearwardly ad-

jacent the central fore-and-aft axis of the ship, a controller ring concentric with each rotor, means corresponding to each wing, running on the controller ring and connected with the corresponding wing to tilt the same on its axis, means for supporting said controller ring enabling the same to tilt in different directions, and automatic means connecting the two controller rings and operating when the ship is depressed at one side, to increase the angle of incidence of the wings as they pass rearwardly on that side to raise the depressed side of the ship.

9. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes to change the angle of incidence of the wings, means for rotating each rotor about a substantially vertical axis, a controller ring corresponding to each rotor and mounted substantially concentric therewith, means corresponding to each wing and mounted on its corresponding controller ring for tilting each wing on its own axis to change the angle of incidence of the wing, means for supporting each controller ring, and enabling the ring to be tilted into different positions, and automatic means operating when the ship is depressed on one side, for tilting the controller rings to increase the angle of incidence of the wings on the depressed side of the ship, and thereby to raise the depressed side.

10. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each rotor and mounted substantially concentric therewith, means supporting each controller ring for adjustment enabling the side of the ring toward the fore-and-aft axis of the ship to be raised or lowered, and enabling the fore or aft sides of the ring to be depressed or raised, means corresponding to each wing running on the ring and connected with each wing for tilting each wing on its own axis to adjust its angle of incidence, and means for controlling the position of the controller rings to control the angle of incidence of the wings.

11. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the

ship, a controller ring corresponding to each rotor, means for mounting the same to enable the controller ring to be tilted, means corresponding to each wing and running on its corresponding controller ring and connected with each wing for tilting each wing on its own axis to regulate its angle of incidence, and automatic means connected with the controller rings for increasing the angle of incidence of the wings at the forward side of the ship when the forward side of the ship becomes depressed.

12. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each rotor, means for mounting the same to enable the controller ring to be tilted, means corresponding to each wing and running on its corresponding controller ring and connected with each wing for tilting each wing on its own axis to regulate its angle of incidence, and automatic means connected with the controller rings for decreasing the angle of incidence of the wings at the aft side of the ship when the forward side of the ship becomes depressed.

13. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each rotor, means for mounting the same to enable the controller ring to be tilted, means corresponding to each wing and running on its corresponding controller ring and connected with each wing for tilting each wing on its own axis to regulate its angle of incidence, and automatic means connected with the controller ring for increasing the angle of incidence of the wings at the forward side of the ship and decreasing the angle of incidence of the wings at the aft side of the ship when the forward side of the ship becomes depressed.

14. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each rotor and mounted substantially concentric therewith, means for supporting each con-

troller ring for movement on a front-and-rear axis located on the outboard side of the axis of rotation of its corresponding rotor, means corresponding to each wing running on the
 5 controller rings and connected with the corresponding wings for regulating the angle of incidence of the wings, and means for holding the controller rings in different positions
 10 on their axes to change the angle of incidence of the wings.

15 15. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor
 16 for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each
 20 rotor and mounted substantially concentric therewith, means for supporting each controller ring for movement on a front-and-rear axis located on the outboard side of the axis of rotation of its corresponding rotor,
 25 means corresponding to each wing running on the controller rings and connected with the corresponding wings for regulating the angle of incidence of the wings, means for holding the controller rings in different positions
 30 on their axes to change the angle of incidence of the wings, and means for raising or lowering the forward and aft sides of the controller rings to change the angle of incidence of the wings as they pass away
 35 from, or toward, the fore-and-aft axis of the ship.

40 16. In an airship, the combination of a frame, a pair of rotors located on opposite sides of fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a
 45 controller ring corresponding to each rotor and substantially concentric with the same, a bar corresponding to each ring and extending as a chord across the same in a fore-and-aft direction on the outboard side of the axis of the rotor, a bracket corresponding to each
 50 controller ring and carried on the frame, a universal joint supported on each bracket and supporting the corresponding rock bar, means corresponding to each wing and running on the controller rings with means connecting the same with a corresponding wing
 55 to regulate the angle of incidence of each wing, and means for supporting the inboard side of each ring and for depressing or raising the same to change the angle of incidence of the wings.

60 17. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a
 65 plurality of wings supported on each rotor for

adjustment about correspondingly substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each rotor
 70 and substantially concentric with the same, a bar corresponding to each ring and extending as a chord across the same in a fore-and-aft direction on the outboard side of the axis of the rotor, a bracket corresponding to each
 75 controller ring and carried on the frame, a universal joint supported on each bracket and supporting the corresponding rock bar, means corresponding to each wing and running on the controller rings with means connecting the same with a corresponding wing
 80 to regulate the angle of incidence of each wing, means for supporting the inboard side of each ring and for depressing or raising the same to change the angle of incidence of the wings, and means connected with the rings for adjusting the same on the universal joints to depress or raise the forward and
 85 after portions of the said rings, to change the angle of incidence of the wings as they pass along the forward and after portions of the rings.

90 18. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a
 95 plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each rotor and mounted substantially concentric therewith, means for supporting each controller ring on the frame so that its forward and after portions can be depressed or raised and so that the inboard or outboard sides of the ring can be depressed or raised, means corresponding to each wing running on the controller rings and connected with the wings for moving
 100 each wing on its own axis to change the angle of incidence of each wing, a gravity controlled device, and means connecting the same with the rings operating to depress or raise the inboard or outboard sides of the rings when the starboard or port side of the airship is depressed and operating to raise or lower the forward or aft sides of the rings when the forward end of the ship is depressed or raised.

105 19. In an airship, the combination of a frame, a pair of rotors located, one on each side of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors, controlling means associated with each rotor for controlling the angle of incidence of its wings, and a common gravity controlled equilibrating device for both ro-
 110

tors connected with the said last-named means and operating to increase the angle of incidence of the wings of each rotor as they pass on the forward side of the ship when the forward side of the ship has become depressed, and operating to increase angle of incidence of the wings of each rotor as they pass on the starboard side of the axis of the rotor after the starboard side of the ship has become depressed.

20. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors, controlling means associated with each rotor for controlling the angle of incidence of its wings, a plumb-bob mounted for rotation on a substantially horizontal transverse axis and on a substantially horizontal fore-and-aft axis, means for imparting the relative movements of the plumb-bob in a fore-and-aft direction to the said controlling means, and means for imparting the relative movements of the plumb-bob in a transverse direction to the said controlling means, to regulate the angle of incidence of the wings.

21. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors, controlling means associated with each rotor for controlling the angle of incidence of its wings, a transverse shaft mounted for rotation on its axis, a plumb-bob, with means for connecting the same to the shaft, enabling the plumb-bob to swing transversely of the ship, means connected with the shaft for imparting relative movements of the plumb-bob in a fore-and-aft direction, to the controlling means, and means connected with the plumb-bob for imparting its transverse movements to the said controlling means; for controlling the angle of incidence of the wings.

22. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, a controller ring corresponding to each rotor and substantially concentric therewith, means for supporting each controller ring to enable the same to be rocked for adjustment on a transverse axis and on a front and rear axis, means connecting each ring with its corresponding wings for regulating the angle of incidence of the same, a plumb-bob, means for supporting the same so that it is capable of swinging in a relative fore-and-aft direction

and in a transverse direction, means for imparting the relative movements of the plumb-bob in a fore-and-aft direction to the controller rings, and means for imparting the transverse movements of the plumb-bob to the said rings.

23. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each rotor and mounted substantially concentric therewith, a bracket supported on the frame, means mounted on the bracket for supporting each ring, means running on the rings and connected with the wings for regulating their angle of incidence, a control rod corresponding to each rotor and extending laterally to the same from the central portion of the ship, and means associated with each bracket so that a shifting of the control rods effects a movement in the controller ring to change the angle of incidence of the wings.

24. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each rotor, means running on the ring for regulating the angle of incidence of the wings, means for supporting each ring so that it is capable of being tilted to vary the angle of incidence of the wings at different points in their travel, control members corresponding to each rotor, with means connecting the same with each ring for controlling the ring, said control members extending to a point near the central axis of the airship, the adjacent ends of said control members having oppositely disposed threads, and a turn-buckle mounted on said threads and having means for grasping the same to shift the said control members simultaneously, the opposite threads of said control members enabling the rotation of the turn-buckle to impart equal adjustments to the said rings.

25. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a bracket corresponding to each rotor and carried by the frame, a hanger guided

to slide substantially vertically in each bracket, a controller ring corresponding to each rotor, means for supporting each ring on its corresponding hanger, means running on the controller rings and connected with the wings for regulating their angle of incidence, a rod corresponding to each hanger and extending inwardly to a point near the central axis of the ship, and means associated with the outer end of each rod for raising and lowering the hanger and thereby altering the relative position of the controller ring with respect to the wings.

26. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a bracket corresponding to each rotor and carried by the frame, a hanger guided to slide substantially vertically in each bracket, a controller ring corresponding to each rotor, means for supporting each ring on its corresponding hanger, means running on the controller rings and connected with the wings for regulating their angle of incidence, a rod corresponding to each hanger and extending inwardly to a point near the central axis of the ship, said hangers having threads thereon, a nut on the threads of each hanger for supporting the hanger, a pinion associated with each nut, each rod having a rack meshing with its corresponding pinion to rotate the same when the rods are shifted, and thereby raise or lower the rings.

27. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a controller ring corresponding to each rotor and substantially concentric therewith, a carriage corresponding to each wing mounted to slide on the rings, means connecting each carriage with a corresponding wing for regulating the angle of incidence of the wing, means corresponding to each carriage connected with the rotor and including a flexible connection for enabling the rotor to pull the carriages around the rings, means for supporting each ring so that it is capable of being tilted into different positions to vary the angle of incidence of the wings as they pass around the axis of the rotor, and control means for moving the rings into different positions.

28. In a rotary unit for an airship, the combination of a rotor mounted for rotation on a substantially vertical axis, a plurality

of wings mounted on the rotor for adjustment on a horizontal axis corresponding to each wing, a controller ring mounted substantially concentric with the rotor, a bar extending across the controller ring as a chord, means for supporting said bar near its middle point, said last-named means including a universal joint enabling the ring to be tipped to hold the same in different planes, and means running on the ring corresponding to each wing and connecting with the same to regulate the angle of incidence of the wings.

29. In a rotary unit for an airship, the combination of a rotor mounted for rotation on a substantially vertical axis, a plurality of wings mounted on the rotor for adjustment on a horizontal axis corresponding to each wing, a controller ring mounted substantially concentric with the rotor, means for supporting the controller ring so that it is capable of being tilted in different directions, a bail attached to the ring at two substantially diametrically opposite points for tilting the ring in one direction, control means connecting with the bail for tilting the ring, a second bail attached to the ring for tilting the same in another direction, means connected with the second bail for controlling the same, and means running on the ring and connected with the wings for moving the same slightly on their own axes to alter their angle of incidence.

30. In a rotary unit for an airship, the combination of a rotor mounted for rotation on a substantially vertical axis, a plurality of wings mounted on the rotor for adjustment on a horizontal axis corresponding to each wing, a controller ring mounted substantially concentric with the rotor, a bar extending across the controller ring and secured to the same, said bar located on the outboard side of the axis of rotation of the rotor, means for supporting said bar for rotation on its own axis to change the relative elevation of the inboard and outboard sides of the ring, said supporting means constructed so as to permit movement of the ring in another direction so as to change the relative elevation of the forward side of the after side of the wing, means connected with the ring for controlling the relative elevation of the outboard and inboard sides of the ring, means connected with the ring for controlling the relative elevation of the forward and aft sides of the ring, and means connecting the ring with the wings respectively to regulate their angle of incidence.

31. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the

ship, means for adjusting all the wings on their axes to regulate the angle of incidence of all of the wings simultaneously, and means for controlling the angle of incidence in a complementary manner of the wings on opposite sides of the ship as they pass forwardly remote from the fore-and-aft axis of the ship so that when the angle of incidence of a wing passing forwardly on one side of the ship is increased the angle of incidence of the corresponding wing as it passes forwardly on the other side of the ship will be decreased.

32. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, means for adjusting all the wings on their axes to regulate the angle of incidence of all of the wings simultaneously, and means for controlling the angle of incidence in a complementary manner of the wings on opposite sides of the ship as they pass rearwardly adjacent to the fore-and-aft axis of the ship, so that when the angle of incidence of

a wing passing rearwardly on one side of the ship is increased, the angle of incidence of the corresponding wing as it passes rearwardly on the other side of the ship will be decreased.

33. In an airship, the combination of a frame, a pair of rotors located on opposite sides of the fore-and-aft axis of the ship, a plurality of wings supported on each rotor for adjustment about corresponding substantially horizontal axes, means for rotating the rotors so that the wings pass rearwardly adjacent the central fore-and-aft axis of the ship, a relatively fixed controller ring corresponding to each rotor, substantially horizontal pivot means extending in a fore-and-aft direction for supporting said ring for adjustment on a substantially horizontal fore-and-aft axis, means running on said ring and connected with the wings respectively for tilting the same on their axes, and cooperating with the controller ring to give the wings different pitch at different points in their rotation about the axis of the rotor.

Signed at Los Angeles, California, this 7th day of May, 1931.

JAMES W. HESS.