March 2, 1937. J. GERIN 2,072,299

AIRPLANE HAVING A VARIABLE LIFTING SURFACE

Filed Feb. 15, 1935 4 Sheets-Sheet 1

FIG. 1.

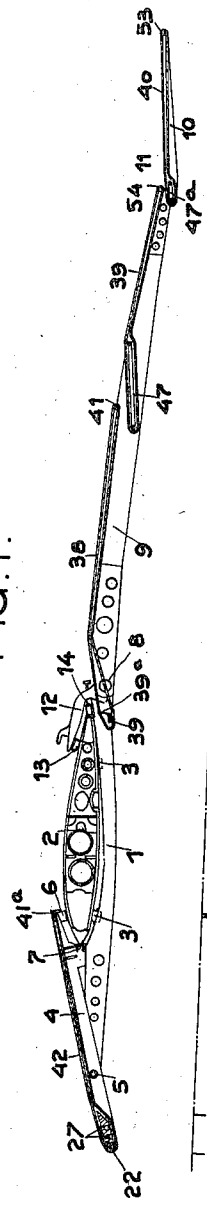
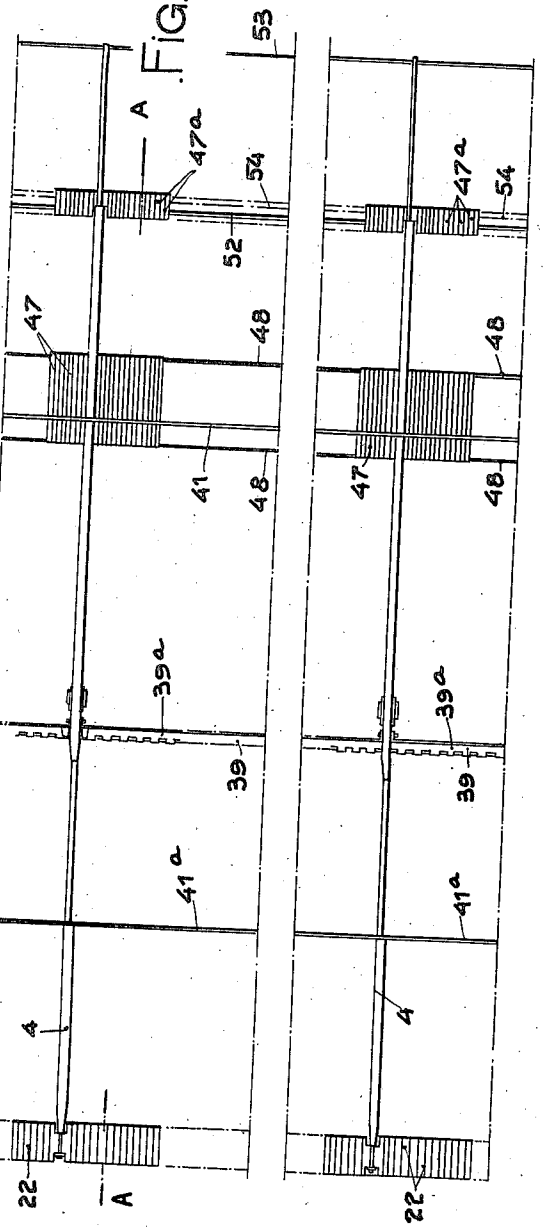


FIG. 2.



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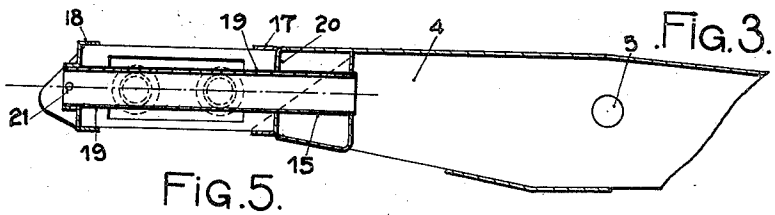


FIG. 3.

FIG. 5.

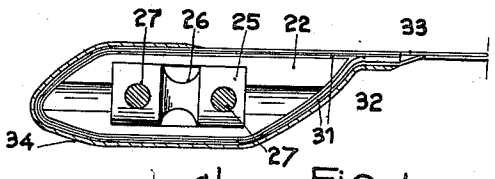


FIG. 4.

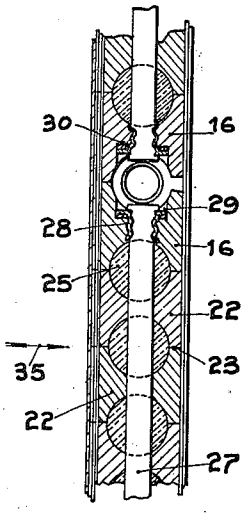


FIG. 6.

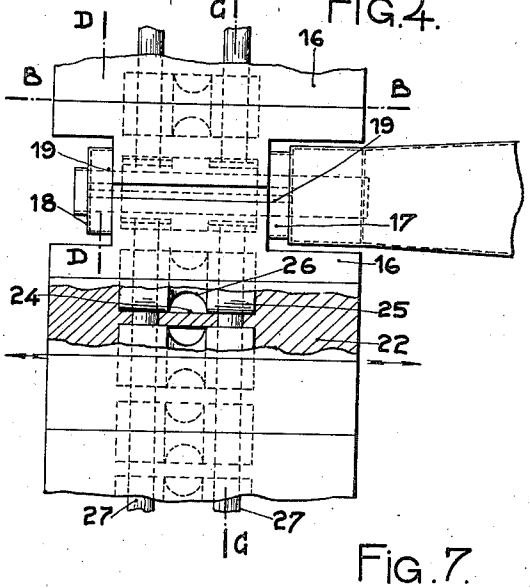


FIG. 7.

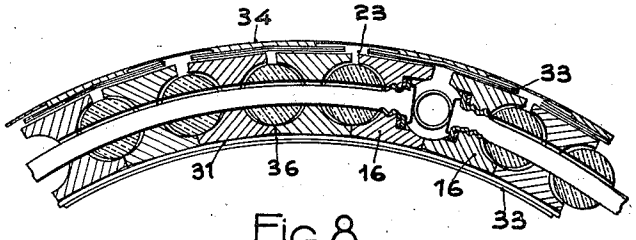
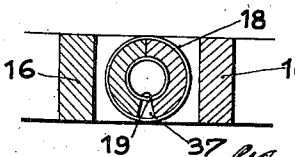


FIG. 8.



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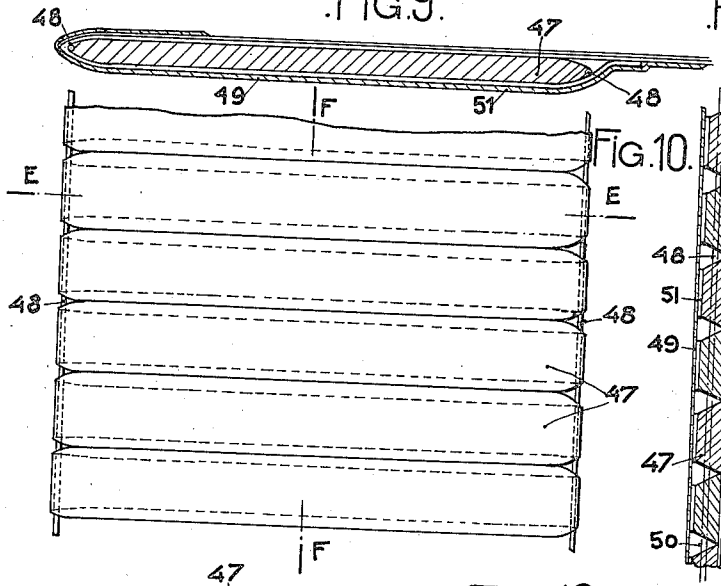
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AIRPLANE HAVING A VARIABLE LIFTING SURFACE

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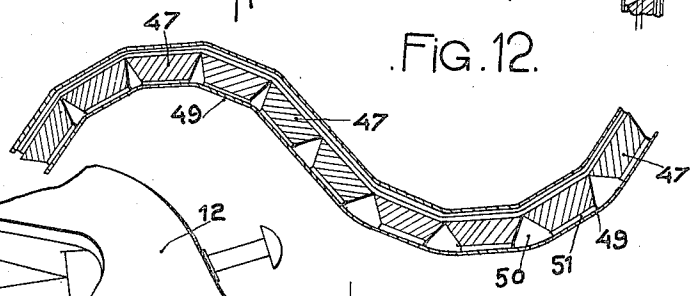
.FIG.9.

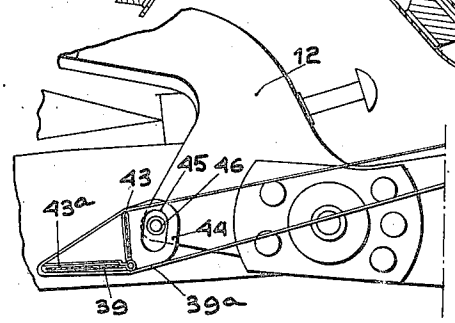


.FIG.11.

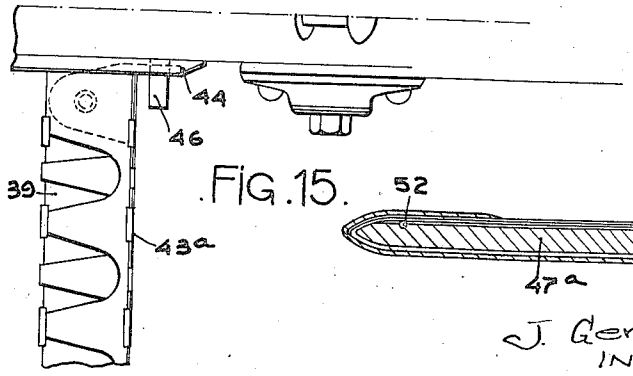
.FIG.10.

.FIG.12.





.FIG.14.



.FIG.15.

.FIG.13.

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AIRPLANE HAVING A VARIABLE LIFTING SURFACE

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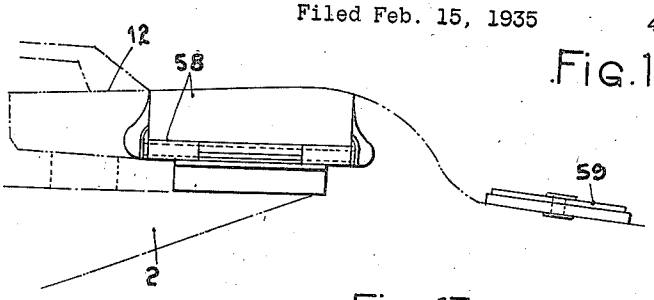


Fig. 16.

Fig. 17.

Fig. 19.

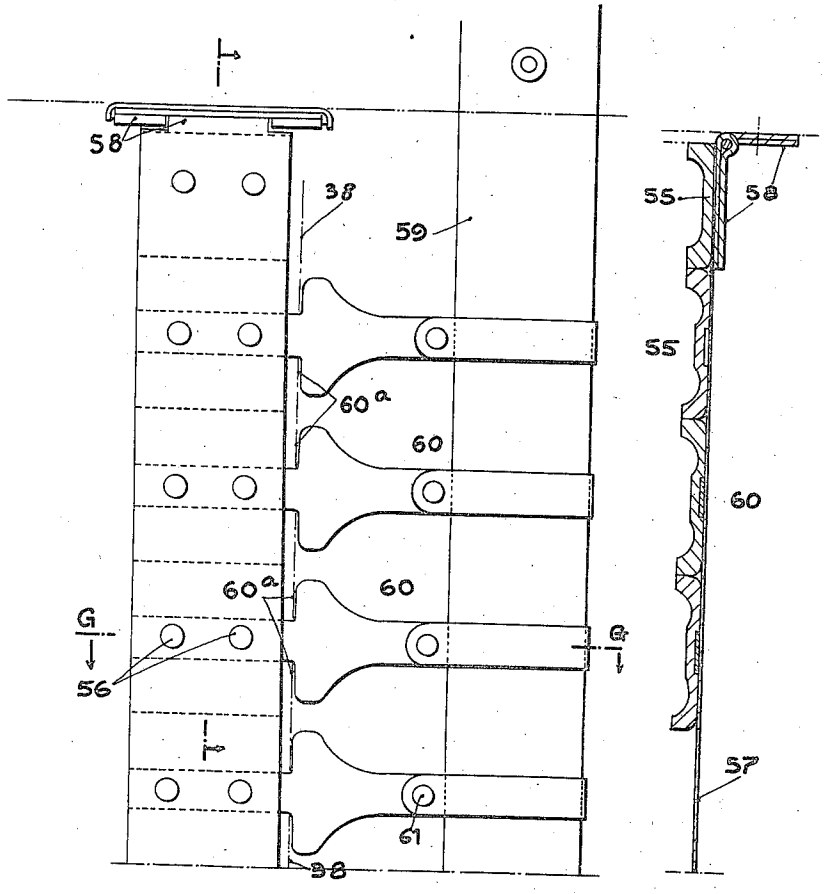
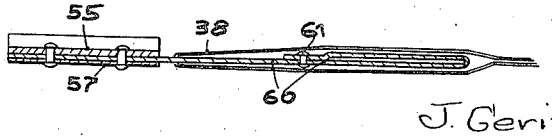


Fig. 18.



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UNITED STATES PATENT OFFICE

2,072,299

AIRPLANE HAVING A VARIABLE LIFTING SURFACE

Jacques Gerin, Boulogne-sur-Seine, France

Application February 15, 1935, Serial No. 6,737
In France February 20, 1934

4 Claims. (Cl. 244—43)

This invention relates to airplanes having a variable lifting surface, in which the fixed wing constructed for supporting the airplane at high speed is transformed into a wing of the same span, but of greater width for taking off or landing. Flexible surfaces can be wound on drums within the fuselage, or extended outwardly from the fuselage over the fixed wing, to constitute an enlarged surface when landing or taking off.

Embodiments of this general arrangement have been described in various patents in the name of the applicant and particularly in the French Patent No. 742,569, of the 9th December 1931. The embodiments forming the subject-matter of said patent comprise, among other features, ribs for flexible surfaces, made of three main elements:

A central element provided with rollers which, when the surface is being extended or spread out, allow it to move along the fixed wing and which, during flight, constitute bearings on this wing if this central element is located on the side of the intrados of the fixed wing.

A front or leading element pivoted at the front end of the central element and extending rearwardly beyond its pivot point in order to bear, through one or more rollers, on the face of the fixed wing opposed to that in contact with the central element of the rib.

A rear element the front part of which is pivoted to the rear end of the central element and extending forwardly beyond its pivot point in order to bear, through one or more rollers, on the fixed wing and on the same face of the latter as the front element of the rib.

The rear element is itself made in several sections all pivotally connected to each other, the second one being preferably pivoted about the pivot pin which connects the first section to the central element of the rib. This arrangement allows the spread out wing to assume a curvature having a lifting power so much the greater as the speed of the airplane is lower. The simple curvature, which has a high lifting power at very reduced speeds, can be converted into a double curvature by upward bending of the extreme portion of the rib or trailing portion of the wing, at high speeds. These variations of curvature take place by relative angular displacements of the sections of the rear element of the rib, about their pivot pins, in opposition to the reactions of resilient returning means. This construction is adapted to hold in a substantially constant position the center of thrust of the wing, whether the latter is reduced to the fixed wing (reduced surface) or increased by spreading out the flexible surface, and this at all intermediate speeds between the lowest and the highest.

The improvements forming the subject-matter of the present invention relate to flexible surfaces provided with ribs presenting the main features which have just been set forth. The objects or industrial results of these improvements are the following:

(*a*) Concerning the leading edge of the flexible surface, to ensure the relative rigidity of this edge between the ribs when the surface is spread out or extended, but to allow it to become distorted when it winds on the operating drums.

(*b*) In order to constitute a slotted wing, to obtain gaps in the rear portion of the flexible surface and, for that purpose, to devise the edges of said gaps in the same manner as the leading edge or according to an equivalent principle.

(*c*) To cause the edges satisfying the conditions indicated in (*a*) and (*b*), to participate in the bracing of the ribs in the direction for moving the latter closer together, and this separately or in combination with independent bracing means.

For that purpose, the improvements forming the subject-matter of the invention are mainly characterized by the following points applicable separately or according to any combinations:

1—The leading edge of the entire flexible surface is constituted by the juxtaposition, substantially edge to edge, of rigid elements streamlined in the direction of advance of the airplane and fitted on resilient bands connecting the front ends of the ribs together, so as to constitute a continuous canvassed strip and so covered that it is practically undistortable under the action of aerodynamic thrusts during flight, but can wind on the operating drums without other resistances than the reactions of the resilient bands.

2—The trailing edges of the various portions of the flexible covering are reinforced by cables which brace the ribs from place to place.

3—The leading edges of the other portions of the covering are constituted by juxtaposition of rigid elements which take a bearing upon at least one cable bracing the ribs, and said rigid elements are connected together by gluing on a covering reinforced by a layer of resilient material.

4—The ribs are connected together by a continuous steel ribbon extending over the entire width of the flexible surface, and combined with ribbon sections, between two adjacent ribs, hingedly connected to the continuous ribbon so that the latter being secured to a rib element, the

free section can, by connection with the adjacent element, assume two extreme positions: a position in the same plane as the continuous ribbon for winding on the drums and a position in a perpendicular plane when the flexible surface is spread out.

The accompanying drawings illustrate, by way of example only, forms of construction of the improvements above set forth in their principle.

Fig. 1 is an elevation, partly in section according to line A—A of Fig. 2, showing a rib.

Fig. 2 is a corresponding plan view, the coverings of the flexible surface not being shown for greater clearness.

Fig. 3 is a fragmentary longitudinal section, on an enlarged scale, of the front or leading element of a rib.

Fig. 4 is a partial plan view of Fig. 3, with parts broken away, showing the leading edge of the entire movable surface.

Fig. 5 is a longitudinal section along line B—B of Fig. 4.

Fig. 6 is a transverse section along line C—C of Fig. 4.

Fig. 7 is a view similar to Fig. 6, showing the leading edge distorted for winding on the operating drum.

Fig. 8 is a transverse section along line D—D of Fig. 4.

Fig. 9 is a longitudinal section along line E—E of Fig. 10, showing a leading edge of a rear portion of the flexible surface covering.

Fig. 10 is a corresponding partial plan view of Fig. 9.

Fig. 11 is a cross section along line F—F of Fig. 10.

Fig. 12 is a view similar to Fig. 11, showing the leading edge distorted.

Fig. 13 is a view similar to Fig. 9, showing another leading edge of the rear part of the covering.

Fig. 14 illustrates in a fragmentary view, on an enlarged scale, a rib joint with a hinged steel ribbon.

Fig. 15 is a corresponding plan view of Fig. 14.

Figs. 16 to 19 illustrate a constructional modification of a device for bracing the central portions of the ribs of the flexible surface.

Fig. 16 is a partial diagrammatic elevation of the rear end of the central portion of a rib.

Fig. 17 is a plan view corresponding to Fig. 16.

Fig. 18 is a transverse section along line G—G of Fig. 17.

Fig. 19 is a vertical section made according to line H—H of Fig. 17.

As illustrated in Figs. 1 and 2, each rib of the flexible surface comprises a central element 1 movable transversely to itself along the fixed wing 2 on which it bears through rollers 3. This central element extends on either side of the edges of the fixed wing 2 and receives, at its front part, a front element 4 pivoted at 5 and bearing upon the extrados face of the wing 2 through a roller 6, and upon the leading edge of said plane through one or more rollers 7.

At the rear end of the central element 1 is pivoted at 8 the floating part of the rib. In the example illustrated, this floating part is composed of two main sections: the rear element proper 9 and the extreme or trailing element 10, pivoted at 11 on the rear element 9. A lever 12 is pivoted about the pivot pin 8 common to both front and rear elements 1 and 9; this lever 12 can bear on the dorsal face of the wing 2 through a roller 13. One or more other rollers 14 are provided for bearing upon the trailing edge of the wing 2, and a suitable mechanism acts for angularly locking the lever 12 on the central element 1 when the flexible surface is spread out and for releasing it when the rib moves away from the fixed wing, at the root of the latter, for reacting the winding up drum. The front central element 4 abuts against the element 1 so that, through the roller 6 bearing on the extrados of the fixed wing 2, it constitutes with the central element 1 a rigid unit. When a rib moves away from the root of the fixed wing 2, the elements 4, 12, 9 and 10, being free about their pivots, move so as to be placed according to a mean straight line, in order to limit the space occupied by the flexible surfaces on their drums. Moreover, a connection by cable and resilient returning means is provided and arranged within the hollow rear element 9, between the elements 12, 9 and 10; so that, according to the value of the aerodynamic thrust on the flexible covering of the element, the entire wing can pass from a great curvature of very high lifting power, to a double curvature (case shown in Fig. 1) of small lifting power.

The arrangements which have briefly been described do not constitute features of the present invention. They are known per se and have formed the subject-matter of a prior patent in the name of the applicant.

According to the present invention, the leading edge of the entire flexible surface is constituted by juxtaposition of elements, preferably wooden elements, streamlined in the direction of advance of the airplane. As more clearly illustrated in Figs. 3 to 8, the free end of each rib element 4 is provided with a journal 15 on which fit two shells 16 held in the longitudinal and transverse directions between two rings or cups 17 and 18. These shells 16 bear, through the medium of cylindrical bearing portions 19, on the journal and externally fit, on the one hand, in the cup 17 pressed against the flange 20 of the journal 15 and, on the other hand, in the cup 18 held stationary on the journal by a pin 21 or other equivalent means.

Between their bearing portions 19 of the journal 15, the shells 16 are internally recessed for the purpose indicated later on.

Between two adjacent ribs is interposed a chain constituted by the following similar elements:

A block 22 shaped as shown in Fig. 2 and having two plane side faces 23 with two semi-cylindrical recesses 24 open on each of these faces 23.

A cylindrical journal 25, made of hard wood and which, for greater lightness, can be reduced in diameter at 26. The diameter and length of the journal 25 are such that the latter exactly fit into the opposite recesses 24 of two adjacent blocks 22. The latter are thus rigidly connected in the longitudinal direction and, consequently, cannot slide one against the other in the direction of the arrows (Fig. 4), or in a direction at right angles to the plane of the drawings; but they can be subjected to angular displacements about the axes of the journal 25 or of adjacent parallel axes. Resilient flexible bands, constituted for instance by sandows 27, pass through perforations provided in the blocks 22, journals 25 and shells 16. These sandows or bands are anchored at their ends, after a suitable initial tension, on the shells 16 and, for that purpose, they are clamped in sockets 28 the flange 29 of which presses upon washers 30 bearing on the bottom of the recesses 24 of said shells 16 (Figs. 6 and 7).

The blocks 22, assembled as just stated, con-

stitute a streamline unit which is enclosed in a first nonextensible canvas band **31**, glued on the entire outer surface of said blocks and sewn on itself at **32**. On this canvas band is secured by gluing a two-ply rubberized fabric **33** which constitutes the covering of the entire flexible surface in front of the fixed plane (Figs. 5 and 1). The lower face of the leading edge of the two canvas layers are then cut in the vicinity of the junction lines **23** of the blocks **22**, and the whole is covered, by gluing, with a rubber strip **34** which does not adhere to the canvas **33**. This rubber strip, as shown in Fig. 5, covers the entire lower face of the blocks **22** and a portion of their lower face.

The technical effects obtained by means of the form of construction thus described, are the following:

If a stress directed in the direction of the arrow **35** (Fig. 6) is exerted on the leading edge, that is to say a stress corresponding to the aerodynamic reactions exerted on the wing during flight, the distortion of the edge can take place only by rupture of the two layers of continuous canvas bands of the upper face. To the resistance of these canvas bands is further added, to a certain extent, the resilient reaction of the sandows or bands **27**. These resistant elements are easily calculated in order that no appreciable distortion of the leading edge will take place during flight.

But, when the flexible surface is to be wound on its drum, the curvature which is to be assumed by the leading edge is that shown in Fig. 7. The canvas strips of the dorsal face of the leading edge are not subjected to an extension, whilst the gaps provided at **23** in the same strips on the central face of the leading edge allow the blocks **22**, by extension of the rubber strip **34**, to move apart by pivotal movement about theoretical axes mingled with their lower edges **36**.

The relative displacement of the shells **16** about their journal **19** is rendered possible by a play or clearance **37** provided between their adjacent faces (Fig. 8).

The covering of the rear portions of the flexible surface comprises, in the example illustrated, the three covering parts **38**, **39** and **40** (Fig. 1). The leading edge of the part **38** is constituted by a continuous steel ribbon **39a** secured on the lower face of the ribs **1** and on which a pull is exerted for spreading out the flexible surface. The covering **38** constituted by a double thickness of fabric, as shown in Fig. 1, has its trailing edge reinforced by a flexible metal cable **41** transversely connecting the ribs and which can also participate in the winding and the spreading out of the flexible surface. A cable **41a** is also provided on the trailing edge of the front covering **42**. Between two adjacent ribs is provided a steel ribbon section **39a** which, as shown in Figs. 14 and 15, is enclosed in a thin sheet steel hinge eye **43** bent on itself and pivoted on a second hinge eye **43a** similarly secured to the continuous ribbon **38**. At each of its ends, the hinge eye **43** is provided with a transverse sole member **44**, in a notch **45** of which fits a finger **46** secured on the lever **12** of the rib. The amplitude of the notch **45** is determined in such a manner that the ribbon section **39a** is restored in the plane of the ribbon **39** when all the elements of the rib are placed in a line at the point when they reach the drum, or is restored in a perpendicular plane (case shown in Figs. 14 and 15), when the flexible surface is spread out.

When the continuous ribbon **38** and the steel ribbon sections **39a** are arranged in one and the same plane, they can be curved for winding on the drum; when, on the contrary, they are arranged in two perpendicular planes, they constitute a unit the moment of inertia of which prevents any transverse distortion and ensures, in combination with the blocks **22** of the leading edge of Figs. 4 and 5, the bracing of the ribs of the flexible surface.

The portion **39** of the covering of the flexible surface (Fig. 1) is provided for constituting a slotted wing. Its leading edge is formed by juxtaposition of blocks **47**, preferably wooden blocks, shaped as shown in Figs. 9 to 12. The cross section of these blocks **47** is a trapezium, the larger base of which is placed in the dorsal face of the covering; they are notched at their ends in order to bear on two cables **48** for bracing the ribs. The whole is covered with canvas as explained with reference to the leading edge of the entire surface and also covered with a rubber strip **49**. Gaps **50** being provided in the nonextensible canvas **51** glued on the side of the small bases of the trapezium-shaped sections of the blocks, the whole can be bent or distorted as shown in Fig. 12, whilst remaining practically rigid in the relative wind when the flexible surface is spread out.

Fig. 13 shows a form of construction, based on the same principle as the form of construction illustrated in Figs. 9 and 12, of the leading edge of the extreme trailing portion **40** of the flexible covering. In this case, the blocks **47a** bear only on a single cable **52** for bracing the ribs. This cable fits in a notch formed in the upper face of the block. Cables **54** and **53** respectively reinforce the trailing edges of the parts **39** and **40** of the flexible covering.

In the constructional modification of a device for bracing the central parts of the ribs, use is made of a series of shoes **55**, made of light metal for instance, and completely rigid. These shoes which may have a profile such as that shown in Fig. 19, have a rectangular shape, in plan view, and are riveted, at **56**, on a steel ribbon **57**; the latter is connected, at its ends, by hinges **58**, to the lever elements **12** of two consecutive ribs (Fig. 1). The shoes **55** bear, in the example under consideration, on the dorsal face of the fixed wing **2**, so that, the ribbon **57** being nonextensible, the unit formed by **57** and the shoes **55** constitutes a rigid bracing member preventing the ribs from moving towards each other. When the flexible surface is wound on its operating drum, the ribbon **57** curves according to the required radius by spacing apart the side faces of the shoes **55** which were in contact.

For constituting the leading edge of the flexible covering corresponding to the part **38** of Fig. 1, a steel ribbon **59** is secured to the ribs and connected, at intervals, to the shoes **55** by flexible steel elements **60**, bent round the ribbon **59** and riveted at **61**. These elements fit, on the other hand, at their front end, into notches provided in the shoes **55** (Fig. 19) and are secured to the ribbon by the rivets **56** previously mentioned. The flexible covering **38** is notched for the passage of the front portions of the elements **60** and folded on itself (Fig. 18) by bearing on the flaring edges **60a**. When, as indicated above, the curvature of the flexible surface is altered by displacement of the portions **9** of the ribs (Fig. 1) about the pivots **8**, the flexible elements **60** become distorted, but, in this case, a slotted wing is not obtained at the place under consideration, as in the example illustrated in Fig. 1.

What I claim as my invention and desire to secure by Letters Patent is:

1. In an airplane construction having a main wing, the combination therewith of a series of longitudinal ribs comprising front, central, rear and trailing elements pivotally connected with each other, the central rib elements being provided with means for transverse displacement with regard to said main wing, a flexible covering for said rib elements normally streamlined in direction of advance.

2. In an airplane construction having a main wing, the combination therewith of a series of longitudinal ribs comprising front, central, rear and trailing elements pivotally connected with each other, the central rib elements being provided with means for transverse displacement with regard to said main wing, a flexible covering for said rib elements normally streamlined in direction of advance, distortable bands between the adjacent ribs and rigid elements placed edge to edge for forming braces maintaining the ribs at constant spacing while permitting the winding of the flexible surfaces transversely of said wing.

3. In an airplane construction having a main wing, the combination therewith of a series of longitudinal ribs comprising front, central, rear and trailing elements pivotally connected with each other, the central rib elements being provided with means for transverse displacement with regard to said main wing, a flexible covering for said rib elements normally streamlined in direction of advance, a single metallic ribbon for connecting the rib elements, independent ribbon members between two adjacent rib elements, hinges for connecting the said independent ribbon members to the single ribbon, means for connecting the said independent ribbon members to the articulated rib elements on the central element, inextensible flexible cables between the rear rib elements, rigid blocks supported by the said cables and in juxtaposition for constituting a linkage and forming leading edges of the rear portions of the flexible surface, an inextensible covering fixed on one of the faces of the linkage formed by the said rigid blocks.

4. In an airplane construction having a main wing, the combination therewith of a series of longitudinal ribs comprising front, central, rear and trailing elements pivotally connected with each other, the central rib elements being provided with means for transverse displacement with regard to said main wing, a flexible covering for said rib elements normally streamlined in direction of advance, a flexible metallic ribbon interposed between the outer ends of the rib elements supported on the fixed wing, a hinged connection between each of the ends of the said ribbon and the adjacent rib element, rigid shoes juxtaposed edge to edge on the ribbon for bearing on the fixed wing, a second metallic ribbon for connecting the ribs behind the first ribbon and constituting a leading edge for a portion of the flexible surface, braces fixed to the shoes and to the second ribbon, inextensible flexible cables between the rear rib elements, rigid blocks supported by the said cables and in juxtaposition for constituting a linkage and forming leading edges of the rear portions of the flexible surface, an inextensible covering fixed on one of the faces of the linkage formed by the said rigid blocks.

JACQUES GERIN.