R. ESNAULT-PELTERIE.

AEROPLANE.

APPLICATION FILED MAY 19, 1908.

1,024,928. Patented Apr. 30, 1912.

3 SHEETS—SHEET 1.

Fig. 1.

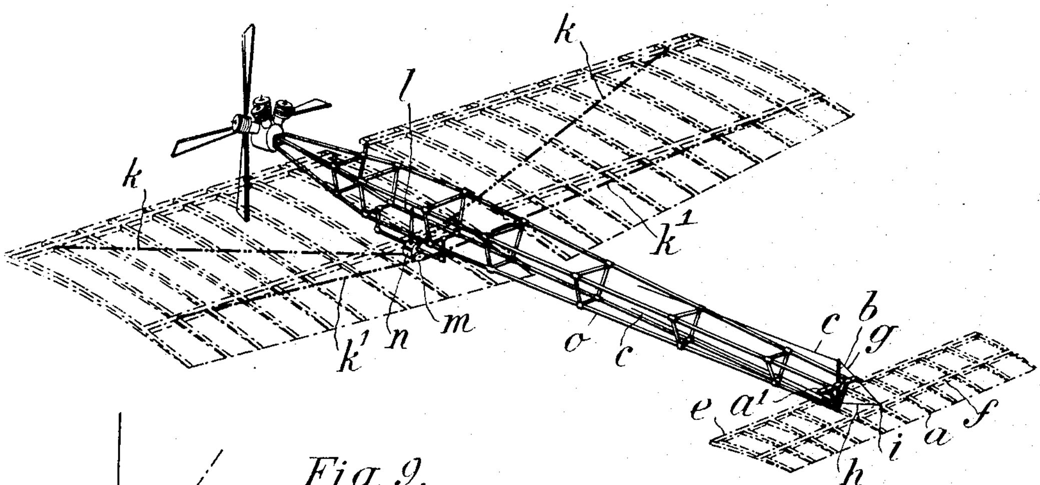


Fig. 9.

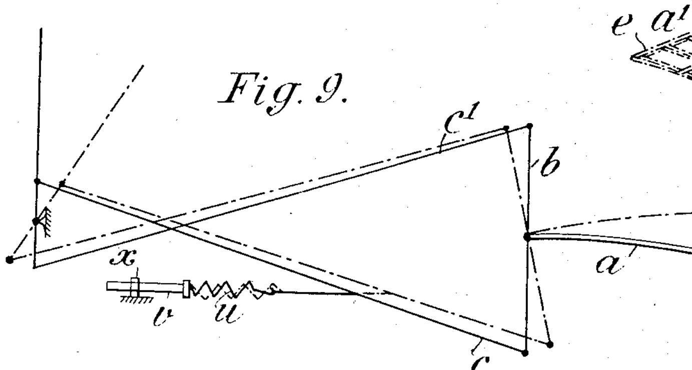


Fig. 12.

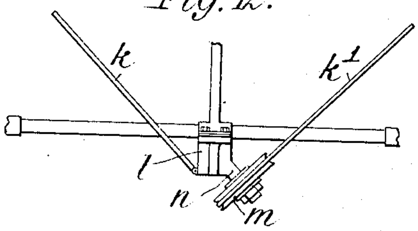
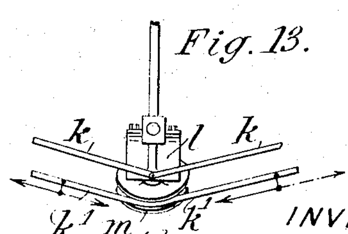


Fig. 13.



WITNESSES:

René Bruine

William F. Martinez

INVENTOR:

Robert Esnault-Pelterie,

By Attorneys,

Fraser Turk & Myers

Eugene V. Myers

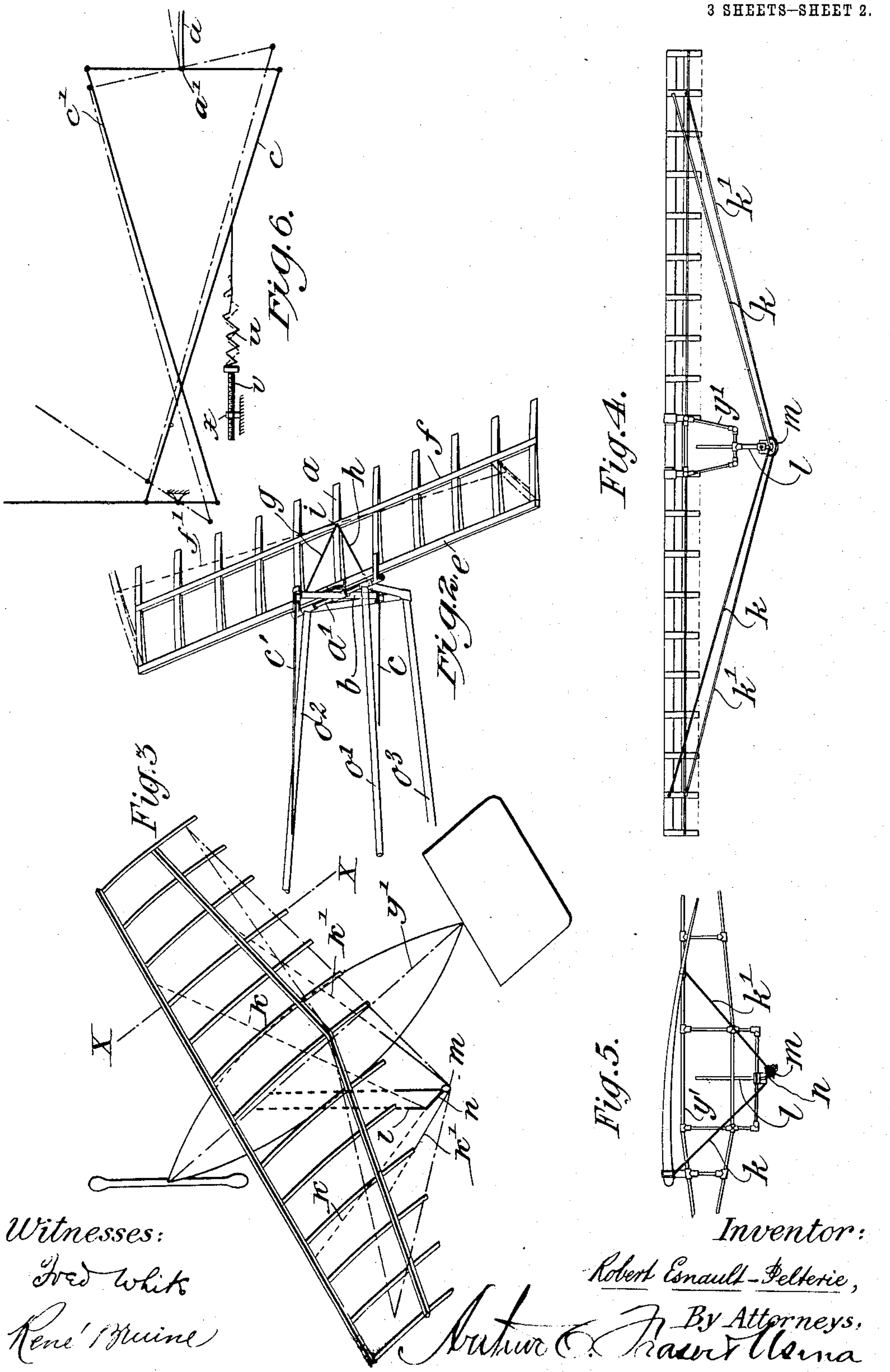
R. ESNAULT-PELTERIE.

AEROPLANE.

APPLICATION FILED MAY 19, 1908.

1,024,928. Patented Apr. 30, 1912.

3 SHEETS—SHEET 2.



Witnesses:

Fred White

René Bruine

Inventor:

Robert Esnault-Pelterie,

By Attorneys,

Arthur E. Fraser Usina

R. ESNAULT-PELTERIE.

AEROPLANE.

APPLICATION FILED MAY 19, 1908

1,024,928. Patented Apr. 30, 1912.

3 SHEETS—SHEET 3.

Fig. 10.

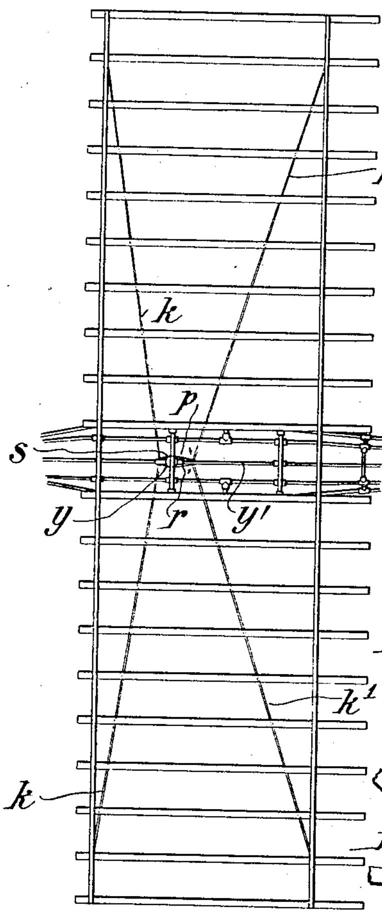


Fig. 7.

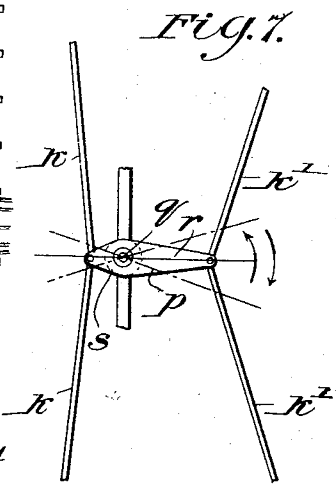


Fig. 8.

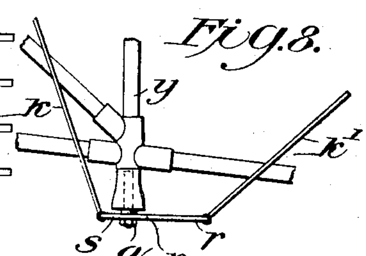
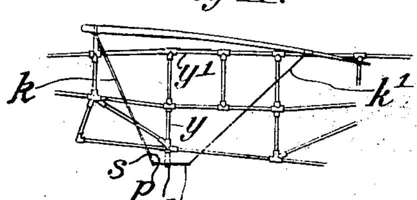


Fig. 11.



Witnesses:

Fred White

René Bruine

Inventor:

Robert Esnault-Pelterie,

By Attorneys,

Arthur C. Fraser Usina

UNITED STATES PATENT OFFICE.

ROBERT ESNAULT-PELTERIE, OF BILLANCOURT, FRANCE.

AEROPLANE.

1,024,928. Specification of Letters Patent. Patented Apr. 30, 1912.

Application filed May 19, 1908. Serial No. 433,789.

To all whom it may concern:

Be it known that I, Robert Esnault-Pelterie, a citizen of the Republic of France, residing in Billancourt, Seine, France, have invented certain new and useful Improvements in Aeroplanes, of which the following is a specification.

When an aeroplane moves in still air or in a uniform current of air, the aeronaut is able to effect in a positive manner the deformation of the supporting and steering surfaces, required for changing the direction of travel of the air-ship and insuring its stability. These conditions of stillness or regular movement of the air are, however, exceptional, since on the contrary the masses of air do not as a rule form homogeneous currents, but present all kinds of whirls and cross-currents which are apt to endanger the aeroplane by rapidly changing the conditions of stability and direction. It is for this reason necessary that the carrying and steering surfaces should be able to alter their form automatically as rapidly as possible so as to balance and compensate for the influences disturbing and destroying the stability and the course of the air-ship.

The present invention has for its object a system of surfaces arranged in a manner to allow of this sudden and automatic deformation.

The system of surfaces consists in principle of two beams arranged transversely to the axis of the aeroplane, which beams are rectilinear, broken or curved and are connected to each other by bracing or lacing which is either sufficiently elastic, namely capable of deformation, and fixed at its ends rigidly to the beams, or is rigid in itself but mounted with a certain play on, or articulated to, the beams. These surfaces which are of course covered with an impermeable and slightly elastic cloth, are kept under tension and maintained by ropes in such a manner as to allow of the automatic warping of the surface by the displacement of one beam relatively to the other. This manner of mounting and connecting the ropes permitting the said deformation, may be realized in different ways, some of which will now be described. In all these various modifications the keeping of the surface under tension is designed in such a manner as to allow of an automatic variation of the angle of inclination, the variation on one side of the carrying surface being in a sense opposite to the variation of the other side, so that the pressure immediately decreases on one side and simultaneously increases on the other side, whereby the equilibrium of the ship is automatically restored. This deformation continues so long as there is a difference of forces acting on the two sides of the surfaces, but ceases at once when such difference disappears.

The invention is illustrated in the accompanying drawings and will be more specifically described with reference thereto:

In these drawings, Figure 1 is a perspective view of the complete machine, the wings and the tail being indicated in dotted lines to avoid obscuring the frame. Fig. 2 is a perspective view on a larger scale of the tail or rudder. Fig. 3 is an explanatory diagram. Figs. 4 and 5 are respectively an end and side elevation of the supporting wings and adjacent parts. Fig. 6 is an explanatory diagram. Figs. 7 and 8 are respectively a plan and side elevation of a device for connecting the ropes which permit the automatic warping of the wings. Fig. 9 is a diagrammatic elevation of the rear part of the aeroplane. Figs. 10 and 11 are respectively a plan and side elevation of the supporting wings used in the warping mechanism shown on a larger scale in Figs. 7 and 8. Figs. 12 and 13 are respectively a side and a rear elevation of the connecting means between the warping ropes of Fig. 1.

As shown in Figs. 1, 2 and 9 the tail or rudder *a* is adapted to be turned about a horizontal axis *a'* by means of a double vertical rod *b* to the ends of which is secured the rope *c*. The said rudder consists of two parallel rigid beams *e*, *f* connected by a series of suitably spaced cross members having a certain curvature. The rudder is held only by two tie-ropes *g*, *h*, which are secured to the middle of the beam *f* so as to allow an automatic deformation of the rudder, the beam *f* being enabled to turn about the point of connection *i* of the tie-ropes *g*, *h* and take up for instance the position *f'* indicated in dotted lines in Fig. 2. This arrangement has the advantage of allowing the rudder to yield to a certain extent under sudden wind blasts without developing at any time a torsional couple which might interfere with the control. As a matter of fact, if (in Fig. 1) it is assumed that a wind blast is acting on the right side of the rudder, this side being subjected to a greater lifting force than the other side, will tend to rise, while the left side will tend to drop. Since the front beam e is held by the frame indicated as a whole at o, Fig. 1, and at o' o^2 and o^3 of Fig. 2, it cannot conform to this movement and therefore only the rear beam f can accomplish it by turning in the point i. By this movement which, owing to the small weight of the parts, takes place rapidly, the whole right hand side of the surface decreases its angle of inclination to the disturbing force, whereas the inclination of the left side increases. It will thus be seen that the automatic movement of deformation corrects the harmful effect of the assumed wind blast. In addition to that, the deformation not only neutralizes the disturbing influences but also automatically ceases when the forces acting on the two halves of the surface correspond to equal couples with regard to the horizontal axis o.

Assuming that in Fig. 3 Fv represents the resultant of the elementary lifting forces corresponding to the right half of the front bar e, Fa that exerted on the right half of the rear bar f, Fv' the resultant of the elementary lifting forces corresponding to the left half of the front bar e, Fa' that exerted on the left half of the rear bar f, then the proportions

$$\frac{Fa}{Fv}, \frac{Fa'}{Fv'}$$

are always equal for very small variations of the inclination, and

$$\frac{Fa}{Fv}=\frac{Fa'}{Fv'} \quad (1)$$

for the whole deformation of the surface for the reason that the proportion of the elementary forces

$$\frac{dFa}{dFv}$$

which constitute the same is constant all along the bars e, f, as is proved by experience.

It has been shown that the beam f turns freely about point i. It will therefore discontinue its movement only when the couples due to the forces Fa and Fa' become equal and of opposite signs. Since these forces are disposed in the same manner on both sides of z z' equilibrium will occur when $Fa=Fa'$. From Equation (1) it now follows that $Fv=Fv'$ and therefore $Fv+Fa=Fv'+Fa'$. The couple of the front bar will always be *nil* at the same time as that of the rear bar, and as the equilibrium is attained only when the said couple is *nil*, this couple as also the total couple will always remain *nil*, or approximately so. The rudder or surface so constructed will therefore never have any tendency to turn about the axis z, z' parallel to the direction of travel, whatever wind blasts it may encounter, and the aeronaut will have to deal only with the mean average of the automatic movements in order to preserve the equilibrium.

In order to enable the automatic warping of the wings to take place the front tie-ropes k of the aeroplane (Figs. 1, 4, 5, 12 and 13) may be fastened to a fixed point of a vertical rod l situated underneath the aeroplane. As regards the rear tie-rods k' these are formed by one single rope which passes over a pulley m carried by an arm n projecting from the rod l. Thus, only the rear portions of the wings will be automatically deformed, the deformation on one side being opposite to that on the other side, whenever a wind blast causes the rope constituting the tie-ropes k' to slide over the pulley m.

Another solution represented in Figs. 7, 8, 10 and 11, is such as to allow of the warping of both the front and rear portions of the wings when the deformation takes place. To this end, use is made of a vertical rod y fixed to the body y', to which is pivoted a horizontal lever p the ends of which are connected to the front tie-ropes k and the rear tie-ropes k'. The position of the point of articulation q of the lever p is so chosen that the couple exerted by the rear tie-ropes k' on the said lever shall be larger than that exerted by the front ropes k. In this way on the slightest pressure being exerted on one wing in excess of the simultaneous pressure upon the other wing, the rear portion of the wing will rise and the front portion will drop. To this end, the arm r of the lever may be made suitably larger than the arm s.

The above arrangements have reference to the transverse equilibrium. The disposition now to be described has for its object to insure equilibrium in the longitudinal direction.

In order to enable the rudder to give way by rising vertically under a sudden blast coming from underneath, the lower rope c (Fig. 9) of the two ropes c, c' which serve for turning the rudder about its horizontal axis a' may be connected by a spiral spring u or any other elastic connection to a suitable point of the beam of the aeroplane. This elastic connection may be fixed to a threaded rod v adapted to be screwed more or less into a nut x secured to the beam of the aeroplane, or any other suitable adjusting device may be used instead. As will be understood, whenever a sudden blast is exerted on the rudder or tail a, the rudder can turn around its axis a', since the spring u or other elastic connection interposed will give way. When the abnormal pressure ceases the rudder at once returns to its ordinary position of rest.

Having thus described the nature of this invention and the best means I know of carrying the same into practical effect, I claim:—

An aeroplane comprising oppositely extending supporting wings, front connecting means between said wings at the front, rear connecting means between said wings at the rear, each of said connecting means being mounted to yield laterally to permit the rising of part of a wing at one side and to cause the lowering of part of the corresponding wing at the other, and a reversing lever between the front connecting means and the rear connecting means and having its longer arm connected to the rear connecting means.

In witness whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

ROBERT ESNAULT-PELTERIE.

Witnesses:

MARCEL ARMENGUARD,

H. C. COXE.