Dec. 3, 1935. C. H. GRANT 2,022,806

AIRFOIL

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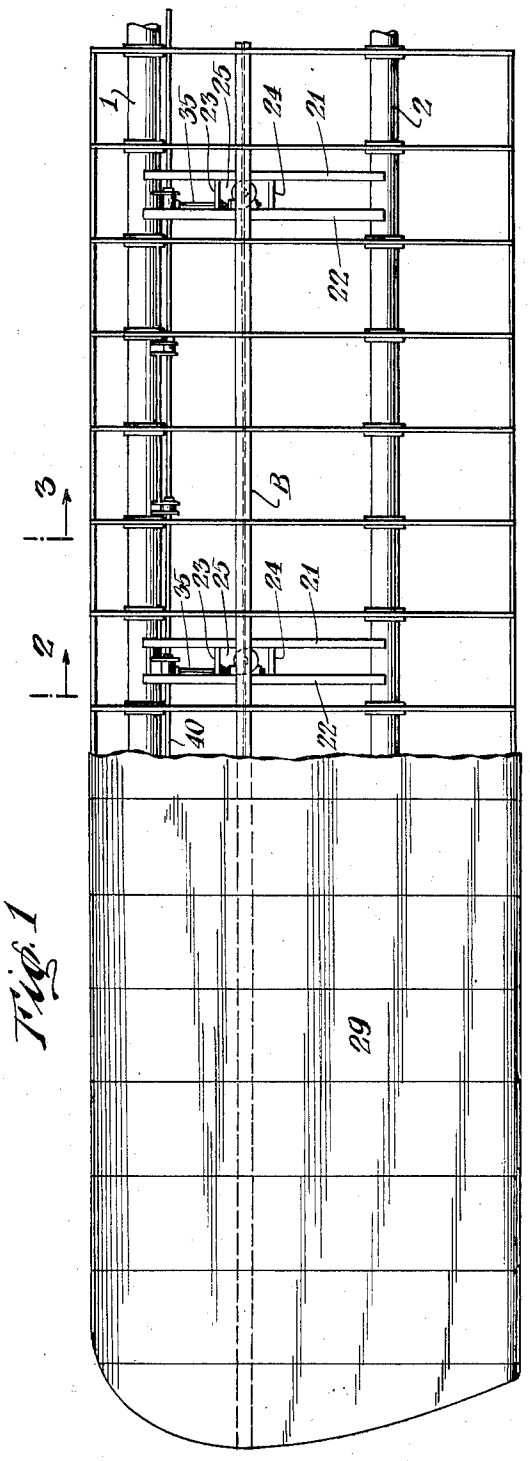


Fig. 1

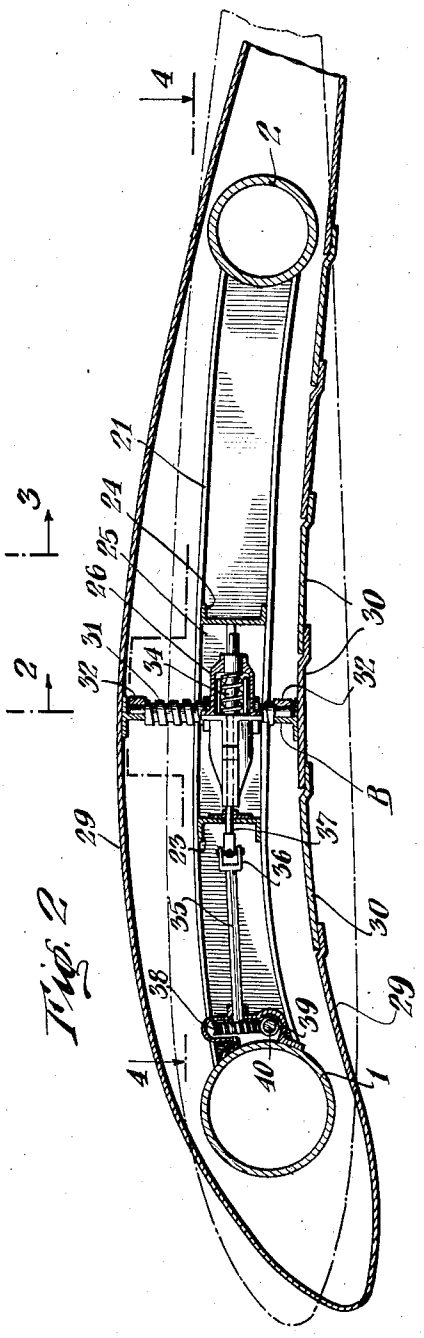


Fig. 2

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Fig. 3

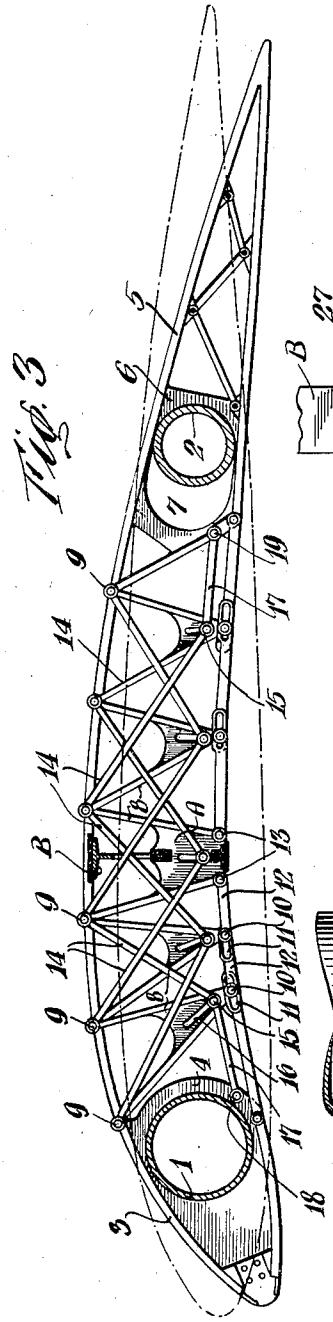
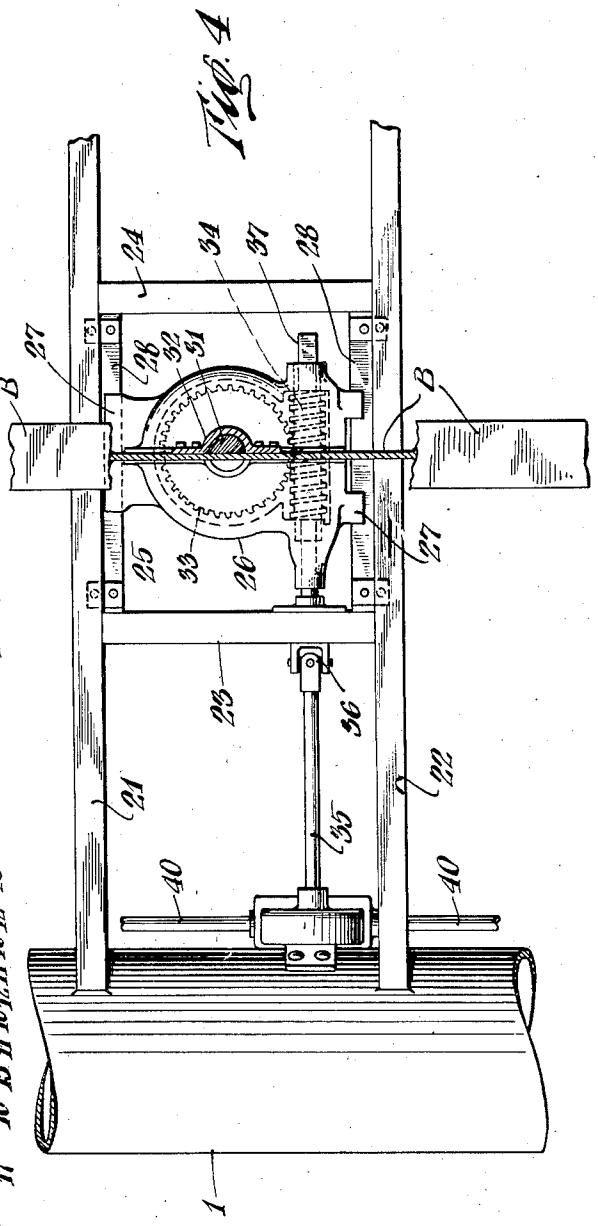


Fig. 4



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2,022,806

AIRFOIL

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Application December 9, 1933, Serial No. 701,607

10 Claims. (Cl. 244—12)

This invention relates to internally trussed structures which are capable of flexing longitudinally, to impart thereto varying degrees of curvature or to vary what may be considered the normal curvature thereof for different purposes.

Particularly, and in this application my improvement is directed to an articulated construction of airfoils for use in aircraft, wherein the airfoil ribs are trussed with jointed, interconnected members, to the end that said ribs, and hence the airfoil of which they form a part, may be flexed so as to either increase or diminish the degree of camber or curvature represented by the airfoil, whereby the airfoil is rendered capable, at high camber, of supporting relatively heavy loads at slow speeds, as in taking off, climbing, and landing, and is capable, when flattened, of attaining high speed in straight-away flight.

Also my invention includes the provision of actuating mechanism, included in the airfoil, for flexing the articulated ribs, together with means, under the control of the pilot, for operating said actuating mechanism.

Other features and advantages of my invention will hereinafter appear.

In the drawings:—

Fig. 1 is a top plan view of an airfoil whose upper covering is partly broken away to disclose the ribs and their actuating mechanism.

Fig. 2 is a vertical section taken on the line 2—2 of Fig. 1.

Fig. 3 is a vertical section taken on the line 3—3 of Fig. 1, this view showing a rib, without the wing covering, and

Fig. 4 is an enlarged, plan view, partly in horizontal section, taken on the line 4—4 of Fig. 2, and showing the actuating mechanism.

In said views let 1 indicate the front spar of an airfoil and 2 the rear spar.

In Fig. 3, which illustrates my improved articulated rib, its nose portion 3 is shown as having a web 4 that engages the spar 1, and the trailing portion 5 is shown as having a web 6 that engages the spar 2, said web 6 having a clearance 7 therein which permits vertical movement of the rib relatively to said spars.

Trussing is employed which pivotally engages and lies intermediate the nose and trailing portions, and consists of pivotal, triangular sections or panels, to permit flexure, the panels being indicated at 8 and interconnecting with each other and the nose and trailing portions at upper apices as by pivots 9, while their lower apices have pivots 10 that engage slidably in slots 11 formed in articulated sections 12 which compose a lower rib longitudinal.

This trussing affords rib reinforcement and enables chordwise variation of airfoil curvature to be effected within set limits.

In my experimenting I have employed different forms of pivotal rib trussing, all having substantially the same effect, the form thereof illustrated and described herein comprising one practical embodiment of my invention.

In Fig. 3 the rib is shown in full lines as curved chordwise in a relatively high camber, and in dotted lines as flattened out.

The central panel 8, also denoted A to distinguish it from the other panels, has two lower pivotal points 13.

Bracing employed in the rib trussing consists of a series of guide links 14 that have engaging pivots 15 slidable in slots 16 formed in the panels 8, near their lower apices, said slots being upwardly directed so that the links 14, which connect at their upper ends, respectively, with the pivots 9, may be shiftable in said slots. Links 17, pivoted respectively to the nose portion and the trailing portion, engage respectively with the forward and rearmost pivots 18 and 19.

The rotation of the panels is restricted within certain limits and to a definite mechanical motion relatively to one another by the braces which are so mounted on the series of panels that when one panel is moved in a direction approximately perpendicular to the longitudinal axis of the chain of panels, all the other panels will be moved relatively to one another and to two restraining points to which the series of panels may be fixed, adapting the chain of panels to always maintain a similar curve but of changing degree. This mechanism can be designed in a variety of forms and applied to various uses. When used in an airfoil rib its height of camber may be increased or decreased as desired by the pilot.

The purpose of the device is to provide a properly braced, rigid truss when held at three or more points, yet which may be flexed into a curve of another degree in order to change the effect of the relative pressure encountered by the airfoil.

The three series braces 14 are attached to the series of panels in such a way that each brace in any one series is linked to the adjacent one, alternate junctures being pivoted to a pivot point every other panel, and their lower pivotally connected ends being free to slide in the vertically disposed slots located in the lower portion of each panel.

Another way of describing the mechanism is by defining it as a series of panels in which, in any three adjacent panels, one point in the middle panel of the series is always proportionally the same distance from two definite fixed points, one in each of the adjacent panels. The whole structure is capable of being flexed so that the curve of the structure is always similar but of possible varying degree.

This system of trussing holds the wing section to a definite form, yet also allows the form or section to be changed to another form or section at the will of the pilot, and the section will remain rigid in form until a subsequent change is desired and executed by the pilot.

The mechanism employed by me for actuating the ribs in their flexure is carried by the frame that is composed of the parallel, spaced members 21, 22 which extend between, and are connected at their respective ends, to the front and rear spars 1 and 2, transverse members 23, 24 connecting members 21, 22 and forming therewith a rectangular space 25. A gear case 26 is contained within space 25, and because a slight shifting movement occurs between the frame and gear case in the flexing of the ribs, therefore said gear case is slidably mounted, as by lugs 27, upon guide members 28 attached to the members 21, 22.

As will be noted in Fig. 2, the skin or covering of the wing or airfoil, indicated at 29, is in the form of intersliding sections 30 for an intermediate portion of its under surface, to thereby enable said under surface to contract and expand coincidently with the flexing of the rib.

The I-beam B, here also interrupted to form opposed T-beam sections, engage by their webs the respective ends of a vertical worm 31, said ends being squared against the webs and secured thereto as by straps 32 that are connected to said webs, so that the worm is held against rotation.

A worm gear 33 is meshed with worm 31, and a horizontal worm 34, meshing with peripheral teeth on gear 33, serves in its rotation to move worm 31 vertically and thus to cause the flexing of the ribs and wing or airfoil, there being several of these actuating devices disposed throughout the wing span.

A drive shaft 35 connects through a universal joint 36 with the shaft 37 of worm 34, said drive shaft carrying a worm gear 38 at its outer end, which worm gear is engaged by a worm 39 upon a shaft 40 that is to be rendered operable from the cockpit for the purpose of controlling the wing camber.

It is intended by me that control means provided in the cockpit for the rotation of shaft 40 shall have a usual form of locking means for holding the actuating mechanism in any desired set degree of curvature for the ribs and wing.

It is also to be understood, that the actuating mechanism illustrated and described is given by way of example only, since obviously other suitable actuating means may be employed.

Variations within the spirit and scope of my invention are equally comprehended by the foregoing disclosure.

I claim:—

1. A truss composed of linear series of pivotally interconnected panels and links, adjacent panels being pivotally connected in manner to permit their relative rotation, adjacent links being pivoted together and pivotally engaged by adjacent panels in manner to restrain and guide the motion of the panels in unified flexure of the truss, one end of each of said links being fixedly pivoted to said panels, the other end of each link being movable upwardly and downwardly, the direction and extent of the motion being determined and restricted respectively within predetermined limits by the panel engaging means, and fixed members with which the truss is pivotally connected.

2. A truss composed of linear series of pivotally interconnected panels and links, adjacent panels being pivotally connected in manner to permit their relative rotation, adjacent links being pivoted together and pivotally engaged by adjacent panels in manner to restrain and guide the motion of the panels in unified flexure of the truss, one end of each of said links being fixedly pivoted to said panels, the other end of each link being movable upwardly and downwardly, the direction and extent of the motion being determined and restricted respectively within predetermined limits by the panel engaging means, and fixed members with which the truss is pivotally connected, the pivotal connection between the fixed members and truss having a linear clearance to take up endwise motion of the truss in compensation for its flexing motion.

3. An airfoil rib having fixed front and rear spars, and a truss system composed of pivotally interconnected panels and links, adjacent panels being pivotally connected in manner to permit their relative rotation, adjacent links being pivoted together and pivotally engaged by adjacent panels in manner to restrain and guide the motion of the panels in unified flexure of the truss, one end of each of said links being fixedly pivoted to said panels, the other end of each link being movable upwardly and downwardly, the direction and extent of the motion being determined and restricted respectively within predetermined limits by the panel engaging means, the nose and trailing portions of said rib having pivotal connection with said spars respectively and also being in pivotal engagement with said truss.

4. An airfoil rib having fixed front and rear spars, and a truss system composed of pivotally interconnected panels and links, adjacent panels being pivotally connected in manner to permit their relative rotation, adjacent links being pivoted together and pivotally engaged by adjacent panels in manner to restrain and guide the motion of the panels in unified flexure of the truss, one end of each of said links being fixedly pivoted to said panels, the other end of each link being movable upwardly and downwardly, the direction and extent of the motion being determined and restricted respectively within predetermined limits by the panel engaging means, the respective end portions of said rib having pivotal connection with said spars respectively and also being in pivotal engagement with said truss, one of said end portions having clearance means to permit endwise motion of said truss in compensation for its flexure.

5. An airfoil having fixed front and rear spars and a series of ribs each provided with a truss system composed of pivotally interconnected panels and links, adjacent panels being pivotally connected in manner to permit their relative rotation, adjacent links being pivoted together and pivotally engaged by adjacent panels in manner to restrain and guide the motion of the panels in unified flexure of the airfoil, one end of each of said links being fixedly pivoted to said panels, the other end of each link being movable upwardly and downwardly, the direction and extent of the motion being determined and re-

stricted respectively within predetermined limits by the panel engaging means, the nose and trailing portions of said airfoil having pivotal connection with said spars respectively and also being in pivotal engagement with the truss system.

6. An airfoil having fixed front and rear spars and a series of ribs each provided with a truss system composed of pivotally interconnected panels and links, adjacent panels being pivotally connected in manner to permit their relative rotation, adjacent links being pivoted together and pivotally engaged by adjacent panels in manner to restrain and guide the motion of the panels in unified flexure of the airfoil, one end of each of said links being fixedly pivoted to said panels, the other end of each link being movable upwardly and downwardly, the direction and extent of the motion being determined and restricted respectively within predetermined limits by the panel engaging means, the nose and trailing portions of said airfoil having pivotal connection with said spars respectively and also being in pivotal engagement with the truss system, together with actuating means within the airfoil for the truss system, and means operable by the pilot for controlling said actuating means.

7. An airfoil comprising fixed front and rear spars and a series of ribs arranged transversely thereof, each rib being provided with a truss system including triangular panels, each panel having its upper apices pivotally connected to the upper portion of the rib, the lower portion of said rib being provided with slots pivotally receiving the lower apex of each panel, said panels having upwardly directed slots arranged adjacent their lower apices and a series of interconnected links pivotally connected to the upper apices of said panels and pivotally mounted in said upwardly directed slots, the arrangement being such that the panels are moved relatively to one another and in a definite proportion to change the degree of curvature of said airfoil.

8. An airfoil comprising fixed front and rear spars, a series of ribs arranged transversely of said spars, each rib being provided with a truss system including triangular panels, each panel having its upper apices pivotally connected to the upper portion of the rib, the lower portion of said rib being provided with slots pivotally reeciving the lower apex of each panel, said panels having upwardly directed slots arranged adjacent their lower apices, a series of interconnected links pivotally connected to the upper apices of said panels and pivotally mounted in said upwardly directed slots, whereby the panels are moved relatively to one another and in a definite proportion to change the degree of curvature of said airfoil, means within the airfoil for actuating said truss system and means operable by the pilot for controlling said actuating means.

9. An airfoil comprising fixed front and rear spars and a series of ribs arranged transversely thereof, each rib being provided with a truss system including triangular panels, each panel having its upper apices pivotally connected to the upper portion of the rib, the lower portion of said rib being provided with slots pivotally receiving the lower apex of each panel, said panels having upwardly directed slots arranged adjacent their lower apices, and a series of interconnected links pivotally connected to said panels and pivotally mounted in said upwardly directed slots, the arrangement being such that the panels are moved relatively to one another and in a definite proportion to change the degree of curvature of said airfoil.

10. An airfoil comprising front and rear spars, a series of ribs arranged transversely of said spars, each rib being provided with a truss system including triangular panels, each panel having its upper apices pivotally connected to the upper portion of the rib, the lower portion of said rib being provided with slots pivotally receiving the lower apex of each panel, said panels having upwardly directed slots arranged adjacent their lower apices, a series of interconnected links pivotally connected to said panels and pivotally mounted in said upwardly directed slots, whereby the panels are moved relatively to one another and in a definite proportion to change the degree of curvature of said airfoil, means within the airfoil for actuating said truss system and means operable by the pilot for controlling said actuating means.

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