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AERONAUTICAL PROPELLER AND METHOD OF MAKING SAME

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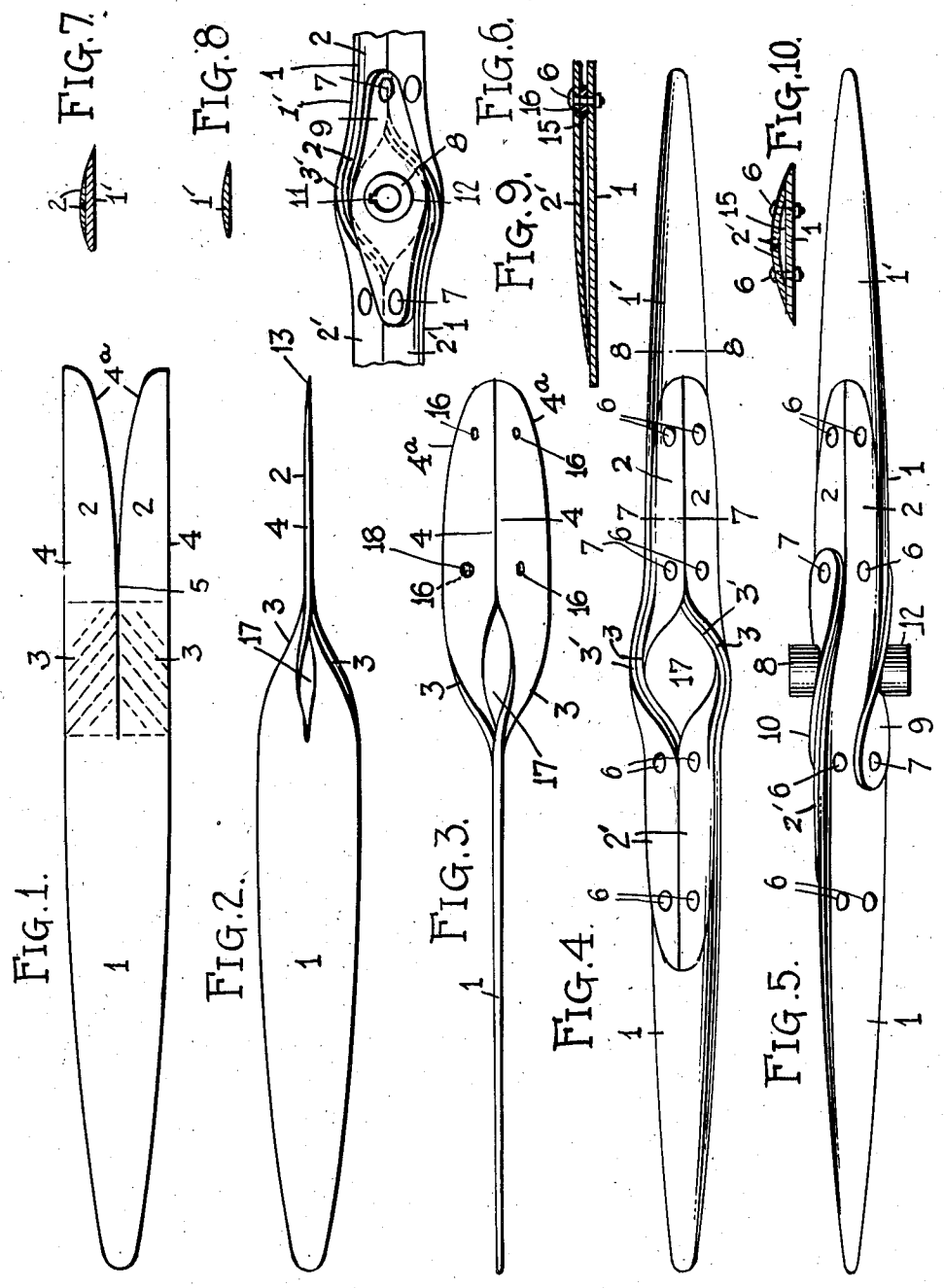

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UNITED STATES PATENT OFFICE

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AERONAUTICAL PROPELLER AND METHOD OF MAKING SAME

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My invention relates in general to aeronautical propellers and a method of making the same, and has reference more particularly to the type of metal propeller blades disclosed in U. S. Patents Nos. 1,463,556 and 1,518,410, granted to me July 31, 1923, and December 9, 1924, respectively, and in which the blades are preferably solid and of forged strong light weight metal alloy and thin relatively to their thrust loads.

In making propellers of this type of very large diameters, such as may be used on motors geared down to a slower propeller rotation, there are manufacturing difficulties and much expense is also involved. I have now devised a novel form of this type of propeller which can be made from rolled metal plates of much less thickness than the maximum blade thickness, and which plates are staple articles of commerce of moderate cost, and furthermore such plates are easily and cheaply and safely cut and bent to make up different propeller designs of a large range of sizes and shapes. My invention also includes a method of making the peculiar construction of blades comprising forked-end interlocking elements, so that they may be readily put together and secured in operative form in a propeller structure. Other important advantages possessed by my improvements will appear from the detailed description hereinafter given.

I have illustrated types of my improved propeller structure in the accompanying drawings, wherein;

Figure 1 shows a plan view of a blank of my improved blade, the dotted-line zone showing the parts of the fork-prongs which are to be bent around the opposite sides of the axis of rotation.

Figure 2 is a similar view to that of Fig. 1, showing the blank with its fork-prongs bent into form for assemblage with a duplicate thereof.

Figure 3 is a similar view to that of Fig. 2, the view being taken at right-angles to said Fig. 2.

Figure 4 shows a side view of a completed propeller made from two duplicate assembled blades, the view being taken looking in the line of the axis of rotation and through the central opening which receives the hub.

Figure 5 is a similar view to that shown in Fig. 4, but at right-angles thereto and with the hub structure added to the propeller.

Figure 6 shows an end view of the hub-structure with portions of the connected blades shown as broken away.

Figures 7 and 8, respectively, show cross-sectional views of the composite propeller, the planes of said views being indicated by the lines 7—7, and 8—8, in Fig. 4.

Figures 9 and 10, respectively, show longitudinal and transverse cross sections, of a modified form of construction with an interspace between the overlap and the overlapped parts.

Referring to the drawings, which are somewhat diagrammatic, the aeronautical propeller therein shown to illustrate a preferred form of my invention is to be considered as measuring 16 feet in diameter, that is, with two 8 foot blades and to run at 900 R. P. M., with 1000 h. p. geared engine. In making such a propeller, I take a pair of annealed rolled plates, like that indicated at 1, Fig. 1, preferably of duralumin or an alloy of that type, about $\frac{1}{8}$ of an inch thick and about 13 feet long and about twelve inches wide.

Each such plate or element, is then sawed or cut at one end to the proper blade outline including the tip, and from the other end a central longitudinal slot 5, is cut about 6 feet long, bifurcating the plate into two branches or tongues 2, 2. The inner corner of each branch is then cut-away on a curvature running into the slit, as at 4^a, the cut-away edges subsequently constituting the outer edges of the overlapping branches and provide a neat and desirable finish for the branch terminals. Beginning at the closed end of the slit 5, each branch or prong 2, is distorted so as to extend outwardly away from each other for about one-third the length of such part and then after the bend to lie in the same plane with each other, which plane is substantially at right-angles to the plane of the unslit portion of the blade, and with the outer edges 4, 4, of each branch

brought to a junction (as indicated in Figs. 2 and 3, and also in Figs. 4, 5 and 6 of the completed device) with their inter-relations reversed, i. e., the former slot-edges become the outer free edges. This arrangement provides a central elongated and wide space 17, for reception of the hub structure and through which extends the axis of rotation, and the center of this space is 8 feet from the tips of the blades.

As the pair of blades are duplicates, in order to make the drawings clear in Figs. 4 to 10, I have marked the reference numerals designating the various parts of the right-hand blade, with a prime mark, thus 1′, 2′, etc.

The plates or elements are then assembled in inter-locked relation, by springing apart the abutting edges 4, 4, of the prongs of one blade and passing the sprung junction over the edge of one of the prongs of the other blade and moving the parts on each other until the two interlocked blades can be relatively shifted into positions in which their tips lie outwardly in line in substantially operative positions, which movements bring the prongs of each plate into contact with those of the other along the bends 3, 3, with the portions beyond the bends in overlapping contact with the adjacent or unslit portions of the blades. The two branches of each blade which thus overlap the unslit portion of its blade-mate are thus disposed on the same side of the propeller and may lie in close surface contact therewith. The overlapping branches of each blade are then united or attached securely to the other blade and particularly to the unslit portion of such overlapped blade, in any well known and convenient manner to form a unit structure, such as by means of rivets or bolts 6, which extend through holes 7, formed in each of the branches and which are of an oblong shape with the long axis lying longitudinally of the blades, to thereby relieve the connection from sustaining any part of the centrifugal stress when the propeller is rotated.

This construction and arrangement results in an aggregate blade thickness in the overlap portions, double the plate thickness, therefore in this case 1⅝ inches. Each composite blade is then carved or otherwise formed as a unit to the desired profiles, as shown particularly in Figs. 7, 8 and 10. The resulting blades are composite for much of their width and a substantial part of their lengths, in this case 5 feet, leaving the outer or tip portion of the blade in this case, 3 feet long, non-composite of a single layer of piece construction, as shown in cross-section Fig. 8, the blade part 1, continuing for the full length of the blade while the overlap 2, falls short of that.

The overlapping part 2, may be disposed with an interspace between it and the overlapped part 1, as shown in Figs. 9 and 10, in which case filler blocks or spools 15, may be used to partly fill the interspace and to sustain the clamping stress of bolts or securing means 6. This interspace may be enclosed by an arching of the overlap 2, to produce more camber.

In the central opening 17, is inserted a suitable metal hub 8, made preferably of nickel steel, which may be secured to the propeller in any convenient well known manner. The tubular hub herein shown comprises a tubular member 12, having an internal key-way 11, to fit the engine drive-shaft, (not shown), and is provided with a fixed external attaching flange 9, and a corresponding removable flange plate 10, which parts are shaped to conform to and snugly fit the contacting surfaces of the blades, over which they extend for a considerable distance in the radial direction. These attaching parts 9 and 10, of the hub, may be secured in place by means of some of the bolts 7, 7, which secure the overlapping portions of the blades together. The upper attaching flange 10, which is removable, is secured to the hub against torsional movements by means of suitable splines or keys.

The extremities of the overlapping branches are tapered to substantially a feather edge for continuity of surface with the overlapped part. After forming the propeller blades, they are then twisted progressively as a unit from the hub region to the blade tips, in order to obtain the proper gradation of angles for the required pitch. The entire propeller is then heat treated or aged.

The resulting propeller has several advantages. The central-lock thereof supports most of the centrifugal stresses, which are at maximum at the center, leaving, if preferred, only a fraction of such stresses to be sustained by the means which secures the overlap to the blade, and this overlap will also balance a part of the centrifugal stress, and thus will reduce the stresses tending to rupture the propeller.

The blades, while thin relatively to their thrust loads, yet have profiles of sufficient camber-ratio for the necessary torsional rigidity, and yet the outer parts of the blade towards the tips, that is, more than one-third of the blade length, which parts move at the highest peripheral velocities and are subject to the most severe operative stresses, are a single piece and solid. A favorable central orifice is provided for the hub by the oppositely disposed inter-twined bends in the blade branches and the comparatively large space surrounding the hub reduces the weight of the propeller. The blades leave the hub region at angles of about 45 degrees, which meets the demands of most propeller designs. The centrifugal force stresses of the high ve-

locity blade ends, are carried integrally by an unbroken extension to the hub and around the central inter-lock.

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

1. In an aeronautical propeller, two blades made from two overlapping solid metal plate elements each extending past the hub to an overlap covering of much of the width and a substantial part of the length of the other blade and secured thereto and formed to merge therewith as a unit, said overlap being bifurcated by a cut or longitudinal slit, each branch of said bifurcation being individually distorted by compound bends to reverse the relative position of its edges and to straddle the center and to interlock with the similar bends of the opposite blade by continuous contact leaving a substantial space for a hub, and a hub inserted in said space and attached to said compound propeller.

2. An aeronautical propeller made from metal plates, said propeller having thin solid blades bifurcated at the roots and centrally interlocking each of the bifurcated roots overlapping one of the blades a substantial distance, and the bifurcations being so distorted for the purpose of the interlock that the blade roots are brought into position with cross-sections at substantially 45 degrees from the plane of rotation.

3. An aeronautical propeller having separate oppositely extending blades with forked roots intertwined with each other and overlapping each other to a substantial extent so that the overlaps shall balance to a substantial degree the stress of centrifugal force.

4. In an aeronautical propeller, blades each having their inner ends forked and formed with elongated prongs passing around opposite sides of the axis of rotation and bent outwardly and then in a plane substantially at right-angles to the portion from which the prongs start and parallel with the overlapped portion of its blade-mate, the bent part of the prongs of each blade intertwining with that of its blade-mate, and means for securing the prongs of each blade to its blade-mate.

5. In an aeronautical propeller, blades each having their inner ends provided with branches overlapping its blade-mate for substantially half the radial length thereof, said branches being bent outwardly and then extending in a plane substantially at right-angles to the portion from which they arise and substantially parallel with the overlapped portion of its blade-mate, said branches of one blade being interlocked with those of the other so that the bent parts thereof are intertwined substantially in contact whereby such parts mutually resist centrifugal force during rotation of the propeller, and means for retaining the blades in assembled relation.

6. In an aeronautical propeller, opposite blades each having forked inner ends with the prongs deformed and their free ends disposed in a common plane with the plane of the space or slit between forks cutting the axis of rotation, the prongs of each blade interlocking with those of the other blade and overlapping a substantial portion of the blade, and means for securing the blades in assembled positions.

7. The method of forming a propeller which comprises forming a plurality of blades each with prongs, then bending the prongs so that they are turned on themselves to such a degree as to bring into abutting relation the outer edges of said prongs, passing the prong of the fork of one blade into the space between fork prongs of its blade-mate, and then relatively shifting the blades on each other so that the fork prongs of each blade overlap a portion of the other blade.

8. The herein described method of forming interlocking blades in a propeller, which consists in forming the inner end of each blade with prongs, and then deforming or bending the prongs so that they are turned on themselves to such a degree as to bring into abutting relation the outer edges of said prongs.

9. For an aeronautical propeller a blade having the inner end thereof forked and having the forks twisted substantially at right angles to the main body of the blade, the originally outer edges of the forks being positioned adjacent to each other.

10. In an aeronautical propeller, a hub, and blades each having forked inner ends, the forked ends of each blade passing on opposite sides of the hub of the propeller and overlapping another one of the blades a substantial distance.

Signed at New York city, in the county of New York and State of New York, this 19th day of December, A. D. 1928.

SYLVANUS A. REED.