

Feb. 17, 1942.

G. R. WALDRON

2,273,303

HELICOPTER TYPE AIRSHIP

Filed Nov. 28, 1939

4 Sheets-Sheet 1

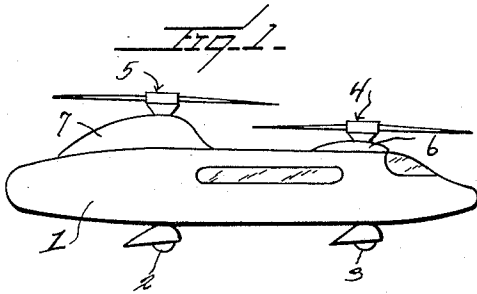
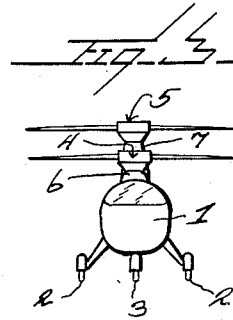
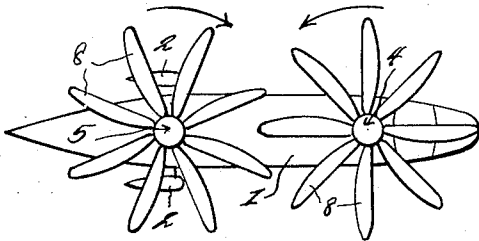


FIG. 2

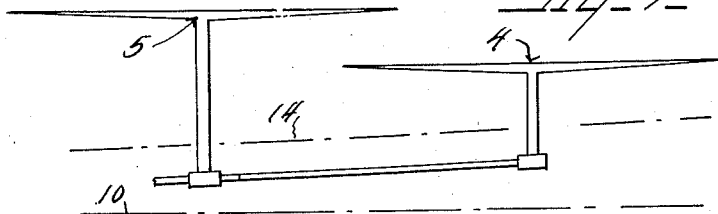


FIG. 7

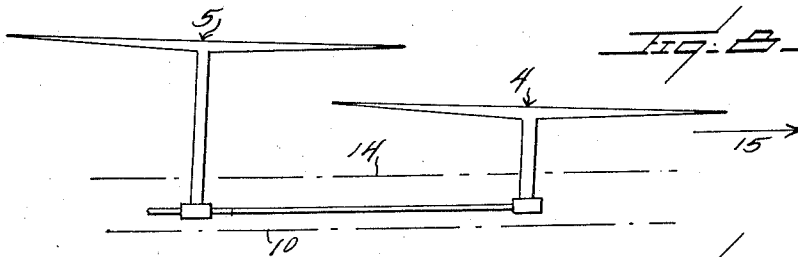


FIG. 8

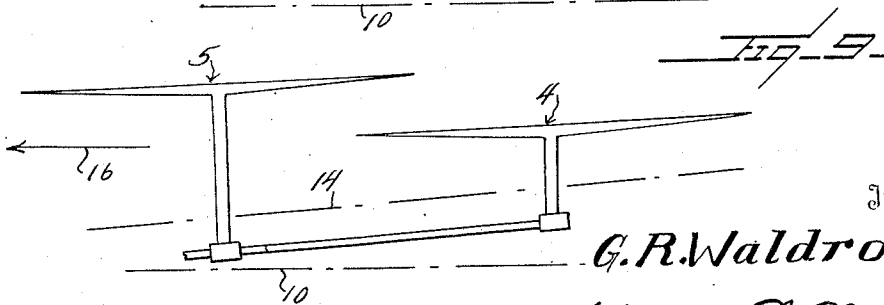


FIG. 9

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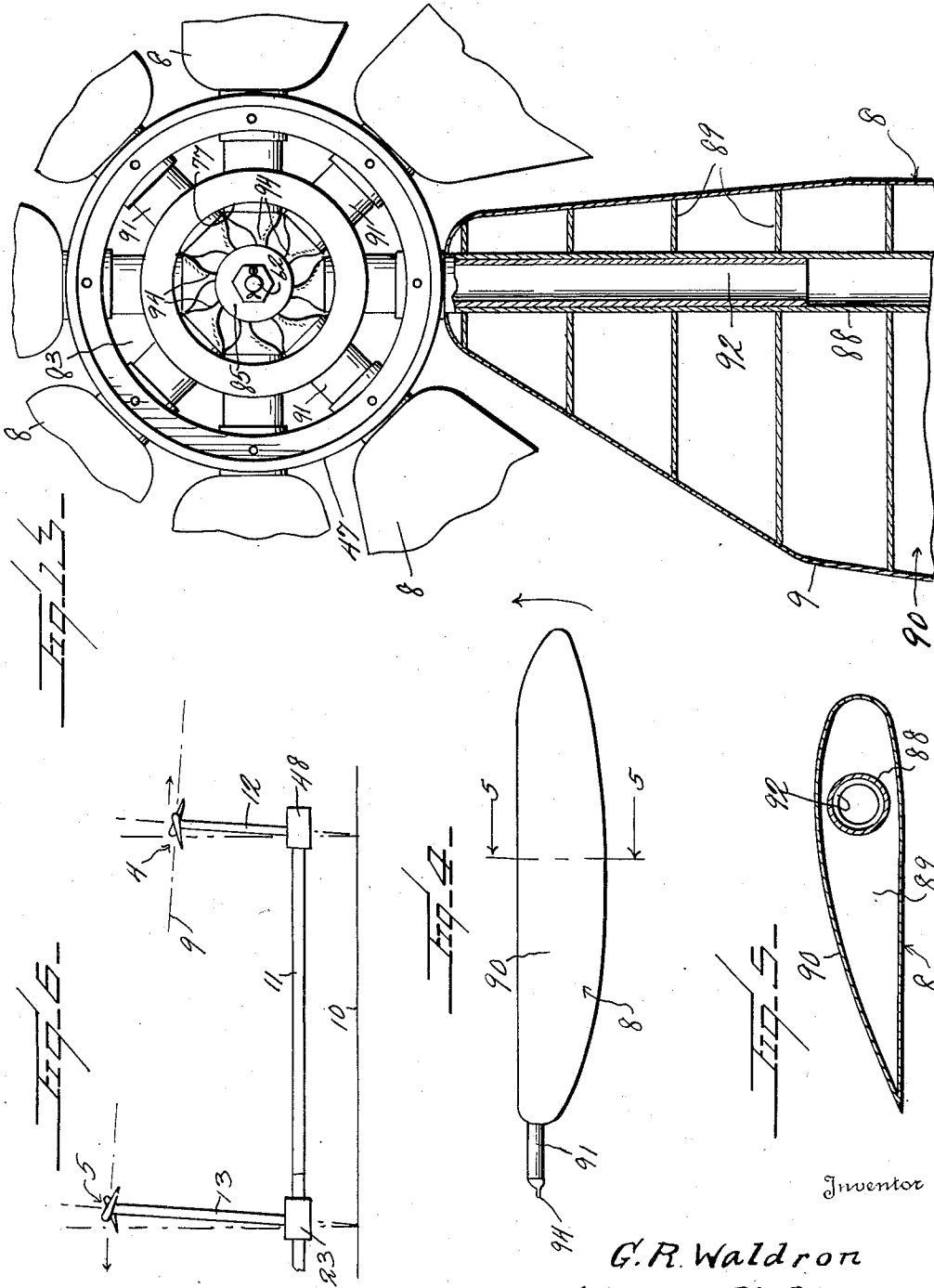
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4 Sheets-Sheet 2



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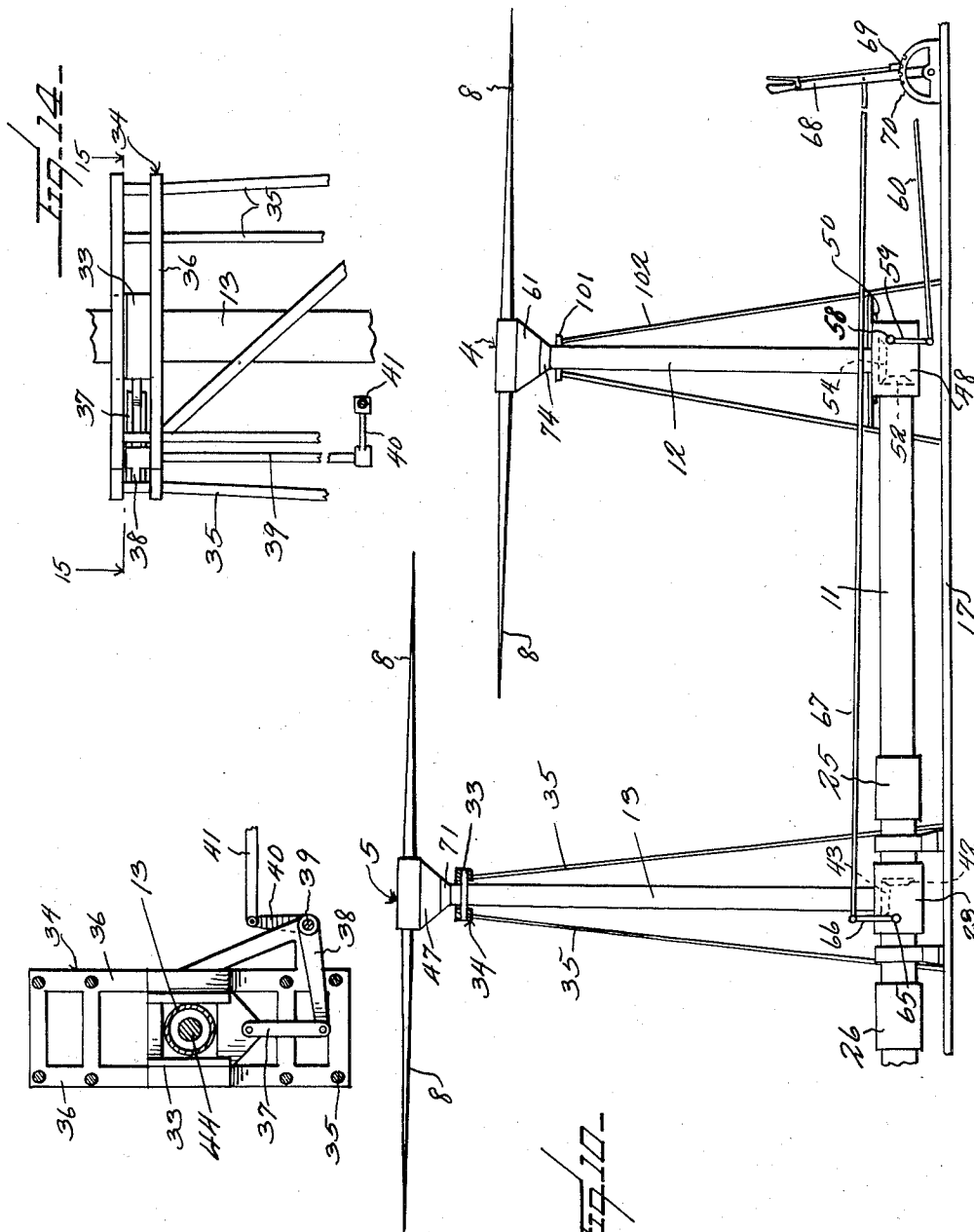
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HELICOPTER TYPE AIRSHIP

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4 Sheets-Sheet 3



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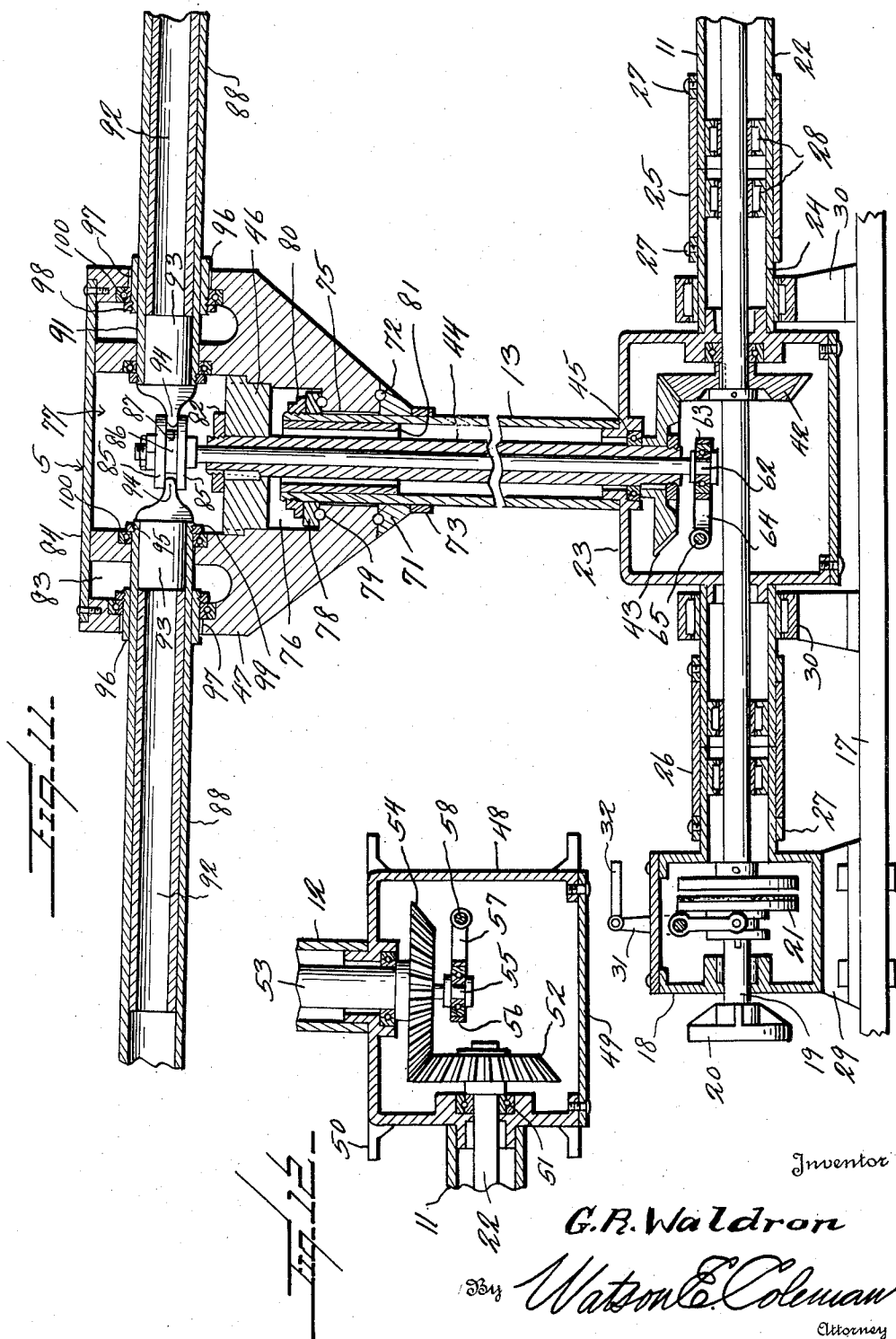
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HELICOPTER TYPE AIRSHIP

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4 Sheets-Sheet 4



UNITED STATES PATENT OFFICE

2,273,303

HELICOPTER TYPE AIRSHIP

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Application November 28, 1939, Serial No. 306,563

12 Claims. (Cl. 244—17)

This invention relates generally to the class of air vehicles or flying machines and pertains particularly to a novel and improved form of helicopter.

The primary object of the present invention is to provide in a helicopter type of flying machine, a new and novel method and means of controlling the movements of such machine by means of the rotating blade units which are employed for raising the machine into the air.

Another object of the invention is to provide in a helicopter type of flying machine, a new and novel blade construction for the rotary operating units together with a novel mounting means for such units whereby the vertical and forward movement of the machine in the air may be readily accomplished.

Still another object of the invention is to provide in a helicopter type of flying machine, rotary blade units in which the blades are of novel form and mounted so that the angle of attack may be varied and, in addition, wherein such units are disposed in a novel manner with respect to the longitudinal center of the ship, the said means for adjusting the pitch of the blades together with the novel form of the blades and the manner in which the units are mounted with respect to the longitudinal center of the ship, facilitating movement of the ship in the air vertically, forwardly or laterally as may be desired without the employment of steering mechanism of any character.

A further object of the invention is to provide in a helicopter type flying machine, a pair of rotary blade units arranged in fore and aft relation upon the fuselage of the ship, the units being supported for rotation in planes at an angle to the longitudinal center of the ship and the rear one of such units being adapted for limited swinging movement transversely of the ship, the arrangement of the rotary units in the said angular planes together with the lateral movement of the aft unit facilitating the movement of the ship and the steering of the same.

A still further object of the invention is to provide in a helicopter type flying machine, rotary lifting units employing blades having the cross sectional design of an airfoil, such blades being hereinafter referred to as "airfoil blades," by means of which blades, mounted in a novel manner upon the body of the ship, the combined forward and upward movement of the ship together with other desired movements resulting from the adjustment of the pitch of the blades, are accomplished.

Still another object of the invention is to pro-

vide in a helicopter type airship employing two rotary blade units arranged in the manner stated, a novel means whereby one of such blade units may be oscillated along an arcuate path extending transversely of the fuselage for the purpose of steering the ship.

A still further object of the invention is to provide in a structure of the character stated, a novel mounting for the airfoil blades whereby the pitch of such blades may be changed or controlled by the operator of the machine to facilitate movement of the machine through the air at a desired rate of speed.

The invention will be best understood from a consideration of the following detailed description taken in connection with the accompanying drawings forming part of this specification, with the understanding, however, that the invention is not to be confined to any strict conformity with the showing of the drawings but may be changed or modified so long as such changes or modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

In the drawings:

Fig. 1 is a view in side elevation of a helicopter constructed in accordance with the present invention.

Fig. 2 is a view in top plan of the same.

Fig. 3 is a view in front elevation.

Fig. 4 is a view in plan of a blade of a rotor unit.

Fig. 5 is a section on the line 5—5 of Fig. 4.

Fig. 6 is a diagrammatic view illustrating the theory of operation of the present device.

Figs. 7, 8 and 9 are diagrammatic views illustrating the method of control of the present helicopter.

Fig. 10 is a view in side elevation of the operating mechanism per se.

Fig. 11 is a view in vertical longitudinal section through the rear unit of the operating mechanism, the same being partially broken away and illustrating the clutch control means.

Fig. 12 is a view in vertical longitudinal section through the lower part of the front unit of the mechanism.

Fig. 13 is a fragmentary view in plan of one of the rotor unit heads showing the connections of the blades therewith.

Fig. 14 is a view in elevation of the control means for shifting the rear rotor unit, the view being taken looking longitudinally of the aircraft.

Fig. 15 is a horizontal section on the line 15—15 of Fig. 14.

Referring now more particularly to the draw-

ings, reference will first be made to and a description given of the parts of the present invention as they appear in viewing the airship exteriorly. As shown in Figs. 1 to 3 where the body of the airship is more or less diagrammatically shown, the ship body or fuselage is indicated by the numeral 1, it having connected with its underside suitable landing gear in the form of wheels 2 and 3, the forward one of the wheels which is indicated by the numeral 3, being preferably mounted upon the longitudinal center of the ship and controllable to operate as a castor wheel whereby the steering of the ship when on the ground may be accomplished. No detailed illustration is given of the interior parts of the ship or of the landing gear as these do not form a part of the present invention.

Supported above the fuselage 1 in the manner hereinafter specifically described are the two rotary blade units which are spaced longitudinally of the ship, the forward unit being indicated generally by the numeral 4 and the rear unit by the numeral 5. The upper parts of the supporting structure for these units are enclosed by the streamlined housings 6 and 7 as shown.

The blades for the rotary units are indicated by the numeral 8 and each of these blades is of the airfoil-type as shown in Figs. 4 and 5, and the units 4 and 5 are supported by the fuselage of the ship to rotate on axes which are inclined from the perpendicular slightly toward the forward end of the ship and in the vertical central longitudinal plane of the ship. The blades 8 of both units are adjustable for pitch as hereinafter described and the rear unit which may be referred to as the steering or control unit, is also movable or adjustable transversely of the ship, as will be hereinafter more specifically described.

The units 4 and 5 rotate oppositely as indicated in Fig. 2, the forward unit 4 rotating in a counter-clockwise direction as seen when looking down upon the ship and the rear unit rotating in a clockwise direction. In both units, the blades are supported so that the blunt or usual leading edge is facing in the direction in which the propeller is moving.

Before describing the detailed constructional features of the present invention, a short statement of the principle of operation of the present machine will be set forth, reference being had particularly to the diagrams constituting Figs. 6 to 9, inclusive.

Referring particularly to Fig. 6, when a multi-blade controllable pitch rotor is positioned with the axis of the rotor slightly out of the vertical as shown in Fig. 6, the plane of rotation of the blades as indicated at 9, is oblique to the horizontal which is designated by the line 10. In this diagrammatic view the numeral 11 designates the shaft housing which encloses the operative driving connection between the blade units 4 and 5, and the numerals 12 and 13 designate the shaft housings enclosing the shafts which carry power to the units. With this arrangement of the blade units when the blades of each unit are set to have a zero degree angle of attack or incidence with reference to the horizontal line 10, when such blades are midway between their highest and lowest positions in the rotary plane, the blades upon one side of such midway position assume a greater angle of attack than those upon the other side of such position. By this it is meant that the blades through half of their rotary movement will be moving downwardly with respect to the horizontal and through the other half of their rotary

movement they will be moving upwardly during which latter movement the angle of attack will be greater than during the first-mentioned movement. As the direction of rotation is such as to cause the blades to move through the air in a normal airfoil movement, the blades having the zero angle of attack or the blades which are moving downwardly with respect to the horizontal, have small resistance to movement through the air while affording the lift resulting from the reaction of the blades on the air. However, the opposite blades having a greater angle, exert a thrust or pushing force tending to move the rotor in a horizontal direction while at the same time giving a lift.

By the use of two rotors, in combination with a fuselage in an air craft and disposing the rotor axes on the fore and aft line of the air craft and turning the rotors in opposite directions, the forces of torque are balanced and the center of gravity, longitudinally, being below and on a line with the centers of the rotors results in the transverse balancing of the air craft.

The longitudinal balance of the craft is at all times under the control of the pilot by reason of the control of the lift of the individual rotors through the adjustment of the pitch of the blades. Such longitudinal balance or control of the craft may be described in the following manner in conjunction with the diagrammatic Figs. 7 to 9.

Assuming that a fuselage is combined with the rigidly connected rotor assemblies, by increasing the pitch of the blades of the forward rotor 4, Fig. 7, to cause the forward rotor to rise to a position which places the planes of the two rotors in a horizontal position or parallel with the horizontal line 10, the air craft because of the lift of the two rotors and due to the lack of thrust in either direction horizontally, will remain poised in position with no horizontal movement. In this position the center line of the fuselage, indicated by the numeral 14, has an angle to the horizontal ground line 10. If the pitch of the propellers of the two rotors then be increased an equal amount, the air craft will rise, the condition of descending being brought about by decreasing the angle of attack of the blades of the two rotors an equal amount until the weight of the air craft exceeds the lift of the rotors.

By increasing the lift of the rear rotor 5, Fig. 8, and raising the rear of the air craft so that the planes of the rotors extend forwardly and downwardly with respect to the horizontal line 10, the blades take the position of thrust on the rearwardly moving blades and low resistance to passage through the air on the forwardly moving sides of the blades and the air craft will move in the direction shown by the arrows 15 in this figure.

In order to move the craft in the opposite direction as indicated by the arrow 16 in Fig. 9, the lift of the blades of the forward rotor 4 is increased until the planes of the two rotors extend downwardly and rearwardly to the horizontal line 10 in the manner illustrated.

In the event of failure of the power plant of the air craft, the connection between the power plant and the rotors may be disengaged by the clutch mechanism to be described and the angle of incidence of the blades of both rotors decreased to below zero or to minus degrees angle of incidence, thus the air flowing past the blades as the aircraft descends will tend to slow the aircraft in its descent and will cause the rotors

to rotate and this rotary action of the rotors may be utilized for effecting landing of the craft without shock or damage, by increasing the pitch of the rotor blades just before the craft reaches the ground.

The mechanism of the present invention will now be described.

In Figs. 10 and 11, the numeral 17 designates a portion of the fuselage upon which the driving connections for the rotors 4 and 5 together with other parts of the mechanism are supported. As previously stated, the rotor 5 is rearwardly of the rotor 4 and the planes of rotation of the rotors are one above the other, the forward rotor 4 being in the lower plane.

The numeral 18 designates a clutch housing into which extends the drive shaft section 19 having upon its rear end a suitable coupling 20 for connecting it with an engine (not shown) by which rotary power is transmitted to the rotors. This clutch housing encloses suitable clutch mechanism generally indicated by the numeral 21 for transmitting power from the shaft section 19 to the power shaft 22 which extends forwardly through the horizontal shaft housing 11 to the forward rotor.

The vertical housing 13 for the rear rotor joins at its lower end with a gear casing 23 and this gear casing has connected therewith stub housings 24, one of which is coupled with the rear end of the housing 11 by a coupling sleeve 25 while the other stub housing is coupled by a corresponding coupling sleeve 26 with the clutch housing 18 in the manner illustrated. These coupling sleeves 25 and 26 are maintained in place upon the adjacent ends of the housings by rings 27 which are fixed to the shaft housings in the manner illustrated. Within the housings 11 and 24 are suitable bearings 28 disposed upon opposite sides of the joint between the housing sections, for the support of the power shaft 22.

The clutch housing 18 is supported by a suitable base 29 upon the portion 17 of the fuselage or body and at the front and rear of the gear housing 23 is a combined supporting standard and bearing 30 through which a stub housing 24 passes. This combined bearing and standard performs the double function of supporting the gear housing 23 together with the vertical shaft housing 13 and the rotor unit upon its upper end, and permitting this entire structure to be oscillated transversely of the craft as hereinafter stated.

The clutch mechanism 21 is controlled by a suitable lever 31 which is actuated by a rod or shaft 32 extending forwardly therefrom to the part of the aircraft structure in which the operator or pilot is positioned.

As previously stated, the rear unit 5 constitutes the steering control for the craft for which reason this unit has been mounted, so that it may be transversely oscillated as stated. The upper end of the housing 13 is enclosed in a collar 33 which is slidably supported in an elongated rectangular frame 34 which is disposed so that its length extends transversely of the craft and is housed within the upper part of the housing 7 and supported therein by suitable standards 35. The frame 34 includes in its make-up the vertically spaced parallel longitudinal guides 36 upon each of its sides and between these guides the collar 33 for the shaft housing 13 is supported for movement. This collar upon one side has connected therewith a link 37 which is joined to one end of a lever 38 which is carried upon the

upper end of a vertical rod 39, the lower end of this rod having a lever 40 connected therewith to which is attached one end of an actuating rod 41 which extends forwardly to the pilot's seat so that the pilot by manipulating the control 41 may effect sliding movement of the collar 33 and oscillation of the shaft housing 13.

Within the gear housing 23 at the lower end of the vertical shaft housing 13 the power shaft 22 supports a spur gear 42 which meshes with a bevel gear 43 which is supported upon the lower end of the vertical tubular shaft 44 which extends upwardly through the shaft housing 13. The lower end of this vertical shaft 44 is supported by a suitable bearing 45 at its lower end, as shown, while the upper end of this shaft carries and has keyed thereto a key spider 46 by means of which the vertical drive shaft 44 is connected with the rotary head 47 of this rotor unit.

Since the interior construction of each of the rotary units is the same, a detailed description will be given of the construction of one rotary unit only, it being understood that such description will apply also to the other unit. However, before proceeding with the description of the detailed construction of the rear rotary unit 5, a description will be given of the lower structure of the forward rotary unit 4.

At the lower part of the forward rotary unit 4 is a gear housing 48, the lower part of which is closed by a removable plate 49. This housing 48 is provided with suitable ears 50 for facilitating its connection with the supporting part of the fuselage.

Upon the side of the gear housing 48 nearest the housing 23 for the rear unit gear mechanism, there is provided the bearing 51 through which extends the forward end of the shaft 22 and within the housing 48 there is secured to the shaft 22 the forward spur gear 52.

The vertical drive shaft housing 12 for the forward unit encloses a tubular vertical shaft 53 upon the lower end of which is secured the bevel gear 54 which meshes with the spur gear 52. This vertical drive shaft 53 is supported like the shaft 44 in a lower or step bearing, not shown, which is of the same character as the bearing 45.

Extending longitudinally through the tubular shaft 53 is a reciprocable rod 55, the lower end of which extends below the gear 54 into the box 48 and has coupled therewith through the medium of a suitable collar 56, a yoke 57 which is carried upon a rock shaft 58 which extends into the gear box from one side thereof and this shaft upon its outer end, exteriorly of the gear box, carries an arm 59 with which is connected a control rod 60.

The forward motor unit also includes a rotary head 61 which is coupled with the shaft 53 to be turned thereby through the medium of a spider, not shown, like the spider 46 described in connection with the rotor unit 5.

The tubular shaft 44 of the rotor unit 5 has a reciprocable rod 62 extending longitudinally therethrough, the lower end of which projects downwardly into the gear box 23 and has connected therewith through the medium of a collar 63, a yoke 64 which is connected with a rock shaft 65 which extends to the exterior of the gear housing and carries the upwardly extending crank arm 66 with which is connected an end of a control rod 67. This control rod 67 like the rod 60 extends forwardly to a point adjacent the seat

of the pilot or operator of the craft where it may be connected with a suitable control mechanism such as the hand lever 68 which is provided with a shiftable securing tooth 69 which cooperates with a toothed segment 70 to maintain the lever in adjusted position.

As previously stated, the construction of the upper part of both of the rotor units is the same, therefore, a description will now be given of the detailed construction of rotor unit 5 with the understanding that, although the detailed construction of the interior of the upper part of rotor unit 4 has not been illustrated, it is exactly the same as that of unit 5 and, therefore, the present description will apply to unit 4. The vertical shaft housing 13 has secured thereto adjacent its upper end a fixed bearing collar 71, the upper surface of which is formed to provide a raceway for anti-friction elements 72. Secured to this housing beneath the collar 71 is a separate collar 73 which is welded to the housing and constitutes an additional support for the bearing collar 71.

On the vertical shaft housing 12 of the rotor unit 4, the corresponding bearing collar is indicated by the numeral 74.

The head 47, and likewise the head 61 of unit 4, has its underface suitably formed to coact with the bearing collar 71 and the anti-friction elements 72 and this head has a longitudinal passage 75 leading into a chamber 76, and this chamber 76 in turn opens into an upper chamber 77. The passage 75 receives the upper end of the tubular shaft housing 13 and fixed to and encircling the upper part of this housing and lying within the chamber 76 is a bearing collar 78, the under face of which coacts with the bottom of the chamber 76 and engages anti-friction elements 79. A suitable securing nut 80 is threaded upon the upper end of the shaft housing 13 and engages the collar 78 to maintain the latter firmly in position, and this nut 80 and bearing collar 78 coact with the fixed collar 71 to rotatably support the hub in position upon the upper end of the shaft housing. The interior of the vertical shaft housing is reinforced at its upper end by an inserted sleeve or body of tubing 81.

Between the chambers 76 and 77 the head has the spider 46 coupled therewith and this spider, as previously stated, is keyed to the upper end of the shaft 44 and is held against longitudinal movement on the shaft by the nut 82 which is threadably secured to the shaft.

The upper part of the head 77 has the annular chamber 83 formed therein around the central chamber 77. These chambers are both covered by the removable cover plate 84.

The reciprocable rod 62 which passes through the tube shaft 44 extends into the chamber 77 and carries two disks 85 which are maintained in spaced relation by an inserted washer 86, thus providing a circular channel 87.

Each of the rotor blades of each unit is, as previously stated, of the airfoil type and each of these blades is provided with a longitudinally extending central tubular portion 88 across which extend the framework ribs 89 which carry the covering or skin material 90 which may be of metal or other suitable material. This tubular central part or backbone for each of the propeller blades 8 extends beyond the inner end of the blade to form the blade hub 91. The inner end portion of the tubular part 88 of each blade is reinforced by an inserted sleeve 92 and secured

within the end of the hub and abutting against the adjacent end of the reinforcing sleeve 92 is an inserted body 93 which is formed at the outer end to provide an eccentric finger 94.

The end of the hub of each blade has a reduced threaded portion 95 and inwardly from this reduced portion a threaded collar 96 encircles the blade hub.

Each rotor head has formed therein a series of radial openings 97 which extend from the eccentric finger chamber 77 to the outer side of the head through the annular chamber 83. Through these radial passages or openings 97, the hub ends of the rotor blades are extended and the threaded portion of the collar 96 of each blade extends into the annular chamber 83 where it receives a securing nut or ring 98 while the threaded terminal portion 95 of the hub extends into the chamber 77 where it receives a threaded nut or ring 99. The portions of each blade hub which carry the securing nuts or rings 98-99 pass through bearings 100 suitably mounted in the head into which the blade hubs extend and the securing rings 98-99 engage these bearings, in addition to serving to prevent the blade from moving radially outwardly from the head, thus maintaining the adjacent rotary portions of the bearings in position.

When the hub ends of the blades are secured in their respective openings 97, the eccentric fingers will be engaged in the annular recess 87 which is provided between the spaced peripheries of the plates 85. Thus it will be seen that upon reciprocation of the rod 62 for the unit 5 or the rod 55 for the unit 4, pressure will be brought to bear upon the eccentric fingers 94 which will tend to turn the rotor blades on their longitudinal axes and by this means, the pitch of the blades or the angle of attack may be altered as desired.

The forward unit 4 has the tubular housing 12 provided adjacent its upper end with suitable ears or flanges 101 for the attachment thereto of bracing struts 102 by which the forces generated by the rotary action of the blades are transmitted to the fuselage structure.

It will be noted that the spur gears 42 and 52 in the gear housings of the rear and front units respectively, are arranged so that upon rotation of the driving shaft 22, rotary motion will be given to one of the vertical shafts oppositely to the vertical shaft of the other unit.

It will also be noted that both vertical drive shafts are inclined slightly forwardly from the horizontal in the vertical central longitudinal plane of the ship and thus by this arrangement in association with the means for changing the pitch of the rotor blades, it is possible to control the movements of the ship in the manner stated in the first part of the specification.

It will also be seen from the foregoing description that by the provision of the stub housings for the horizontal driving shaft 22, connected with the clutch housing and the main horizontal housing 11 by the sleeves 25 and 26, the entire rear unit 5 may be oscillated slightly transversely of the airship through the medium of the control rod 41, and in this manner steering movement may be imparted to the ship structure. By the use of the control rods 60 and 67, rectilinear movement may be imparted to the reciprocable rods 55 and 62 of the two units whereby the pitch of the propellers of either or both units may be varied as may be found desirable or necessary.

An aircraft or airship designed in accordance

with the present invention may be made to rise or descend vertically without moving at all in a horizontal direction or it may be caused to remain at a desired elevation and in horizontal position in the air. It is also possible to make a complete turn of this airship in a circle whose radius is no greater than the length of the ship. Also in accordance with the description given in the first part of the specification, it will be apparent that by suitably manipulating the rotor units, the ship may be made to move either in a forward or backward horizontal direction or may be made to move upwardly and forwardly or upwardly and backwardly as may be desired.

While in the present illustration of the invention, there has been shown a coupling at the rear of the rear rotor unit for connecting the driving engine with the rotors, it will be understood that the invention is not to be limited to the connection of the power unit at this point as it may be advisable in certain types of aircraft to install the driving motor between the vertical shafts. It is also to be understood that while there have been shown gear drives between the horizontal power shaft and the vertical shafts, such drives may be supplemented by a chain drive or by any other suitable driving connection if found desirable.

In the previously given description, the part 17 has been referred to as a portion of the fuselage. This may comprise any suitable frame-work in the air craft upon which the power units or rotors may be supported or it may constitute a portion of the bottom wall of the fuselage, it being understood that in the preferred construction of the helicopter, the horizontal driving shaft between the vertical shafts and the driving motor will be located in the extreme lower part of the fuselage with the vertical shafts extending upwardly through the body on the vertical longitudinal center of the same.

By disposing the rear rotor and blades in a plane above the blades of the front rotor, there is avoided interference with the operation of the rear rotor in flight by air disturbances created by the front rotor, thus the efficiency of the machine as a whole is improved or increased over what it would be if the rotors were disposed in the same plane.

What is claimed is:

1. In a helicopter type airship, a fuselage, a pair of upwardly extending rotatable shafts carried by and projecting above said fuselage and spaced longitudinally thereof, means for applying rotary power to said shafts, said shafts being at a fixed inclination from the vertical forwardly with respect to the longitudinal center of the fuselage, a rotor unit mounted upon the upper end of each shaft to be turned thereby and including a plurality of adjustable pitch blades, said shafts being of unequal height to dispose said rotor units in vertically spaced parallel planes with the forward unit disposed in a plane below the plane of the rear unit, and means for oscillating the rearward unit transversely of the fuselage.

2. In a helicopter type airship, a fuselage body, a pair of shafts supported by and extending upwardly from said body, said shafts being at a fixed inclination slightly from the vertical forwardly with respect to the longitudinal center of said body and each of said shafts being of tubular form, means for coupling a power unit with said shafts for effecting simultaneous rotation of the same, a hollow head supported upon the upper

end of each shaft, a plurality of blades carried by and extending radially from each head, said blades being rotatable with the head in a plane perpendicular to the supporting shafts therefor, a reciprocable rod extending longitudinally through each of said shafts into the head, means for effecting the rectilinear movement of each rod from a point in the fuselage remote from the shafts, and means operatively coupling the upper ends of said rods with said blades within the hollow heads whereby the pitch of the blades will be changed upon such rectilinear movement of the rods.

3. In a helicopter type airship, a fuselage body, a pair of shafts supported by and extending upwardly from said body, said shafts being inclined slightly from the vertical forwardly with respect to said body and each of said shafts being of tubular form, means for coupling a power unit with said shafts for effecting simultaneous rotation of the same, a head supported upon the upper end of each shaft, a plurality of blades carried by and extending radially from each head, said blades being rotatable with the head in a plane perpendicular to the supporting shafts therefor, a reciprocable rod extending longitudinally through each of said shafts, means for effecting the rectilinear movement of each rod from a point in the fuselage remote from the shafts, means operatively coupling the upper ends of said rods with said blades whereby the pitch of the blades will be changed upon movement of the rods, and means facilitating movement of the upper end of one of said shafts in an arcuate path extending transversely of the fuselage.

4. A helicopter type airship, comprising a fuselage body, a driving shaft extending longitudinally of the body, means facilitating coupling a power unit with said shaft for turning the latter, a pair of shaft housings extending upwardly with respect to the fuselage and beyond the top of the same, each of said shaft housings being inclined forwardly from the vertical and said housings being spaced longitudinally of the fuselage, a shaft extending longitudinally through each of said housings, an operative coupling between the lower end of each of said last shafts and said driving shaft, a unit supported upon the upper end of each of said housings and coupled with the shaft therein for rotation with the adjacent shaft, each of said units including a plurality of adjustable pitch blades, means facilitating the adjustment of the pitch of said blades of each unit, means supporting the rear one of said housings for oscillation transversely of the fuselage about said driving shaft as a center, and means for effecting the oscillation of said rear shaft housing.

5. A helicopter type airship, comprising a fuselage body, a driving shaft extending longitudinally of the body, means facilitating coupling a power unit with said shaft for turning the latter, a pair of shaft housings extending upwardly with respect to the fuselage and beyond the top of the same, each of said shaft housings being inclined forwardly from the vertical and said housings being spaced longitudinally of the fuselage, a shaft extending longitudinally through each of said housings, an operative coupling between the lower end of each of said last shafts and said driving shaft, a unit supported upon the upper end of each of said housings and coupled with the shaft therein for rotation with the adjacent shaft, each of said units including a plurality of adjustable pitch blades, means facili-

tating the adjustment of the pitch of said blades of each unit, means supporting the rear one of said housings for oscillation transversely of the fuselage about said driving shaft as a center, and means for effecting the oscillation of said rear shaft housing, the said blade units being arranged to rotate in planes perpendicular to the axes of the shafts with which they are coupled and the forward one of said units being disposed in a plane below the plane of the rear unit.

6. In a helicopter type airship, a fuselage body, a pair of tubular shaft housings extending upwardly with respect to the fuselage body and spaced apart longitudinally of the body, said housings being inclined slightly forwardly from the vertical with respect to the longitudinal center of the body, means supporting the rear housing at its lower end for oscillation in an arcuate path extending transversely of the body, a shaft extending longitudinally through each of said housings and rotatably supported in the same, means coupled with said shafts for transmitting rotary power thereto from a power source, means facilitating the coupling of a power source with said power transmitting means, a bearing supported upon the upper end of each of said shaft housings, a head receiving the upper end of each housing and rotatably supported upon the adjacent bearing, a plurality of blades supported by and extending radially from each head, the supporting means for each of said blades being designed to facilitate oscillation of the blade on its long axis, the blades of one head being disposed to rotate in a plane below the plane of rotation of the blades of the other head and said planes being perpendicular to the axes of the shafts with which the heads are connected, means for oscillating the said rear one of the housings, and means connected with the blades of each head facilitating the oscillation of the blades of the heads selectively as a group for the adjustment of the pitch of such blades.

7. In a helicopter type airship, a fuselage body, a pair of rotor units supported by said body for oscillation above the top of the same, said rotor bodies being spaced longitudinally of the fuselage and each including a rotary head and a plurality of blades extending radially from each head, said blades being of the airfoil type, the blades connected with one head being arranged for rotation in a plane below the plane of rotation of the blades of the other head, the said rotor units being disposed whereby the planes of rotation of the blades are parallel with one another and are at an acute angle with respect to the longitudinal center of the fuselage, the blades of said units being mounted for adjustment of the pitch thereof, means for effecting the adjustment of those of the other unit, and means for transmitting rotary power to said rotor units.

8. In a helicopter type airship, a fuselage body, a pair of rotor units supported by said body for oscillation above the top of the same, said rotor bodies being spaced longitudinally of the fuselage and each including a rotary head and a plurality of blades extending radially from each head, said blades being of the airfoil type, the blades connected with one head being arranged for rotation in a plane below the plane of rotation of the blades of the other head, the said rotor units being disposed whereby the planes of rotation of the blades are parallel with one another and are at an acute angle with respect to the longitudinal center of the fuselage, the blades

of said units being mounted for adjustment of the pitch thereof, means for effecting the adjustment of the pitch of the blades of one unit independently of those of the other unit, means for transmitting rotary power to said rotor units, and means for swinging the rear rotor unit in an arcuate path transversely of the fuselage.

9. In a helicopter type airship, a fuselage body, a pair of upwardly extending shaft housings carried by the body and spaced apart longitudinally thereof, said housings being inclined forwardly slightly from the vertical with respect to the longitudinal center of the fuselage, the rear one of said housings being of greater height than the forward one, a head rotatably supported upon the upper end of each housing a tubular shaft extending longitudinally through and rotatably supported in each housing and operatively coupled at its upper end with the adjacent head, a plurality of blades carried by and extending radially from each housing, the plane of the blades of the forward housing being parallel with and below the plane of the blades of the rear housing and said planes being perpendicular to the axes of the shaft, each of the blades being supported in its head for oscillation on its long axis and each having an eccentric finger at its inner end within the adjacent head, a reciprocable rod extending through each tubular shaft, means coupling the upper end of each rod with the fingers of the blades in the adjacent head facilitating rocking of said blades on their axes upon reciprocation of the rod, each of said rods extending at its lower end out of the lower end of the tubular shaft, an actuating lever coupled with the lower end of each of said rods, means coupled with each lever facilitating its actuation from a point remote from the rod with which it is coupled, and means facilitating the coupling of a power unit with said shafts by which the shafts may be simultaneously rotated.

10. In a helicopter type airship, a fuselage body, a pair of upwardly extending shaft housings carried by the body and spaced apart longitudinally thereof, said housings being inclined forwardly slightly from the vertical with respect to the longitudinal center of the fuselage, the rear one of said housings being of greater height than the forward one, a head rotatably supported upon the upper end of each housing, a tubular shaft extending longitudinally through and rotatably supported in each housing and operatively coupled at its upper end with the adjacent head, a plurality of blades carried by and extending radially from each housing, the plane of the blades of the forward housing being parallel with and below the plane of the blades of the rear housing and said planes being perpendicular to the axes of the shaft, each of the blades being supported in its head for oscillation on its long axis and each having an eccentric finger at its inner end within the adjacent head, a reciprocable rod extending through each tubular shaft, means coupling the upper end of each rod with the fingers of the blades in the adjacent head facilitating rocking of said blades on their axes upon reciprocation of the rod, each of said rods extending at its lower end out of the lower end of the tubular shaft, an actuating lever coupled with the lower end of each of said rods, means coupled with each lever facilitating its actuation from a point remote from the rod with which it is coupled, means facilitating the coupling of a power unit

with said shafts by which the shafts may be simultaneously rotated, the said rear one of the shaft housings being supported at its lower end for oscillation on an axis extending longitudinally of the fuselage, and means facilitating the rocking of the rear housing on said axis whereby the head and blades carried thereby will be moved in an arcuate path extending transversely of the fuselage.

11. In a helicopter type airship, a fuselage body, a pair of upwardly extending shaft housings carried by the body and spaced apart longitudinally thereof, said housings being inclined forwardly slightly from the vertical with respect to the longitudinal center of the fuselage, the rear one of said housings being of greater height than the forward one, a head rotatably supported upon the upper end of each housing, a tubular shaft extending longitudinally through and rotatably supported in each housing and operatively coupled at its upper end with the adjacent head, a plurality of blades carried by and extending radially from each housing, the plane of the blades of the forward housing being parallel with and below the plane of the blades of the rear housing and said planes being perpendicular to the axes of the shaft, each of the blades being supported in its head for oscillation on its long axis and each having an eccentric finger at its inner end within the adjacent head, a reciprocable rod extending through each tubular shaft, means coupling the upper end of each rod with the fingers of the blades in the adjacent head facilitating rocking of said blades on their axes upon reciprocation of the rod, each of said rods extending at its lower end out of

the lower end of the tubular shaft, an actuating lever coupled with the lower end of each of said rods, means coupled with each lever facilitating its actuation from a point remote from the rod with which it is coupled, means facilitating the coupling of a power unit with said shafts by which the shafts may be simultaneously rotated, the said rear housing being supported at its lower end for oscillation on an axis extending longitudinally of the fuselage, a frame structure enclosing the upper end of the rear housing and limiting swinging movement of such end in an arcuate path transversely of the fuselage, a collar loosely encircling the rear housing and supported in said frame for sliding movement transversely of the fuselage, and mechanism coupled with said collar facilitating its reciprocatory movement in said frame from a point remote therefrom.

12. In a helicopter type airship, a fuselage, a pair of upwardly extending rotatable shafts carried by and projecting above said fuselage and spaced apart longitudinally thereof, means for applying rotary power to said shafts, said shafts being inclined from the vertical forwardly with respect to the longitudinal center of the fuselage and being of unequal height, a rotor unit mounted upon the upper end of each shaft to be turned thereby and including a plurality of adjustable pitch blades, and means for effecting the axial turning of the blades, the blades of the units being maintained by the unequal heights of the shafts for rotation in vertically spaced parallel planes.

GEORGE R. WALDRON.