Feb. 3, 1931. L. BREGUET 1,791,233

AEROPLANE WING

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Fig. 1

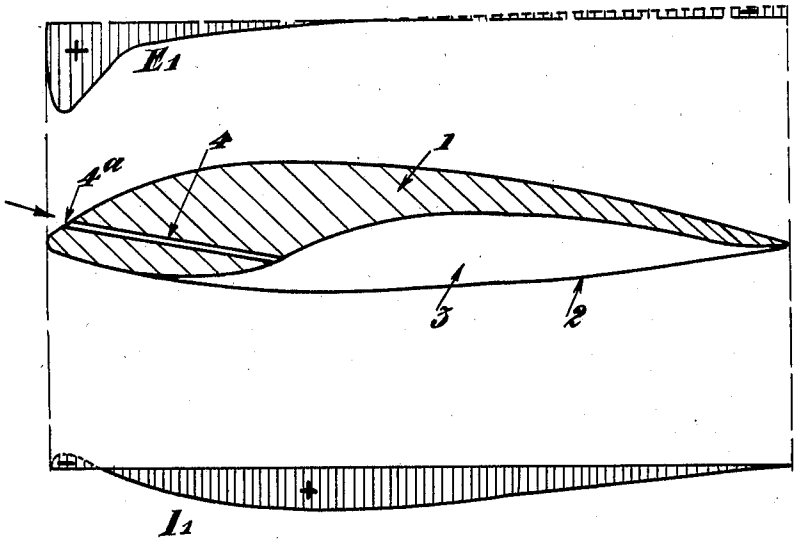
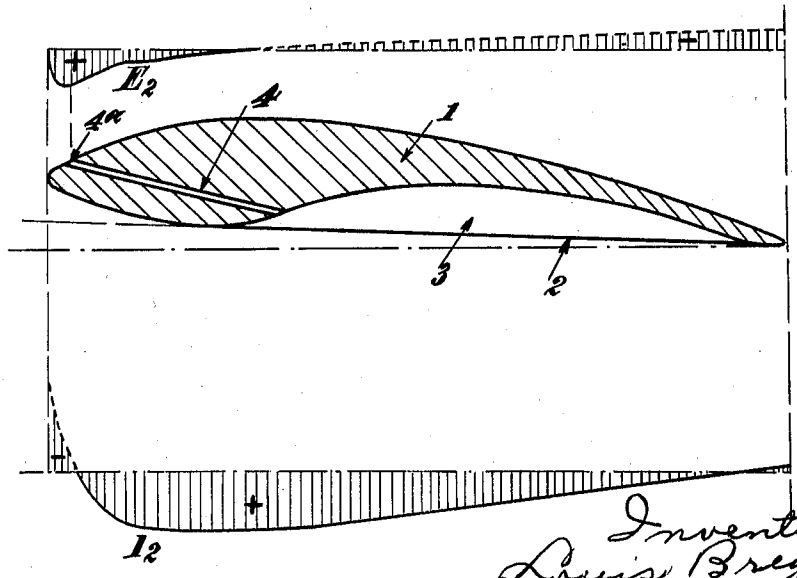


Fig. 2



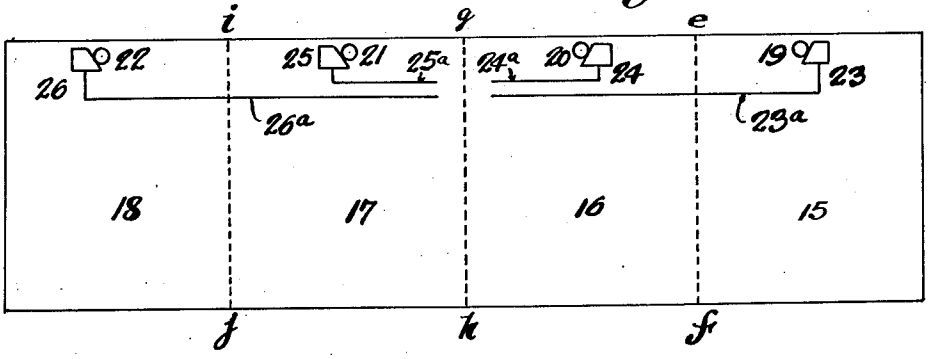
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AEROPLANE WING

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Fig. 6.



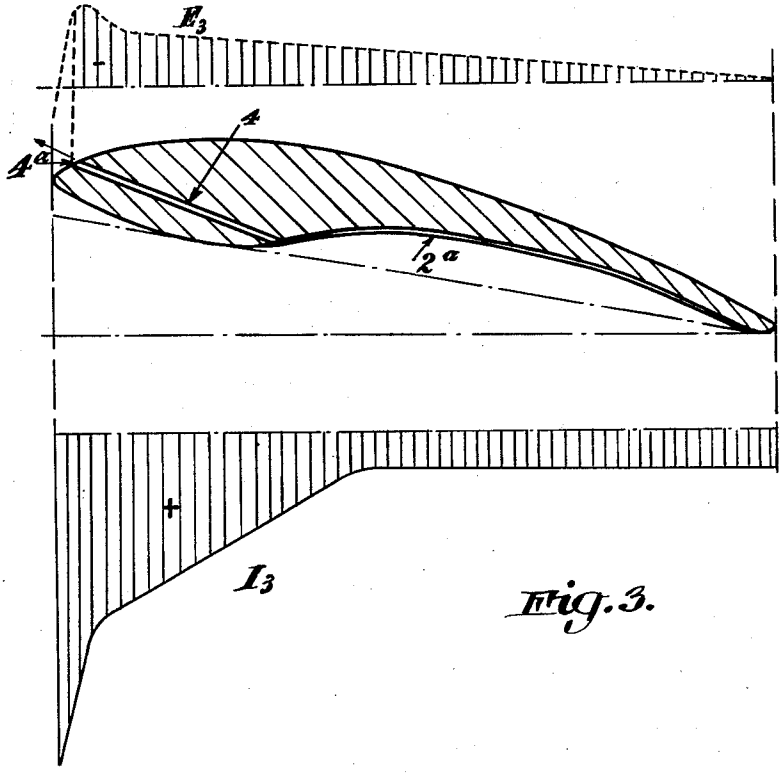


Fig. 3.

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Fig. 4

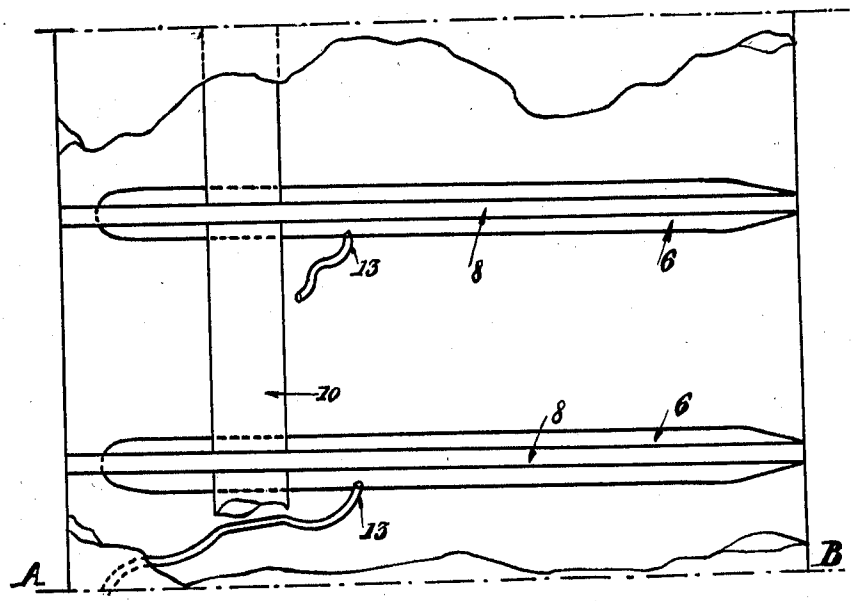
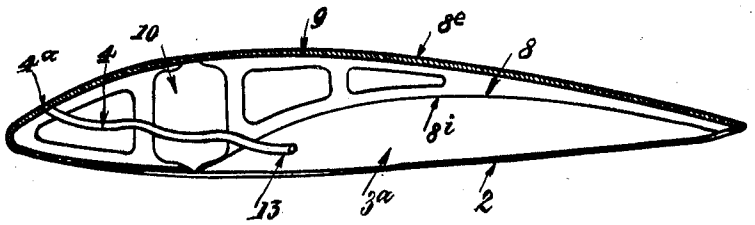


Fig. 5



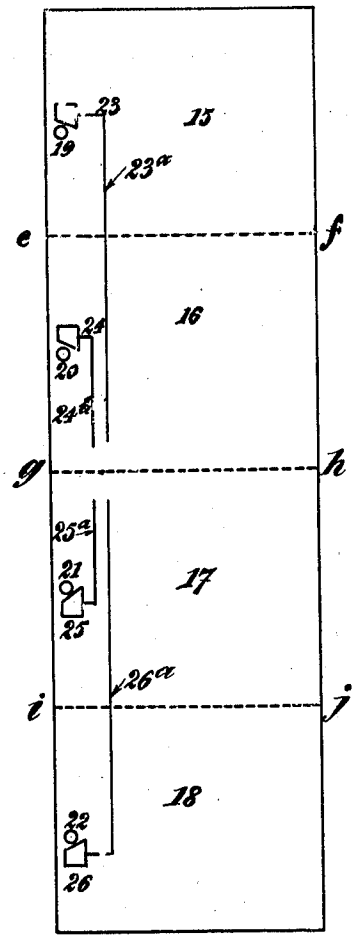
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AEROPLANE WING

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Fig. 6



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Patented Feb. 3, 1931 1,791,233

UNITED STATES PATENT OFFICE

LOUIS BREGUET, OF PARIS, FRANCE, ASSIGNOR TO SOCIETE ANONYME DES ATELIERS D'AVIATION LOUIS BREGUET, OF PARIS, FRANCE, A COMPANY OF FRANCE

AEROPLANE WING

Application filed May 21, 1928, Serial No. 279,467, and in France June 25, 1927.

The invention has for an object an aeroplane wing whose leading edge and extrados form a rigid assembly containing the framework and whose intrados is constituted by a flexible wall adapted to be deformed under the action of a gaseous pressure.

The said gaseous pressure is generated either by the dynamic action of the relative wind, or by other suitable means such as a fan or the exhaust gases.

By altering the said pressure, a scale of different outlines may be established suitable in each case for the end sought to be attained.

The said alteration in pressure may be either automatic or controlled.

The following description taken in connection with the accompanying drawing, given by way of an example, will enable the invention to be readily understood by those skilled in the art.

In the drawing:—

Figs. 1, 2 and 3 illustrate a wing in different incident positions and show diagrammatically in section the configurations of the intrados as well as the pressures which are exerted on the intrados and extrados;

Fig. 4 is a plan view with parts broken away to show the inner structure of the wing;

Fig. 5 is a section taken along the line A—B of Fig. 4; and

Fig. 6 is a diagrammatic view in plan of a modified form of wing.

As shown in Fig. 1, the water tight wing 1 has its intrados formed by an elastic movable wall 2 of rubber, cloth or other suitable covering material, in such wise as to establish on the interior of the wing a pocket 3, in which a dynamic pressure is maintained by means of a suitably regulated nozzle 4, placed in the direction of the relative wind. The regulation is such that at a mean angle of attack, not very different from the zero lift angle, the pressure maintained in the wing acting on one of the faces of the elastic wall will be equal and opposed to the mean exterior pressure acting on the other face of said wall and giving rise to sustentation.

Under these conditions the elastic wall occupies the position of equilibrium which is illustrated in Fig. 2. The rigid part of the outline is preferably studied in connection with this position of equilibrium of the wall, with a view of establishing the best aerodynamic qualities possible in maximum sensitiveness flying.

This equality of pressures obtained at a relative wind speed of predetermined magnitude will still be the same at other speeds as the two pressures considered are both proportional to the square of the speeds.

Supposing the wind speed to be constant, if the incidence of the wing be increased (Fig. 3) the thrust increases and as a result the mean pressure acting on the exterior surface of the wall of the intrados likewise increases and the intrados can then bear against the bottom of the rigid part of the wing, as will be pointed out hereinafter.

In the case where the dynamic internal pressure is maintained by a nozzle, whose direction remains fixed with respect to the wind, the dynamic pressure acting on the interior surface of the wall will remain constant.

If, however, the nozzle is fastened to the wing, then it is established that the pressure maintained thereby diminishes when the incidence increases. It suffices if the arrangement or position of the nozzle with respect to the wing is such that the wind strikes the nozzle more and more obliquely as the incidence of the wing grows larger.

The internal pressure likewise diminishes with large angles of attack if it is maintained by orifices suitably disposed in the outline. This is shown by the curves representing the distribution of pressure at different incidences. The curves marked E_2 and E_3 represent the extrados whereas those indicated by I_2 I_3 represent the intrados in Figs. 2 and 3 respectively.

The curves in full lines represent the increase in pressure with respect to the static or atmospheric pressure and the curves in dotted lines represent the diminution in pressure with respect to the static pressure. The orifice 4^a of nozzle 4 is provided in a part of the surface outline where the absolute pressure is greater in the case of Fig. 2 (over pressure) than the pressure and in the case

of Fig. 3 (under pressure). When the pressure is maintained by orifices such as the orifice 4^a suitably disposed the internal pressure diminishes as the incidence increases. It results that, in the case of flying with large angle of attack, the pressure maintained by the nozzles or orifices in the interior of the wing on the internal surface of the elastic wall generally become inferior to the pressure acting on the exterior surface of the wall. The intrados of the outline then becomes strongly hollow and occupies the position 2^a (Fig. 3).

If on the contrary the angle of attack is diminished (Fig. 1) by maintaining a constant wind speed, the thrust grows less and the mean pressure on the exterior surface of the wall likewise grows less.

If the dynamic pressure is maintained by a nozzle whose direction remains fixed with respect to the wind, the dynamic pressure remains constant.

If the nozzle is fastened to the wing, it may be wedged therein that is to say disposed with respect thereto in such wise that the dynamic pressure increases when the angle of attack diminishes. It is sufficient for example that the axis of the nozzle make with the chord of the wing an angle superior to the zero lift angle.

In the case where the pressure is maintained by orifices such as orifice 4^a shown in Fig. 1, the distribution pressure curves shown at E_1 and I_1 compared with the curves E_2 and I_2 show that the pressure transmitted to the interior of the wing through the orifice increases as the incidence diminishes.

It results therefrom that in the case of flying with small angle of attack the pressure acting on the interior face of the elastic wall generally becomes greater than the pressure acting on the exterior surface. The intrados greatly swells and occupies the position such as that of Fig. 1.

These automatic deformations produce the following advantages:

1. Improvement of the polar axis:—

With angles in the neighborhood of zero lift angle the outline possesses the good qualities of sensitiveness of plano-convex outlines.

With large angles of attack, the outline presents the advantages of biconvex outlines, slightly drooping at light loads.

The polar axis of the wing with elastic intrados and internal dynamic pressure is thus constituted by the assembly of points of the polar axes which are the most advantageous of the principal sets of outlines.

2. Diminution of the displacement of the center of thrust:—

In the ordinary rigid outlines the center of thrust becomes strongly displaced. It becomes about 28% of the depth of the fore edge of the wing for large angles of attack and becomes about 60% for flying under conditions of light carriage. If it is attempted to diminish the displacement of the center of thrust of a rigid outline the maximum lift of the outline is reduced and in practice the displacement pointed out is generally permissible.

In the case of the wing forming the object of the invention, the coefficient of moment C_m has a small value at small lift because the outline of the wing has become biconvex and it results therefrom that the center of thrust at its extreme rear position is chiefly advanced with respect to that which takes place in the usual outline.

This diminution in displacement of the center of thrust becomes translated practically into a diminution in wing fatigue establishing an abatement in weight of the framework and in a reduction in the efficiency required of the horizontal stabilizer.

3. Considerable reduction of the coefficient of moment C_{mo} at zero lift.

In the ordinary rigid outlines there must be allowed a rather momentous coefficient of moment at zero lift because if it is attempted to reduce this coefficient the other qualities of the outline are reduced, and in particular the maximum lift thereof.

When darting at zero lift the aeroplane attains considerable speed and the moment of torsion on the wings proportional to the coefficient of moment and to the square of the speed attains, in the case of rigid outlines, enormous values fatiguing the covering considerably.

In the wing with internal dynamic pressure the increase in speed when darting has for effect to increase the expanding of the intrados and the elasticity of the wall may be calculated in order that the outline becomes symmetrical at the vertical darting speed of the aeroplane.

In this case the coefficient C_{mo} is annuled and the wing no longer subjected to torsion stresses.

4. When the angle of attack diminishes, the intrados of the outline swells and the coefficient of lift decreases more rapidly for a given variation in incidence than in the case of a rigid outline. It results that between the flying at small lift and high lift the variations in incidence are smaller than in the case of rigid outlines. The fuselage of an aeroplane furnished with a covering according to the invention will, on the average, be better orientated in the wind than the fuselage of an aeroplane with rigid covering.

There will be described hereinafter, by way of example, another embodiment of the wing forming the object of the invention.

The pressure may act on the interior of bags contained in the interior of the wing, which, in expanding, alter the form of the intrados whose covering is elastic.

If the pressure is maintained in the bags by simple tubes orientated in the relative wind whose axis is substantially at an angle with the chord of the wing equal to the zero lift angle, the dynamic pressure maintained in the bags is greater, in the case of flying at about zero lift angle of attack, than the mean pressure acting on the intrados of the outline. The internal pressure is still greater if the tubes be replaced by pressure multiplying nozzles. For establishing equality of pressure forces on the exterior and interior surface of the deformable wall constituting the intrados, it is necessary that the surface of the bags in contact with the wall be small with respect to the total surface of the wall and suitably calculated.

The bags may be secured to the ribs of the wing and the distance between ribs may be choosen with a view to establishing the desired bag surface acting against the deformable wall.

Figs. 4 and 5 represent an example for realizing this fact. The ribs represented by 8 are slid over a frame beam 10 and the extrados 8^e thereof as well as their leading peaks are covered with a rigid cloth covering 9. The concave part 8^1 of each rib carries a bag 3^a constructed for example of rubber, secured by lacing sewing or other analogous means. The pressure at the level of orifice 4^a acts on the interior of bag 3^a through the medium of tube 4 fixed at 13 to the sac 3^a.

In swelling the said bag bears on the deformable intrados 2 of the wing formed by a veneering or covering of elastic texture.

When the bags are caused to collapse, the elastic wall then bears on the hollow part 8^1 of the rib.

When the bags are inflated, the elastic wall forming the intrados takes a curved form. By choosing suitably calculated thicknesses for the walls of the bags the deformations desired may be obtained. As in the preceding embodiment a position of equilibrium of the wall 2 is realized at each incidence. The deformations take place in accordance with the incidence in the same direction as in the case of the preceding embodiment and the same advantages are manifest.

The deformations of the outline may be instigated voluntarily for the purpose of obtaining a variety of evolutions of the aeroplane by acting on the pressure maintained in the wing.

In this end, the device represented in Fig. 6 has been provided.

The interior of the wing, whose intrados is constituted, for example, by an elastic wall, is divided into compartments, which are shown in the figure as four in number at 15, 16, 17, 18, by partitions represented at *e—f*, *g—h*, *i—j*. In each compartment can act the dynamic pressures transmitted by four orifices 19, 20, 21, 22, adapted to be regulated, for example, by means of vanes 23, 24, 25, 26 controlled by rods 23^a, 24^a, 25^a, 26^a.

If it be supposed, for a better understanding of the device, that the aeroplane is flying horizontally at open throttle and the orifices regulated in accordance with the indications given in the first embodiment, the outline will be biconvex.

If the four vanes be regulated simultaneously in such wise that the internal pressure diminishes, the intrados of the outline becomes flat and, at the same incidence of the rigid part, the coefficient of lift grows.

The aeroplane then begins to mount as if its angle of attack had been altered. The simultaneous opening and closing of the vanes therefore plays the same part as the tilting operation of the horizontal rudder. The initial regulation being reestablished, if the regulation of vanes 23 and 26 be altered in such wise that the extremity 15 of the wing swells and the extremity 18 becomes hollow, for example, then the portance of the extremity 15 diminishes while that of extremity 18 grows and the aeroplane becomes tilted as under the influence of a tilted aileron.

All sorts of evolutions can be performed by various combinations of the regulation of all the vanes whose control can be centralized in the pilot's cockpit.

Instead of uncovering the orifices, nozzles might be provided with cocks which are inclined in the wind or by any other expedient capable of altering the internal pressure of the bags.

In any event the manipulation of these organs does not require any effort on the part of the pilot and their manœuvring can be confided directly to the piloting instruments without necessitating servo-motors.

The invention can moreover be generalized. The elastic walls capable of being expanded by a gas under pressure may also be placed on two faces of the outline.

It will be conceived that modifications may be established in the different embodiments just described without departing from the invention thereby as defined within the scope of the claims and in particular the invention may also be applied to propeller blades, rotating planes and also keels.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. An aeroplane wing comprising a curved frame, a rigid covering on the extrados of said frame, a flexible covering on the intrados of said frame adapted to be deformed under the action of the varying pressure of a gas, means associated with said frame for dividing the interior of the wing into a plurality of chambers, means for introducing a gas under pressure into said chambers and means for regulating the pressure of said gas for controlling the evolutions of the aeroplane.

2. An aeroplane wing comprising a curved frame, a rigid covering on the extrados of said frame, a flexible covering on the intrados of said frame adapted to be deformed under the action of the varying pressure of a gas, means associated with said frame for dividing the interior of the wing into a plurality of chambers, nozzles for introducing a gas under pressure into each of said chambers and means for opening and closing certain of said nozzles at will for controlling the evolutions of the aeroplane.

3. An aeroplane wing comprising a curved frame, a rigid covering on the extrados of said frame, a flexible covering on the intrados of said frame adapted to be deformed under the action of the varying pressure of a gas, and a nozzle formed in said wing facing in the direction of the relative wind, said nozzle being so directed with respect to the wing that the pressure in the interior of said wing is greater in the case of flying at zero lift angle of attack than the mean pressure acting on said intrados of said wing.

4. An aeroplane wing comprising a curved frame, a rigid covering on the extrados of said frame, adapted to be deformed under the action of the varying pressure of a gas and a nozzle formed in said wing, facing in the direction of the relative wind, said nozzle being substantially at an angle with the chord of the wing equal to the zero lift angle.

5. An aeroplane wing comprising a curved frame, a rigid covering on the extrados of said frame, a flexible covering on the intrados of said frame adapted to be deformed under the action of the varying pressure of a gas, means associated with said frame for dividing the interior of the wing into a plurality of chambers, nozzles for introducing a gas under pressure into each of said chambers and means for opening and closing certain of said nozzles, said nozzles being substantially at an angle with the chord of the wing equal to the zero lift angle.

In testimony whereof I have signed this specification.

LOUIS BREGUET.