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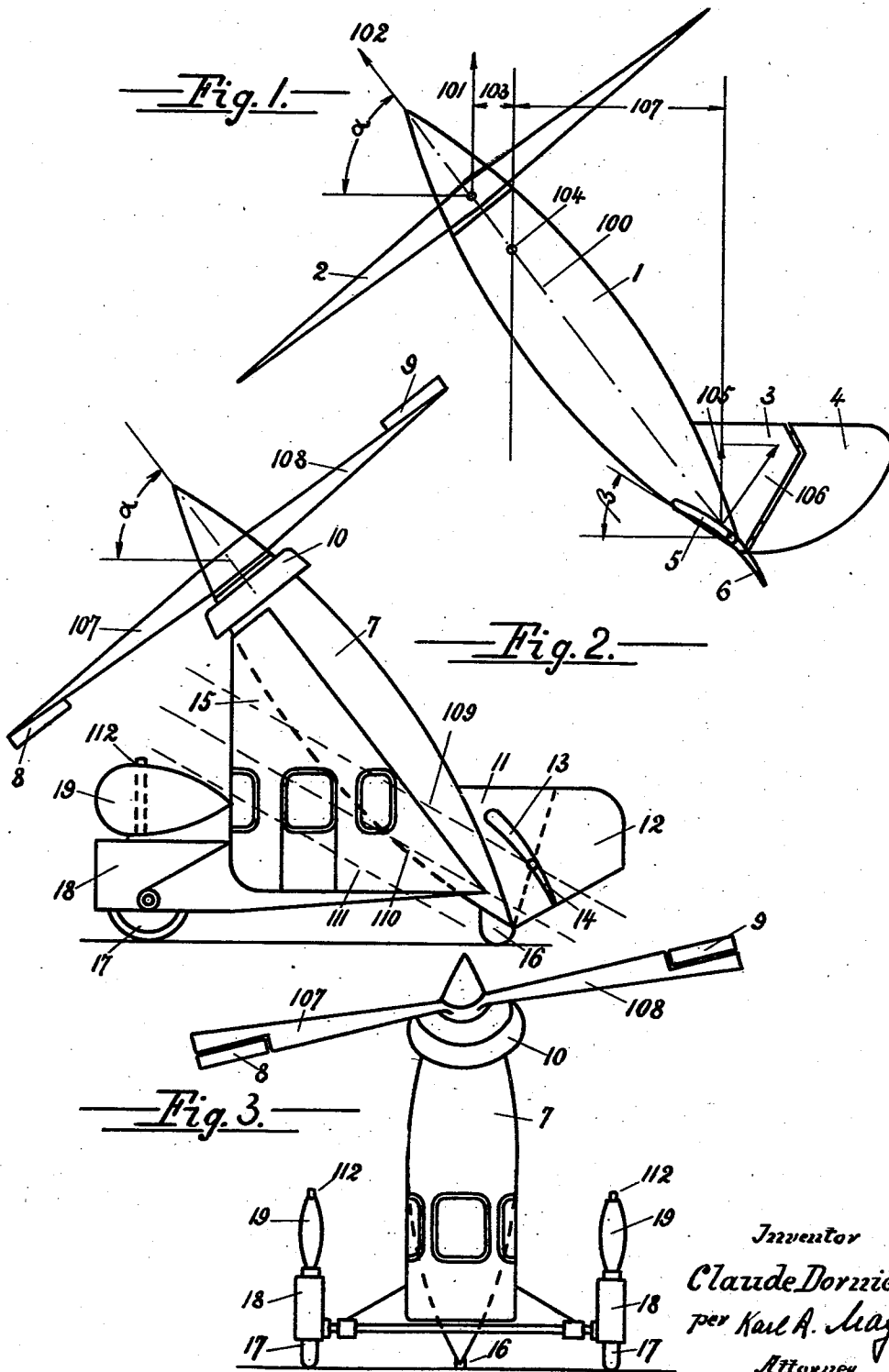
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2,023,760

ROTOR FLYING MACHINE

Filed Jan. 10, 1934

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

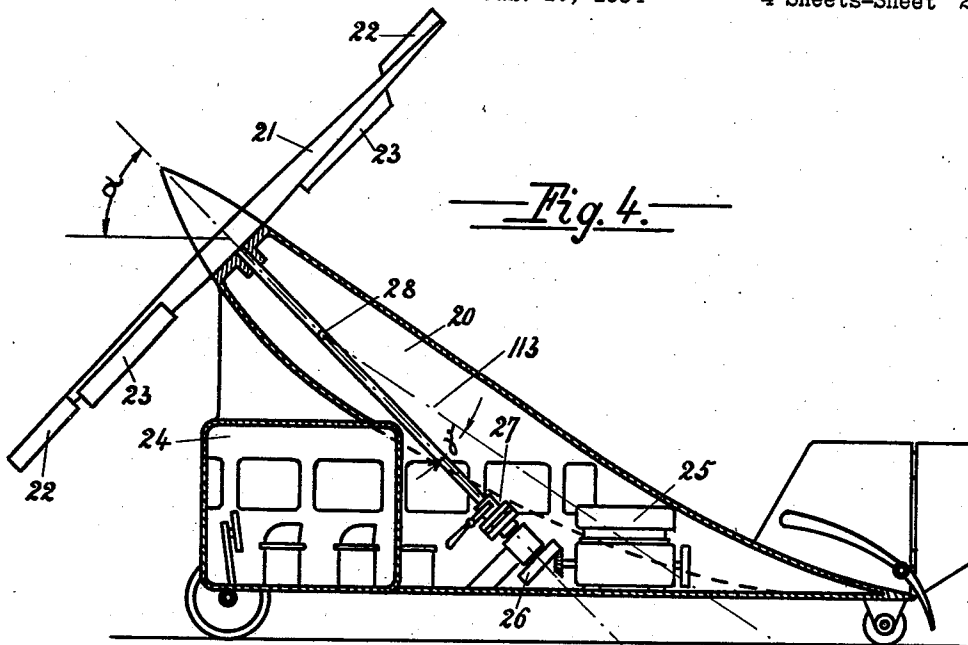
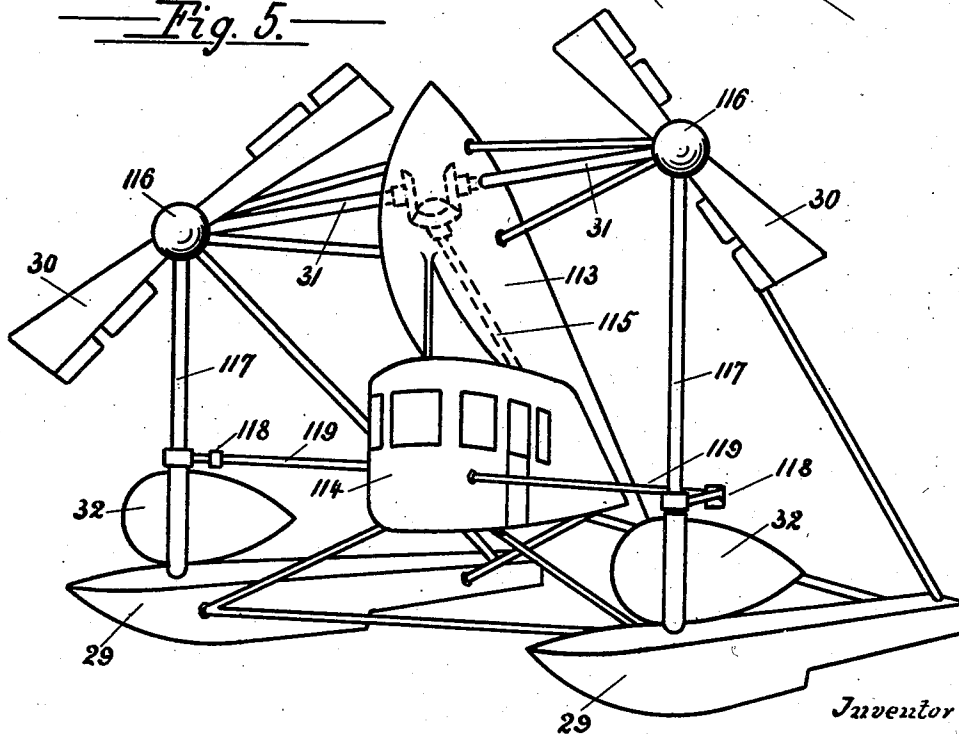


Fig. 5.



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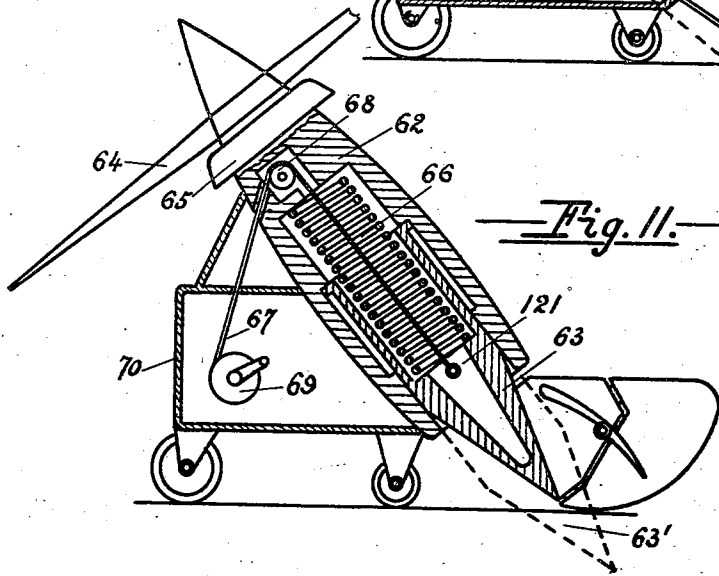
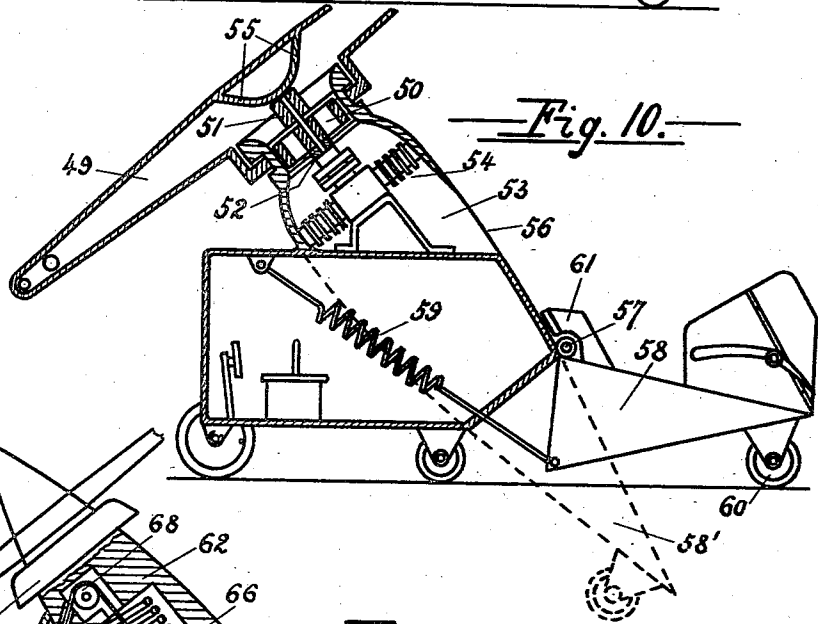
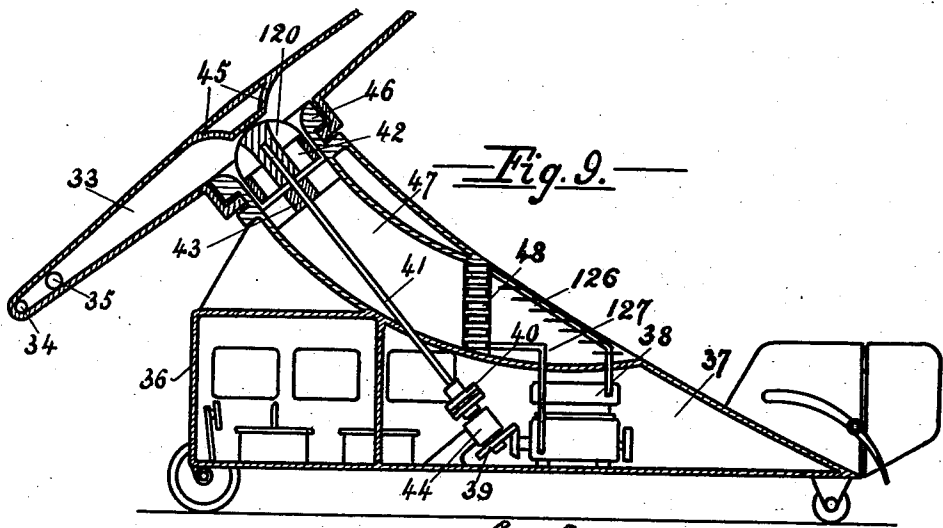
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UNITED STATES PATENT OFFICE

2,023,760

ROTOR FLYING MACHINE

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Application January 10, 1934, Serial No. 706,090
In Germany January 16, 1933

12 Claims. (Cl. 244—19)

This invention relates to a flying machine, more particularly to a flying machine having, instead of stationary wings mounted to the fuselage, a system of rotating wings hereinafter shortly called "rotors" adapted to move the machine horizontally, vertically or on an inclined course. Instead of one rotor, I can employ a plurality of rotors having parallel axes, e. g., in connection with large flying machines. The rotors are power driven but can be disconnected from the source of power, e. g., when the machine descends.

An object of this invention resides in the provision of a flying machine having only one power driven means for actively propelling the machine in a horizontal as well as in a vertical direction.

An object of this invention resides in the provision of a flying machine having only one means for lifting and propelling the machine, said means being arranged adjacent to the main body of the machine.

An object of this invention resides in the provision of a lifting and propelling rotor system for flying machines assuring utmost ease in operation and air-cushioned vibrationless motion.

An object of this invention resides in the provision of a flying machine having an adjustable fuselage assuring a most convenient configuration of the fuselage for landing, loading and unloading purposes and the most efficient outside contour for flying.

An object of this invention resides in the provision of a collapsible fuselage for flying machines providing a contour and dimensions securing greatest flying efficiency and efficiency of the rudder and balancing apparatus and, at the same time, a most convenient form of the fuselage for landing, loading, unloading and hangaring.

An object of this invention resides in the provision of a flying machine having a telescoping fuselage adapted to assure best operating and maneuvering efficiency and also smallest and most suitable shape for landing, starting, loading, unloading and hangaring.

An object of this invention resides in the provision of a flying machine of such configuration as to assure best equilibrium and balancing conditions.

An object of this invention resides in the provision of a flying machine having novel adjustable means for assuring best equilibrium and balancing conditions.

Further and other objects of the present invention will be hereinafter set forth in the accompanying specification and claims and shown in the drawings which, by way of illustration, show what I now consider to be a preferred embodiment of my invention.

In the drawings:
Fig. 1 is a schematic side view of the machine according to my invention.

Fig. 2 is a side view of a flying machine according to my invention with body for receiving passengers, load, running gear and other details attached.

Fig. 3 is a front view of the machine illustrated by Fig. 2.

Fig. 4 is a part cross sectional side view of a modification of a flying machine according to my invention.

Fig. 5 is an isometric illustration of a large seaplane according to my invention.

Fig. 6 is a longitudinal part cross sectional view of a wing system according to my invention showing the mechanism for adjusting the wing control surfaces in particular.

Fig. 7 is a transverse part cross sectional view substantially along line 7—7 of Fig. 6.

Fig. 8 is a top view of a rotating wing system according to my invention.

Figs. 9, 10 and 11 are part sectional side views of flying machines according to my invention illustrating certain details.

I shall now proceed to generally describe the underlying ideas of my invention with the assistance of the diagrammatic sketch Fig. 1. How these ideas can be carried out practically will be described later with the assistance of Figs. 2 to 11 which illustrate preferred embodiments of my invention.

Fig. 1 diagrammatically illustrates a flying machine according to my invention omitting the showing of the motor drive, provisions for carrying passengers and freight and the undercarriage or floats. At its front end, the body 1 has a system of rotating lift-producing wings 2 henceforth called "rotor". At the lower rear end of body 1 is the tail unit consisting of the tail fin 3, the rudder 4, a tail plane 5, and an elevator 6. When flying in horizontal direction the axis around which rotor 2 rotates is inclined. It forms an angle α with the horizon which is open in the direction of the flight and is always larger than 0° and smaller than 90° . Body 1 has the shape of a spindle the longitudinal axis of which substantially coincides with the rotating axis of wing system or rotor 2. In practice the shape of body 1 deviates more or less from that of a true spindle, as will be described later. Instead

of one rotor, a plurality of co-axial and pairwise counterrotating rotors can be employed, as shown in my copending application Ser. No. 708,395. Large machines can be provided with 5 outriggers each equipped with one or a plurality of rotating wing systems, wherein the axes of the individual rotors are parallel with respect to one another. The tail unit which is at or near the rear end of spindle body 1 is preferably located 10 in the air current discharged by the rotor; the stabilizers 5 constituting the elevator can be operated from the pilot's seat, whereby the angle of attack can be changed at will. The connections required for this operation are not shown in the drawings because the mechanism is well 15 known in the art. As is obvious from Fig. 1, the vertical component 101 of the force 102 generated by rotor 2 acts on the system at the small distance 103 from the center of gravity 104 of the system; while the vertical component 105 of the force 106 resulting from the elevator unit acts on the system at the much greater distance 107 from the center of gravity 104 of the system. The weight of the flying machine is thus chiefly carried 25 by the rotor and only a small part of it is carried by the tail unit; the lift power of the tail unit can be adjusted by adjustment of the angle of attack in order to keep the machine balanced at various operating conditions. As will be described later, a disconnectable coupling is provided between rotor 2 and the motor driving it and not shown on Fig. 1; the rotor is of such dimensions that, when light running, i. e., when the before 30 mentioned coupling is disconnected, it rotates by itself in such a direction and at such a speed as to assure a descending speed suitable for landing. The wings of the rotor are adjustable in well known manner permitting an adjustment of their power absorbing capacity in accordance with the change of the inclination of the revolving 40 axis with respect to the horizontal. It is also advisable to provide flaps on the rear edges of the wings or auxiliary wings at the end of the main rotating wings, the position of said flaps and/or wings being automatically controlled so that the work of each rotating wing periodically changes during each revolution; the extent of this change can be adjusted, as will be described later. Rotary systems of this type greatly assist 50 the tail unit at the rear end of the fuselage with respect to maintaining the flying machine in properly balanced condition. For the same purpose, particularly for counterbalancing the torque of the rotor, stationary and/or movable means may be provided at greatest possible distance 55 from the axis of symmetry of the machine. These means can be arranged on the undercarriage or the floats and can be adjustable during the flight and of such configuration as to generate air pressure and/or currents to balance the torque of the motor and to serve for other stabilizing purposes. Bodies acting in the aforesaid manner can, at the same time, be used for covering parts of the machine which must be protected from the flying 65 wind such as, e. g., the wheels of the undercarriage. This will also be described later.

As already stated, it is not always possible to design the fuselage in true spindle shape because of the necessity of providing room for passengers, 70 freight, motors etc. For this purpose I provide a goiter-like body on the lower front side of the spindle, said body having the shape of a right-angled triangle the hypotenuse of which is the rotating axis of the rotor, the bottom of said body 75 being one cathetus of said triangle, the latter

being in a substantially horizontal position before starting and when flying in a horizontal direction. The body has a streamline configuration which follows the air stream resulting from the forward movement of the machine and the air current 5 generated by the rotor. The goiter-like extension permits entirely free vision for the pilot forwards and downwards. The motor is disposed either in the rear part of said triangle-shaped body or adjacent to the rotor. 10

The rotor or rotors can be driven by one or a plurality of shafts connected to gears driven by the motor. These gears can be located either close to the rotor or to the motor. If a great ratio of transmission is required, instead of one gear, 15 several gears can be installed some of which are disposed near the motor or motors and others near the rotor or rotors.

Fig. 2 is a side view of a flying machine according to my invention and equipped with undercarriage and cabin for the passengers. 20

Fig. 3 is a front view of the same machine. The spindle shaped body 7 carries at its front end a rotor consisting of wings 107 and 108 the revolving axis of which is inclined with respect to the 25 horizontal by the angle α . The ends of the wings 107 and 108 of the rotor are equipped with adjustable flaps 8 and 9. If they are so adjusted that they both project from the same side of the plane of rotation of the wing system, they 30 aid in increasing the lift of the whole rotor. If one flap projects on one side and the other flap on the other side of the plane of rotation of the wing system and if the position of the flaps is periodically changed in known manner during 35 each revolution, the equilibrium of the flying machine can be affected. The motor driving the rotor is disposed adjacent to the rotor underneath an annular hood 10. The tail unit is attached to the rear end of the fuselage and consists of the side fin 11, the side rudder 12, the tail plane 13, the angle of attack of which can be adjusted during the flight, and the elevator 14. At the lower front side of the spindle-shaped 45 body is the extension 15 serving as room for passengers and freight. The outside contour of the side view of this extension is substantially like a rightangled triangle. Body 15 has streamline configuration, particularly in the planes designated by the dotted lines 109, 110 and 111 which 50 are vertical with respect to the sheet of drawings and are in the direction of the air flow resultant from the forward movement of the machine and the air current discharged by the rotor. For resting on the ground the machine is provided 55 with a spur 16 and an undercarriage with wheels 17. Wheels 17 are covered by covers 18. These covers together with the streamlined bodies 19 which are revolvable around vertical axes 112 generate air forces by their form and/or adjustment which counteract the torque of the rotor or produce other stabilizing effects. 60

Fig. 4 is a longitudinal section through a flying machine using my invention in a modified way inasmuch as the motor 25 is arranged in 65 the rear of the room for the passengers and freight and stands on a plane common with the floor plane of said room. The body 20 carries the rotor 21 at its front end. The longitudinal axis 113 of body 20 does not coincide with the 70 rotating shaft 28 of the rotor. In order to obtain the greatest distance possible between the tail unit and the rotor and in order to reduce the height of the flying machine, the longitudinal axis of body 20 forms an angle γ with the re- 75

volving axis of the rotor, and the rear end of body 20 is slightly curved upwards resulting in a saddle-like configuration of the back of body 20.

The wings of rotor 21 are provided at their ends with flaps 22 which are movable and adjustable so that they may be projected from different sides of the plane of rotation of the rotor. They are adapted to periodically change their position in known manner during each revolution and to thereby periodically increase or decrease the lifting force of the individual wing. Other flaps 23 are provided and located closer to the hub of the rotor; these flaps 23 both project from one side of the plane of rotation, and the degree of projection can be adjusted. This adjustment causes a change of the lifting power of the whole propeller. These flaps permit the adjustment of the work done by the rotor as required by a change of the angle α , i. e., the angle formed by the axis of the rotor and the horizon. Below body 20 is an extension 24 adapted to receive passengers or freight. The rotor is driven by motor 25 via gear 26 located adjacent to the motor, the disconnectable coupling 27 and shaft 28. Motor, coupling and gear are in one chamber which is on the same plane as the room for the passengers. The flying machine as illustrated is built as a land plane and is provided with landing wheels.

Fig. 5 is a perspective illustration of a flying machine differing from the previously described machines in regard to its size and the provision of floats 29 instead of landing wheels and the provision of two rotors instead of one. The floats are connected with the fuselage by a frame work in the usual and known manner. The motor is located in the lower part of body 113 and in the rear of the passenger and/or freight room 114, as was the case in the machine shown by Fig. 4. The power is transmitted by shaft 115 to the front end of body 113 and therefrom over a bevel gear to shafts 31 and via further bevel gears covered by hub bodies 116 to the rotors 30. The reduction of speed of the motor to that required by the rotors can thus be conveniently distributed over a plurality of gears. The rotor wings are equipped with a system of flaps projectable from both sides of the plane of rotation and a system of flaps projecting only from one side of the plane of rotation, as is done in the machine shown on Fig. 4. Streamlined bodies 32 are disposed on top of floats 29 and adapted to be rotated around the vertical shafts 117 which serve at the same time to support the rotors 30. These bodies 32 can be adjusted as to their position by the pilot by means of lever 118 rigidly connected to the body and shafting 119 extending into the pilot's cabin 114. Bodies 32 serve by their configuration and position to stabilize the flying machine.

Figs. 6, 7 and 8 illustrate in detail the mechanism for operating the flaps 22 and 23 in the manner stated in the foregoing paragraphs. I wish it to be understood that the mechanism shown is only one of the possible ways to materialize the object of providing the wings of a rotor with a system of flaps adjustable while the rotor is in operation and adapted to affect the lift power of the rotor and to act as balancing means whereby the balancing effect can also be adjusted while the rotor is in operation. The system substantially consists of a pair of flaps 22 and 23 in each wing 21. Flaps 22 can be turned to project above main wing 21 or below it, as is obvious from Fig. 7. Flaps 22 are connected to shafts 88 which are provided with cranks 86 and 87 respectively. The

end of these cranks has the formation of claws 122 adapted to slidably engage disc 85 which does not take part in the rotation of the rotor. As long as this disc is in a position parallel to shafts 88, the position of flaps 22 with respect to wings 21 will be maintained. The angle of the flaps with respect to the wings can be changed by moving disc 85 up or down. If, however, the disc is held in an inclined position, the angle of flaps 22 with respect to wings 21 will continually change during each revolution of the rotor. This can be carried so far that the flaps periodically project underneath and above wings 21. The lift power of the wing will thus continually change during each revolution of the rotor, being largest at a certain position of the rotor and being smallest at the diametrically opposite position. The degree of the inclination of disc 85 can be adjusted while the whole system is in operation by manipulating lever 80. This rotates around fulcrum 81 carried by support 82 which is located in the fuselage of the flying machine. At equal distance from and at both sides of the fulcrum 81, rods 83 and 84 are linked to lever 80; the other end of these rods is linked to disc 85. All this can readily be seen from Fig. 6 and also how disc 85 is adjusted by moving the handle of lever 80 up or down.

Flaps 23, which need not change their position during each revolution of the rotor, are mounted to the hollow shafts 90 and 91 which have cranks 92 and 93 respectively. Each crank has a claw 123 slidably cooperating with disc 94. This disc is rigidly connected to shaft 95 and can be moved up and down by operating lever 97, swinging around fulcrum 96 and having on one end a fork 124; this fork cooperates with projection 25 of shaft 95. For instance, by depressing the left end of lever 97, the fork end pushes shaft 95 and with it disc 94 and cranks 92 and 93 upwards; thereby shaft 91 is turned clockwise and shaft 90 counterclockwise, when observing this operation on Fig. 7, and both flaps 23 are moved in such a way as to further project from the bottom side of wings 21 and increase their lift power. Fig. 8, which is a top view of a rotor provided with adjustable flaps, further assists to illustrate the foregoing. Like numerals on this figure and Figs. 6 and 7 indicate like parts and render Fig. 8 self-explanatory.

To obtain an absolutely smooth operation of the rotor and to eliminate percussions, a hollow rotor can be provided having apertures at the ends of the wings or near the ends, and the rotor can be driven by the reactive action of an air current flowing from the hollow hub of the rotor through the hollow wings and said apertures or in opposite direction. This air current is generated by a blower driven by the motor which is arranged integral with the rotor, as will be more particularly described later. If such a pneumatic drive of the rotor is employed, provision of a brake for the rotor is essential. The air current is also used for cooling the motor or motors directly or for re-cooling the cooling water.

Fig. 9 illustrates a flying machine of the same type as illustrated by Fig. 4 but having a rotor operated by the reactive force of an air current. Rotor 33 is hollow and has at its ends apertures 34 and 35 through which air is either blown out of or taken into the interior of the rotor wings. A motor 38 is located in the lower part of body 37 having a saddle-shaped concavely curved back and in the rear of extension 36. Via gear 39 and the disconnectable coupling 40, the motor drives shaft 41, carrying the rotor 42 of the blower.

Shaft 41 is carried by the bearings 43 and 44. With its ball-shaped end 120, blower 42 extends into the interior of rotor 33 which is equipped with a projecting part 45 of such configuration as to facilitate the air flow between the blower and the interior of the rotor. Rotor 33 is carried by the fuselage by the axial and radial bearing 46. The air is taken in through channel 47 provided within body 37 and is forced by blower 42 into the hollow rotor 33 and leaves this rotor through the apertures 34 and/or 35 which are placed at the rear edge of the rotor wings. The air flow can also be reversed and the air taken in through openings located near the edge of the rotor wings and discharged through channel 47. In this case, the openings must be arranged in the front edge of the wings. In both cases the air passes through a cooler 48 which is connected with the cooling jacket of motor 38 by conduits 126 and 127 and acts as cooler for the cooling agent of the motor.

Fig. 10 illustrates an embodiment of my invention using the pneumatic reaction type rotor drive and an air cooled motor 54 driving the air pump 50 and located adjacent thereto. Blower 50 is rotatably carried by bearings 51 and 52. The air taken in or exhausted by the blower passes through channel 53 in which the motor is located thereby directly cooling the motor. A guide 55 for the air is provided in the interior of rotor 49.

The fuselage of the machine illustrated by Fig. 10 consists of a front part 56 to which a rear part 58 carrying the tail unit is movably linked by means of the hinge 57. During the flight rear part 58 is held in the position indicated by the dotted lines 58' by means of the spring member 59. When landing the spur wheel 60 at the rear end of part 58 rests on the ground thereby bending the rear end 58 upwards against the action of spring 59 and as far as the stop 61 permits. This arrangement provides that the main body of the fuselage is close to the ground when the machine is landed and that the tail unit is at an efficient distance from the center of gravity of the machine and the rotor when flying.

Fig. 11 illustrates a flying machine according to my invention having a motor driven rotor 64 the motor being adjacent to the rotor and under a hood 65 as is the case in the machine illustrated by Fig. 2. The spindle-shaped part of the fuselage consists of two parts 62 and 63 concentrically arranged within one another. The front part 62 carries the rotor 64 driven by the air cooled motor located underneath the annular hood 65 which guides the cooling air and improves its cooling effect. Spring means which are shown for the sake of illustration as a large coil spring 66 tend to push the telescoping part 63 as far back as possible and to hold it at the position indicated by dotted lines 63'. This is the position when flying. For landing the tail end 63 must be drawn into the mother part 62 and maintained in the position shown on Fig. 11. This may be accomplished by providing a rope 67 which is connected to part 63 by means of pin 121 and runs over a roller 68 mounted to and within part 62 to the winding drum 69 located in cabin 70. When in the air the rope can be released and the rear end of the spindle part of the fuselage projected so far back- and downwards that the tail unit operates at best efficiency.

While I believe the above described embodiments of my invention to be preferred embodiments, I wish to be understood that I do not desire to be limited to the exact details of proc-

ess, design and construction shown and described, for obvious modifications will occur to a person skilled in the art.

What I claim is:

1. A flying machine comprising a substantially spindle-shaped body having two ends, a rotor producing lift and propelling power rotatably connected to one end of said body and a tail unit connected to the other end of said body, said body being inclined when flying in a substantially horizontal direction whereby the elevation of said rotor is greater than that of said tail unit, and a compartment protruding forwards and downwards from said body and adapted to receive passengers and freight.

2. A flying machine comprising a substantially spindle-shaped body having two ends, a rotor producing lift and propelling power rotatably connected to one end of said body, and a tail unit connected to the other end of said body, said body being inclined when flying in a substantially horizontal direction whereby the elevation of said rotor is greater than that of said tail unit, and a compartment protruding downwards and forwards from said body and adapted to receive passengers and freight, said compartment having a bottom and a front wall, the longitudinal extension of said compartment having an outside contour forming a substantially rectangular triangle one cathetus of which is formed by the bottom of said compartment the other cathetus by the front wall of said compartment, and the hypotenuse by said body.

3. A flying machine comprising a substantially spindle-shaped body having two ends, a rotor supplying lift and propelling power for said flying machine and rotatably connected to one end of said body, and a tail unit connected to the other end of said body, said body being inclined when flying in a substantially horizontal direction, and a compartment protruding forwards and downwards from said body and adapted to receive passengers and freight, and outriggers protruding from said compartment, said outriggers carrying running wheels.

4. A flying machine comprising a substantially spindle-shaped body having two ends, a rotor supplying lift and propelling power for said flying machine and rotatably connected to one end of said body, and a tail unit connected to the other end of said body, said body being inclined when flying in a substantially horizontal direction, and a compartment protruding forwards and downwards from said body and adapted to receive passengers and freight, and outriggers protruding downwards and sideways from said compartment, said outriggers carrying floats.

5. A flying machine consisting substantially of a plurality of lift and propelling power producing rotors, a substantially spindle-shaped body having a goiter-like extension protruding forwards and downwards from said body and adapted to receive passengers and freight, outriggers connected to and carried by said body, said outriggers carrying adjustable stabilizers and said rotors.

6. A flying machine consisting substantially of a plurality of lift and propelling power producing rotors, a substantially spindle-shaped body having a goiter-like extension protruding downwards and forwards from said body and adapted to receive passengers and freight, outriggers connected to and carried by said body, said outriggers carrying adjustable stabilizers and said rotors, a power plant located within said body,

and power transmitting means connecting said power plant and said rotors.

5 7. A flying machine comprising a substantially spindle-shaped body having two ends, a rotor producing lift and propelling power rotatably connected to one end of said body, and a tail unit connected to the other end of said body, said body being inclined when flying in a substantially horizontal direction, whereby the elevation of said rotor is greater than that of said tail unit, and a compartment protruding downwards from said body and adapted to receive passengers and freight.

10 8. A flying machine comprising a substantially spindle-shaped body having two ends, a rotor producing lift and propelling power rotatably connected to one end of said body, a tail unit connected to the other end of said body, said body being inclined when flying in a substantially horizontal direction, whereby the elevation of said rotor is greater than that of said tail unit, and a compartment protruding forwards from said body and adapted to receive passengers and freight.

15 9. A flying machine comprising a body being inclined when flying in a substantially horizontal direction, a rotor connected to and supplying lift and propelling power to said machine, a compartment protruding downwards from said body and being adapted to receive

passengers and freight, and outriggers protruding from said compartment and carrying stabilizers.

10. A flying machine comprising a body being inclined when flying in a substantially horizontal direction, a rotor connected to and supplying lift and propelling power to said machine, a compartment protruding downwards from said body and being adapted to receive passengers and freight, and outriggers protruding downwards and sideways from said compartment and carrying adjustable stabilizers.

11. A flying machine comprising lift producing means, a body inclined when flying in a substantially horizontal direction, a compartment protruding downwards from said body and being adapted to receive passengers and freight, and outriggers protruding from said body and compartment and carrying said lift producing means.

12. A flying machine comprising supporting means, lift producing means, a body inclined when flying in a substantially horizontal direction, a compartment protruding downwards from said body and being adapted to receive freight and passengers, and outriggers protruding from said body, said outriggers carrying said supporting and lift producing means.

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