Aug. 30, 1932. U. SAVOJA 1,875,267

AEROPLANE

Filed March 26, 1931 3 Sheets-Sheet 1

Fig. 1

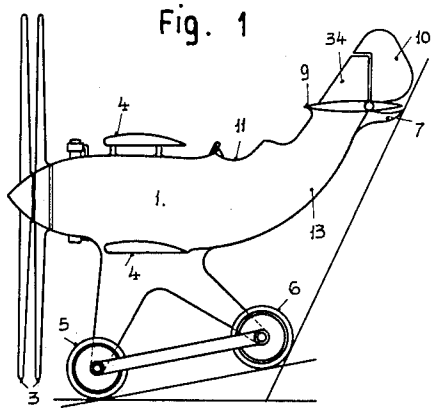

Fig. 2

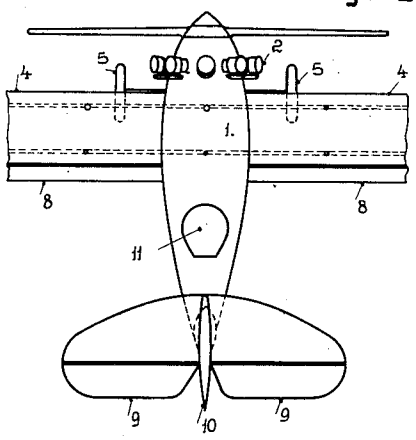

Fig. 3

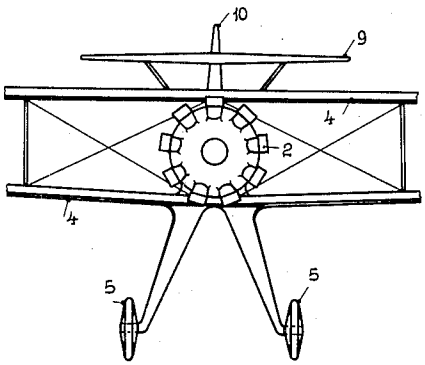

Fig. 4

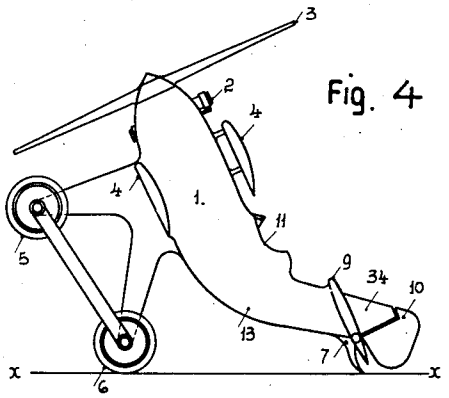

Fig. 5

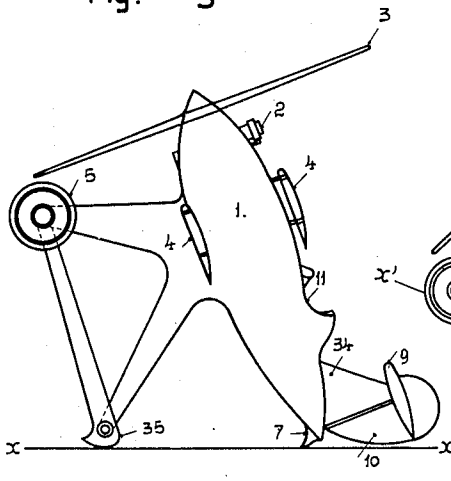

Fig. 6

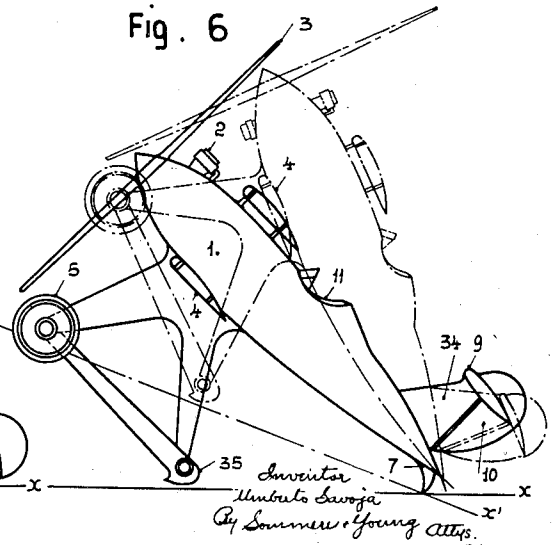

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Fig. 8

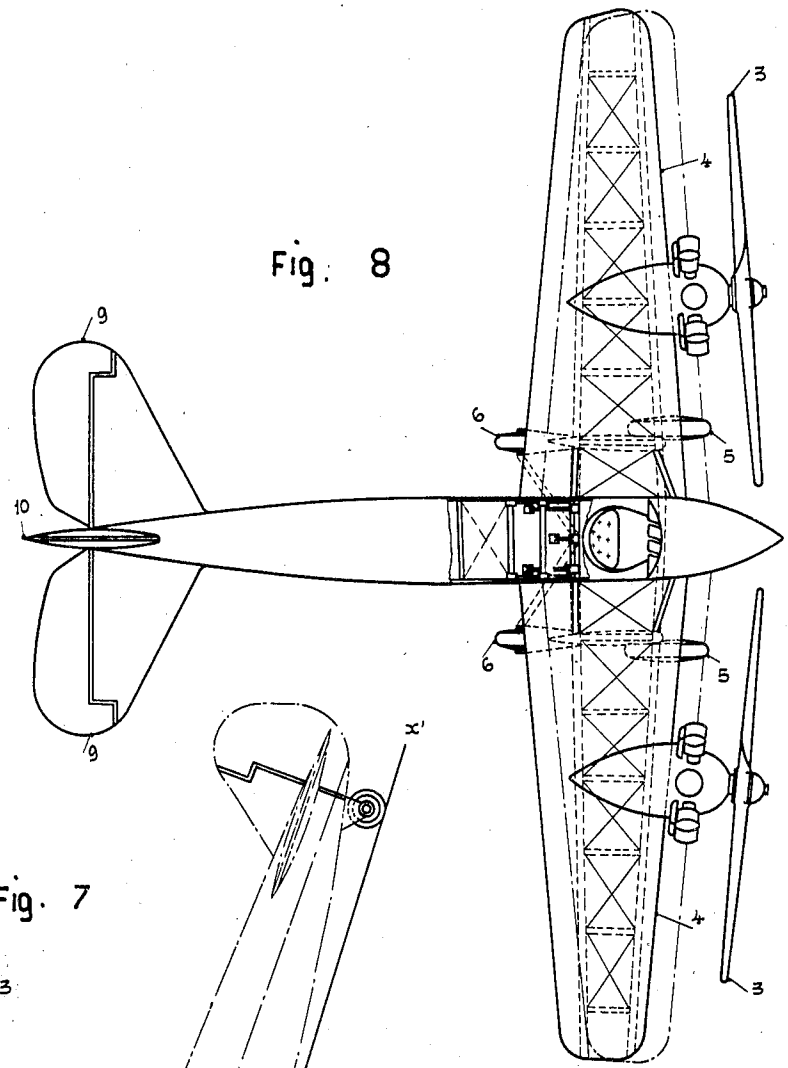

Fig. 7

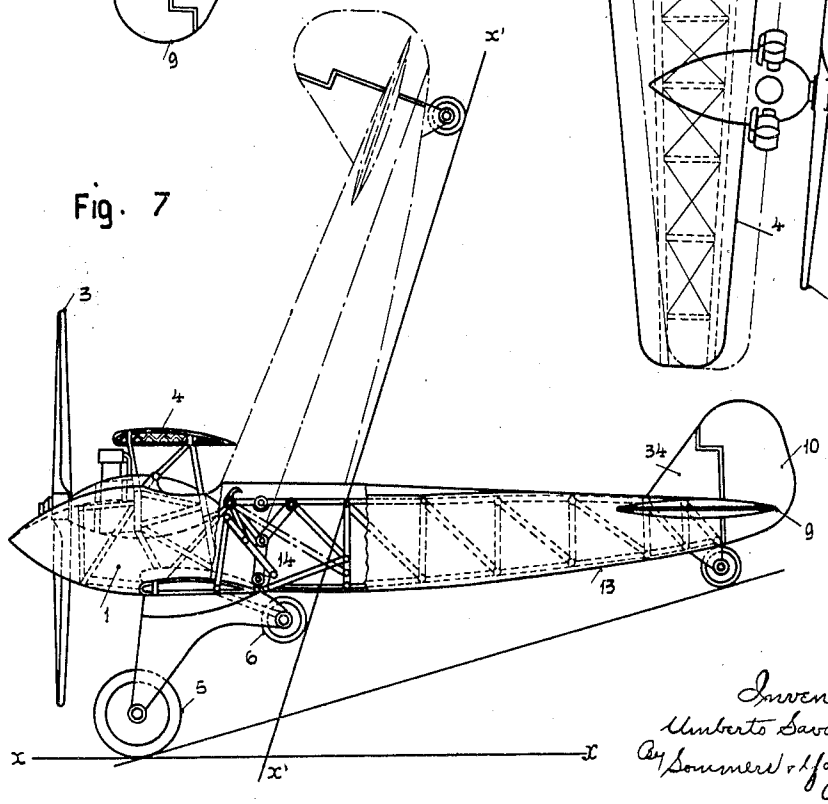

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Fig. 10

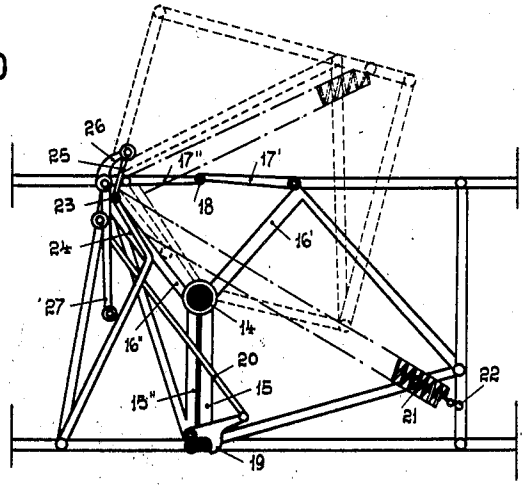


Fig. 11

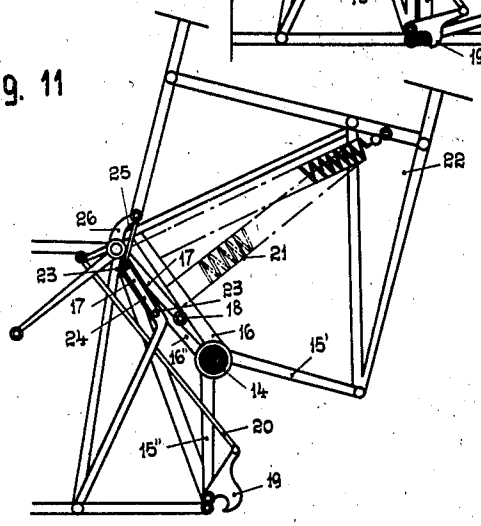
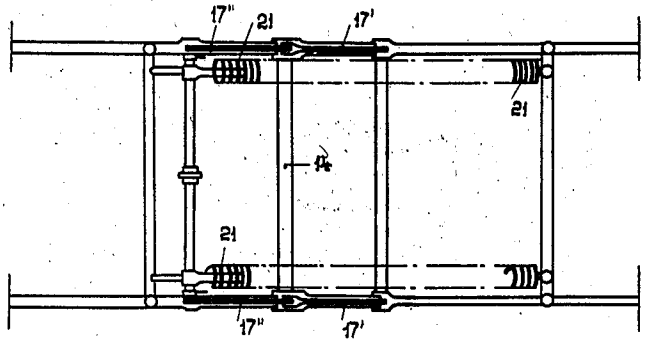


Fig. 9



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UNITED STATES PATENT OFFICE

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AEROPLANE

Application filed March 26, 1931, Serial No. 525,551, and in Italy April 16, 1930.

The drawbacks deriving from the high value of the minimum speeds necessary to keep up the weight of aeroplanes are well known; said speeds require for starting and landing a large and flat ground free from obstacles of any kind or a large quiet water surface. For this reason the launching and alighting places and consequently the range of use of flying machines are necessarily limited, the journeys being bound to said places. This is a drawback of the aeroplane as compared with the helicopter that is in a condition to start and land by ascending and descending vertically even in places of very small area.

It has been proposed to free the aeroplane from such bonds and to enable it to ascend and descend vertically like a helicopter, while remaining capable of travelling horizontally or on even keel in ordinary flight conditions.

Several suggestions have been made as how to reach this purpose, but they all were of no avail as drawbacks of various kinds were connected therewith.

It has been proposed to utilize the air blast from the propellers or propeller slip stream for causing the aeroplane to rise off the ground by producing on an auxiliary suitably designed and arranged surface a strong vertical component exceeding the weight of the flying machine. This method has the drawback that it requires auxiliary lifting surfaces which cannot be adapted to work also as sustaining surfaces during the horizontal flight, so that the usual wings and sometimes also pushing screws other than those ensuring the vertical lift must be used in combination therewith.

It has been proposed further to arrange the same wing serving for the horizontal flight to work also as supporting surface during rising by suitably varying its inclination and by making it of a suitable design. However, a small wing area only is impinged upon by the air blast from the propellers in a flying machine of the usual size and power so that it becomes necessary, in order to cause the full wing area to assist efficiently in rising the machine to distribute the engine power to an adequate number of propellers capable of acting by their slip stream upon practically the full wing surface area.

A third method consists in causing the same screw to work both as lifting screw for ascending and as pushing screw for the horizontal flight.

It has been suggested to carry out this method by employing propellers the axis whereof can be tilted in a vertical plane and is therefore capable of assuming two positions at right angles, a pushing and a sustaining one; this method, however, not only meets with great mechanical difficulties, but also causes the blast from the propellers to react all or in part on the top side of the wings, thus considerably reducing their efficiency.

In order to carry out the principle set forth above, the flying machine should be capable of being tilted back with the propeller shaft in a vertical or almost vertical position for the purpose of ascending and descending vertically or tail-first like a helicopter and with the propeller shaft horizontal or almost horizontal for the flight on even keel as well as for starting and landing in the manner of aeroplanes. This will require two landing frames arranged practically in two planes approximatively orthogonal to each other and the propeller shall be of adequate size in order to work efficiently as sustaining screw, which implies that the screw shall have a larger diameter so that the engine shaft must be kept at a high level from the ground and the aeroplane must be of considerable height. The flying machines of this type should be provided with control means which enable them to go over, while they are up in the air, from a position with horizontal propeller axis to one with vertical propeller axis, and vice versa.

This invention concerns improvements in the flying machines of the type set forth above, which are capable of ascending and descending vertically like a helicopter and of travelling horizontally like an aeroplane, and its object is more particularly to improve the machines of the third above mentioned type in which the propeller works alternatively as supporting and as pushing member, incorporating therein the advantages deriving

from the utilization of the propeller slip stream in order to obtain from a suitable surface an adequate vertical component for the ascent of the machine. This invention does not employ for the object in view a special auxiliary surface, as referred to in the first instance, but it makes use of the same wing area working as supporting surface in horizontal flight, and does not require the whole vertical component to be supplied by this area, the same being largely obtained from the propeller itself by arranging it with strongly inclined axis, so that it works as supporting screw, the vertical thrust whereof is summed up with that of the suitably arranged wing surfaces.

This invention does not require any special type of aeroplane, but merely utilizes the existing types which are suitably modified for the novel method of flight.

The attainment of the desired result is made practically possible by the circumstances which shall be explained hereinafter.

In ordinary constructions, as now in use, and whatever be the specific power (horse power per ton of weight) afforded by the aeroplane, there will always be a screw propeller diameter at which the propeller absorbing the normal engine power is capable of developing with standing flying machine a pushing thrust equal to the aeroplane weight and therefore of working as a helicopter lifting screw, when it is arranged with vertical axis. While the small specific powers (from 100 to 200 horse power per ton) require propeller diameters inadmissible in aeroplanes and allowable only in a helicopter, the higher specific powers nowadays attained by manufacturers together with the use of reducing gears employed in connection with the latest engines, enable screw propellers to be employed which work as lifting screws and are of a diameter such as is practically inadmissible in an aeroplane of correct design.

By way of example, with aeroplanes of 400 horse power per ton developed by engines provided with reducing gears, one screw propeller only having a diameter of less than four meters or two screw propellers having a diameter of less than three meters are sufficient for sustaining the aeroplane weight; in the case of specific powers of 500 horse power per ton one screw propeller having a diameter slightly above three meters or two screw propellers having a diameter slightly above two meters will be sufficient.

An aeroplane of this type is thus in a condition to have its weight balanced by the screw propeller thrust and therefore of being kept up immovable in mid air like a helicopter, sustained by the mere action of the screw propeller when the nose of the machine is turned upwardly.

It is not actually necessary for the flying machine to be lifted upward until the propeller axis assumes a vertical position, since under the action of the air blast on the winged surface, an inclination of the machine at which the resultant of the screw propeller thrust and of the aerodynamic action on the winged surface is directed vertically, i. e. an inclination slightly exceeding 65°, will actually be sufficient.

The invention now consists essentially in the combination, in an aeroplane, of a screw propeller or of two screw propellers having an adequate diameter for supplying with standing machine and in combination with the usual winged surfaces a thrust equal to or greater than the weight of the machine, this latter being provided with means enabling its starting and alighting in a substantially upright position, while allowing launching and alighting also in the position corresponding to horizontal flight with the same features and properties of an aeroplane of the usual type.

It is understood that this aeroplane shall be provided with stabilizing and control members of construction and arrangement such that they can work also in a horizontal flight position, as well as with devices adapted to annul the reaction couple of the propellers when working with standing flying machine.

The accompanying drawings show diagrammatically by way of example some constructional forms of the aeroplane according to this invention.

Figures 1, 2 and 3 show in side, plan and front view, respectively, a first construction of the aeroplane with fixed intermediate frame in the position of flight on even keel.

Figure 4 is a side view of the same machine in its vertical flight position.

Figure 5 is a side view of a second construction differing from the former through the rectilinear shape of the body of the aeroplane and through the use of a fixed skid in lieu of the intermediate frame.

Figure 6 is a side view of a modification of Figure 5.

Figures 7 and 8 are a side and a plan view, respectively of a further construction in which the body is made of two portions hinged together, the position taken by the fuselage rear portion when the aeroplane is about to rise vertically off the ground being shown in dash and dot lines.

Figures 9, 10 and 11 show details of the hinge connecting the aeroplane body with the rear fuselage portion.

The same reference characters denote similar parts throughout the figures of the drawings.

1 denotes the body of the flying machine, 2 the engine which is provided with a reducing gear, 3 the screw propeller. This latter is made of a large diameter for meeting the

above explained requirements. 4 denotes the winged surface, 5 the usual landing frame for the horizontal flight; 6 the intermediate landing frame or skid for the vertical flight; 7 the tail skid used both in horizontal and in vertical landing; 8 the ailerons which are made larger in the portion which is arranged in the propeller slip stream; 9 the elevator flaps; 10 the vertical rudders, 11 the cock-pit, 12 the controls and 13 the tail.

As is clearly shown on the drawings, in the construction of Figs. 1, 2, 3 and 4 the tail is shorter than usual and cambered upwardly to permit of the rudders to remain in the propeller slip stream and of the flying machine to start and land both in the position of horizontal flight appearing in Fig. 1 and in the position of vertical flight appearing in Fig. 4.

In the construction of Fig. 5 the body is again shorter than usual, but its axis is rectilinear and the elevator flaps are supported by a larger vertical keel 34.

Fixed skids 35 are employed in lieu of the wheels 6 of the intermediate frame. In this construction also, the starting and landing position corresponds with the vertical flight position.

In these figures the position of the plane on which the flying machine rests at vertical starting and landing is denoted by the line X—X.

In the construction shown in Fig. 6, these two postions no longer correspond, as in this case the launching and alighting position is less erected than that of vertical flight in order to allow of a greater length of the machine.

In this construction the flying machine is bound, on starting, to complete its erection in order to take the flight position and on landing it touches the ground first by its tail skid and tilts then forward until the intermediate skid reaches the ground.

Figure 7 is a side view and Fig. 8 is a plan view of a construction in which the double landing position is obtained by an intermediate articulated joint of the fuselage between the body 1 and the tail 13, the two positions of this latter with respect to the body of the flying machine being indicated in full and in dash and dot lines, respectively, while the planes on which the machine rests on the ground are denoted by the lines XX and X′X′, respectively.

The joint is shown in detail in Figures 9, 10 and 11, in which it is drawn in plan and in side view in the closed and open position, respectively.

The object of this joint is to permit at starting and landing the automatic rotation of the tail 13 about a hinge 14, so that the tail axis which in normal conditions is in alignment with the axis of the body 1 of the flying machine is brought approximatively to right angles to this latter.

As it appears from these figures, the axis 14 of the hinge constitutes the common edge of two dihedrons, constituted by the rods 15′—16′ and 15″—16″ of which the faces determine the contact surfaces of the body and tail in the open and closed position of the hinge, respectively. The rods 15′ 16′, 15″ 16″ are arranged by pairs on the two sides of the fuselage; the closed position of the hinge, in which the axes of the body of the aeroplane and of the tail are in alignment is shown in Fig. 10, and as it appears from this figure the rods 15′ and 15″ are in this case in contact; the open hinge position, in which the axes of the body of the aeroplane and of the tail are at approximatively right angles, is shown in Figure 11 and in this case the rods 16′, 16″ are in contact with each other.

In the closed position according to Figure 10, the ends of the rods 16′ 16″ are connected together by means of two intermediate connecting rods 17′ 17″ hinged together at 18; these intermediate rods are tilted inwardly on opening of the hinge as shown in Fig. 11. As shown in Fig. 8, the ends of the rods 15′ 15″ are held together in the closed hinge position by a hook 19 operated by a rod 20, which is lifted to the position shown in Fig. 11 upon opening of the hinge.

The body 1 and the tail 13 are further connected together by the springs 21, one end of which is attached to a fixed point 22 of the tail framework, while the other end is attached to a slide 23 movable in a guide groove 24. In this motion the slide remains constantly connected to a rod 25 hinged to the crank 26, the position of which is controlled by the rod 27 through suitable controls within the pilot's reach. The two positions of the movable slide 23 and 23′ are such that in one of them the action of the tail weight slightly prevails over the spring action, while in the other position it is the spring action that slightly prevails. The position 23 corresponds to landing with prevailing spring, and the position 23′ corresponds to starting with prevailing tail weight.

It will be understood that the particular construction of the flying machine as well as its peculiar working put special requirements to its manufacture, first of all a wing shape implying the smallest displacement of the point of application of the sustaining resultant; a considerable width exceeding that usually adopted of the ailerons and of the steadying surfaces; adoption, in case of need, of vertical keels for annulling the propeller reaction couple in vertical flight; separation, if necessary, of the horizontal flight wings from those in the propeller slip stream; use of a screw propeller capable of supplying the thrust necessary for the vertical ascent and affording a good efficiency at

maximum speed of horizontal flight. It may be necessary to adopt a variable pitch propeller in order to meet both these last-mentioned requirements. When two propellers are employed, they can both be driven by the same engine arranged with transverse axis, the two propellers being connected therewith by bevel gears provided at the ends of the engine axis.

The aeroplane described above works as follows:

The machine starts in the vertical flight position with engine going full swing and rises vertically; when it has adequately risen, it tilts forward and goes over gradually to the flight on even keel. All the stabilizing members are controlled in this period as in an ordinary aeroplane. The lifting thrust of the propeller becomes a pulling thrust, the pitch being varied in the case of a variable pitch propeller.

In the flight on even keel the aeroplane is controlled like the usual machines. In case of stoppage of the engine it can effect a gliding descent, while if the engine keeps running the aeroplane lands in vertical flight.

For this purpose the pilot retards the speed of the propeller until this latter exerts a resisting instead of a pulling action and the momentum of the machine rapidly decreases, the nose of the machine is turned upwards until the inclination corresponding to the maximum lift power (about 14°) is reached.

Having thus attained the minimum speed and the maximum reaction of the air on the winged surface, the pilot again clutches in the engine and sharply tilts back the machine to elevate its forward end up to 40°. The machine thus rapidly overcomes the loss in lift power which takes place when the wings are between 14° and 40°. In this new position, the wings effect a braking action and the horizontal speed falls lower down until, by further lifting forward the machine and bringing the propeller thrust to a maximum, the horizontal speed is brought to nought and the machine is set for vertical flight.

It is obvious that the constructions illustrated on the drawings are to be regarded merely as examples; the aeroplane may be a monoplane instead of a biplane, it may have two propellers co-axial to each other or with parallel axes rotating in opposite directions and it may generally adopt any improvements and forms as are used in the usual aeroplanes intended for horizontal flight.

What I claim is:

1. Aeroplane capable of ascending and descending vertically and of flying horizontally comprising, in combination with propellers and wings capable to generate with a stationary flying machine a vertical thrust greater than the weight of the aeroplane, a fuselage angularly bent so as to carry the tail upward, a frame at the front portion of the fuselage, a tail skid at the rear portion of the fuselage and an intermediate fixed supporting member arranged in such manner that by acting in combination with the bent tail it permits two landing positions, one with horizontal axis or nearly horizontal axis of the flying machine and the other in which said axis is strongly inclined to the horizontal axis.

2. Aeroplane capable of ascending and descending vertically and of flying horizontally comprising in combination with propellers and wings capable of generating with a stationary flying machine a vertical thrust greater than the weight of the aeroplane, a fuselage bent to form an angle so as to carry the tail upwards, a frame at the front portion of said fuselage, a tail skid at the rear portion of said fuselage and an intermediate fixed frame arranged in such manner as to co-operate with the front frame for permitting landing and launching in a substantially horizontal position and with the tail skid for permitting landing and launching in a position with an axis strongly inclined to the horizontal axis.

3. Aeroplane capable of ascending and descending vertically and of flying horizontally comprising in combination with propellers and wings capable of generating with a stationary flying machine a vertical thrust greater than the aeroplane weight, a fuselage bent to form an angle so as to carry the tail upwards, a frame at the front portion of the fuselage, a tail skid at the rear portion of said fuselage and a double intermediate skid fast with said frame and arranged in such manner as to cooperate with said frame for alighting and launching with horizontal axis and with said tail skid for alighting and launching with strongly inclined axis, respectively.

4. Aeroplane capable of ascending and descending vertically and of flying horizontally, comprising in combination with propellers and wings capable of generating with a stationary flying machine a vertical thrust greater than the aeroplane weight, a fuselage consisting of two foldable sections so as to carry the tail upwards, a hinge between said sections comprising a spring fixed by one end to a point of the fuselage structure and by its other end to a movable slide, a guide for said slide fixed to the aeroplane body, said slide being brought by the pilot at will through a suitable transmission into two different positions, in one of which, corresponding to the landing position, the action of the spring on the tail slightly prevails over the action of the tail weight, while in the other position, corresponding to the launching position the tail weight slightly prevails over the spring action, a frame fixed to the front

portion of the fuselage, a skid fixed to the rear section of the fuselage and an intermediate frame fixed to the first mentioned frame and arranged in such manner as to co-operate with the front frame for permitting landing in a substantially horizontal position, and with the tail skid for permitting launching in a substantially vertical position.

In testimony that I claim the foregoing as my invention, I have signed my name.

UMBERTO SAVOJA.