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D. A. DICKEY.

COMPOSITE PROPELLER AND METHOD OF MAKING THE SAME.

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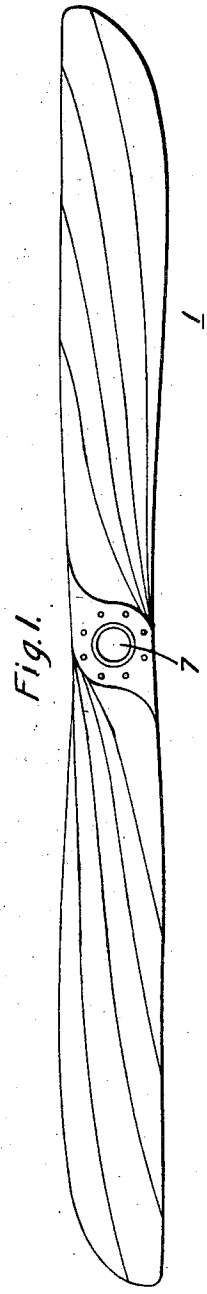


Fig. 1.

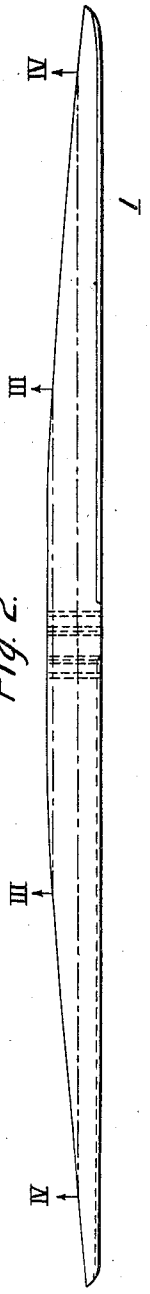


Fig. 2.



Fig. 3.



Fig. 4.

WITNESSES:

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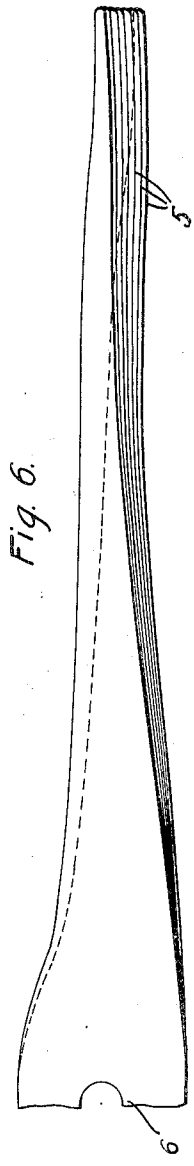


Fig. 6.

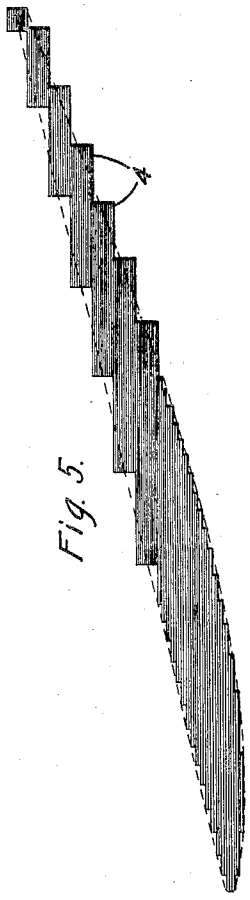


Fig. 5.

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UNITED STATES PATENT OFFICE.

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COMPOSITE PROPELLER AND METHOD OF MAKING THE SAME.

Application filed December 30, 1918. Serial No. 268,949.

To all whom it may concern:

Be it known that I, DANIEL A. DICKEY, a citizen of the United States, and a resident of Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Composite Propellers and Methods of Making the Same, of which the following is a specification.

My invention relates to air screws and more particularly to propellers for aircraft, and it has as one object the provision of a propeller of the type comprising a body formed of superimposed layers of fibrous sheet material impregnated by binder, of suitable character, which has been properly hardened and compacted.

Propellers of such character have been previously proposed in which the superimposed layers of sheet material were disposed in planes substantially parallel to the axis of a propeller hub. In such construction, however, those of the layers, making up the body, which extended completely from end to end were disposed outermost where they are most exposed to injury or weakening strains during the use of the propeller.

As a means for overcoming this objection, as well as for other reasons which will be hereinafter set forth, one of the primary objects of my invention consists in the construction of a propeller, comprising superimposed layers of sheet material united by a binder, in which the several layers are disposed in planes substantially parallel to the faces of the propeller hub, that is, substantially perpendicular to the axis of the hub, so that, such of the layers as extend throughout the length of the propeller will be the innermost of the layers constituting the propeller body.

In this connection, one of the objects of my present invention resides in the provision of a simple and novel means for developing patterns which may be employed in cutting the several layers, of different sizes and shapes, required to form the propeller body.

Still another object of my invention consists in providing an improved means for handling the layers, constituting the body of the propeller, and for assembling them in proper position within a mold to insure uniformity in the finished product so far as possible.

With these and other objects in view, my invention will be more fully described, illustrated in the drawings, in the several views of which corresponding numerals indicate like parts, and then particularly pointed out in the claims.

Fig. 1 is a front elevation of a propeller, constructed in accordance with my invention; Fig. 2 is a side elevation thereof; Figs. 3 and 4 are plan views of layers of sheet material cut to the proper shapes and sizes to be employed in certain portions of the propeller, the portions which these particular layers will occupy being indicated by the section lines III—III and IV—IV of Fig. 2; Fig. 5 is a diagrammatic transverse, sectional view through a propeller blade, illustrating the method of handling the several layers of sheet material employed and of positioning them for molding; Fig. 6 is a plan view further illustrating the manipulation of the several layers as they are placed in a mold.

In practising my invention, I may cut suitable manufactured-composite fibrous sheet-material, such as duck or other woven material or paper, cotton batting or other matted material, to provide a sufficient number of layers of the proper size and shape. I may then impregnate these layers with a suitable binder, such as a phenolic condensation product, shellac or some shellac substitute, such as a copal or a casein composition, and then place the layers in proper superimposed position in a mold of suitable size and shape in order that the assembled body may be compressed, hardened and cured.

Preferably, however, the sheet material is impregnated with a binder and dried sufficiently to drive off any solvent employed, without affecting the binder, before it is cut into the desired layers or laminations, as its handling is thereby greatly facilitated.

Any preferred method of obtaining the requisite patterns for cutting the several layers from the sheet material may be employed but I have found that the most desirable way of obtaining these patterns is to develop them as sections formed by passing a plurality of parallel planes through a propeller model parallel to the faces of its hub.

Obviously, when a suitable number of layers have been cut from patterns thus developed and have been superimposed, in proper successive order, they will form a body approximating the shape of the desired propeller but slightly greater in dimensions, particularly in thickness, to allow for the compression which will occur during molding of the body.

Preferably, the several layers may best be superimposed or assembled directly in a mold in order that they may not be displaced by subsequent handling, and when they are properly disposed in the mold, the mold may be closed and the assembled body may be cured or hardened by suitable means, depending, to a large extent, upon the binder employed.

Referring more particularly to the development of the patterns, it will be apparent that, inasmuch as each pattern will vary slightly, both in shape and size, from the other patterns, the most natural method, from a theoretical viewpoint, would be to pass as many sections through the model propeller and, consequently, to develop as many patterns as there are required layers of sheet material in the finished propeller. Inasmuch, however, as when even heavy duck is employed, several hundred layers are necessary to form a single propeller, it is evidently impossible, from a practical manufacturing standpoint, to follow this theoretically desirable method. I have, therefore, conceived what, as opposed to the theoretical method, may well be termed the "step" method in which each pattern will serve as a guide for the cutting of a plurality of associated layers of sheet material.

According to this "step" method, I pass a suitable number of planes, as, for example, twenty, for a propeller having a hub four inches in thickness, through a propeller model at uniform intervals and parallel to the faces of the hub of the model and develop patterns from the sections thus indicated. For example, in Fig. 2 I have shown where two sections through the propeller which, for present purposes, may be considered as a model, may be taken, and, in Figs. 3 and 4, I have indicated layers 2 and 3 cut from patterns derived from passing planes through the sections indicated. Obviously, when a plurality of sections are passed through the propeller at uniform intervals, a plurality of patterns of this character, varying materially in some instances in both shape and size, will be provided.

By employing each pattern as a means for cutting a plurality of layers of sheet material and superimposing the layers cut from the same pattern, in each instance, a plurality of groups or sections 4 of material may be provided, as shown in Fig. 5, and these groups of material may then be superimposed to approximate roughly the shape of the desired propeller.

Preferably, for the sake of convenience in handling and consequent rapidity of manufacture, I prefer to cut all of the layers of any one pattern simultaneously from a body comprising a plurality of superimposed layers of sheet material. To facilitate this, I may treat the sheet material in a manner fully disclosed in a copending application filed by me on Dec. 30, 1918 and bearing Serial Number 269,950. As there disclosed, a suitable number of layers of impregnated sheet material are superimposed between protective layers of untreated sheet material, and the body or plate thus assembled is subjected to sufficient heat and pressure to cause adhesion between the several layers without affecting the properties of the binder utilized. Preformed plates thus provided may well be utilized in practising my present invention, a group or section 4 of the desired shape and size, in each instance, being cut from a preformed plate by any suitable means as, for example, a band saw.

When the necessary number of groups of material, corresponding to the number of patterns employed, have been formed in this manner, their protective coatings may be peeled off to expose clean, rough surfaces suitable for molding, and the various groups or sections may be superimposed in proper order in a mold, in the relative positions shown in the upper right-hand portion of Fig. 5, and there subjected to heat and pressure to cure the binder and compress and harden the entire assembled body. If the sections are not too thick, the impregnated sheet material will flow or yield sufficiently in the heated mold to fill in the angular spaces between the edges of the adjacent sections, whereby a propeller having a uniformly smooth surface will be provided.

I have found, however, from actual experience, that more uniform and satisfactory results may be obtained by following the method best disclosed in the lower left-hand portion of Fig. 5 and in Fig. 6. By the method here shown, the several layers 5 of each preformed plate section 4 are separated from each other as the section is being placed in the mold, and the layers thus separated are "fanned" or spread out, as clearly shown in Figs. 5 and 6, so that, when the several fanned sections have been superimposed in proper order, the edges of the various layers fall substantially in a surface corresponding, in curvature, to the surface of the desired propeller. By this arrangement, practically all necessity for flow of material in the mold is obviated, and a more uniform propeller, as regards appearance, strength and balance, may be obtained.

Preferably, the various sections employed may be formed with a central shaft-receiv-

ing opening 6 in order to avoid boring through the hardened propeller after it has been molded, a suitable stud or mandrel constituting a part of the mold, seating in these alined openings during the molding.

A suitable keyway may be cut in the hub of the propeller after it is molded, and the propeller may be keyed directly upon its shaft or a metallic hub 7 of any desired type may be employed.

By the foregoing method, the duck or other sheet material is assembled in a logical manner for pressing at the hub as well as at all portions of the blades, the fibres run continuously throughout the length of the propeller and, as the several layers are cut symmetrically, an accurately balanced propeller body results.

While various sheet materials may be employed and also any one of several binders, I prefer to utilize some heavy woven material, such as duck, impregnated with a phenolic condensation product, such as bakelite, as a binder. This material is particularly desirable as a properly shaped body composed of it may be cured in a mold, by subjecting it to heat and pressure, to form a hard, solid, somewhat resilient and substantially insoluble and infusible propeller. Furthermore, a propeller formed of this material is non-inflammable, is not affected by moisture, oils, weak acids or alkalis and will not warp because of climatic changes.

As many changes in the material employed and in the particular methods whereby the material may be provided in the desired form for molding are possible, I do not wish to, in any way, restrict my invention except as indicated in the appended claims.

I claim as my invention:

1. A propeller comprising layers of manufactured-composite fibrous material and a hardened binder, the layers being disposed substantially parallel to the faces of the hub.

2. A propeller comprising superimposed layers of manufactured-composite fibrous material and a hardened phenolic condensation product as a binder, the layers being disposed substantially parallel to the faces of the hub.

3. A propeller comprising superimposed layers of woven sheet material impregnated and joined by a hardened phenolic condensation product as a binder, the layers being disposed substantially parallel to the faces of the hub.

4. The method of forming a propeller which comprises impregnating fibrous sheet material with a binder, cutting layers of suitable shapes and sizes from the treated sheet material, superimposing the layers in proper order relative to their shapes and sizes to build up a body of approximately propeller outline in which the layers are disposed substantially parallel to the faces of the hub portion and curing the body thus built up under pressure.

5. The method of forming a propeller which comprises impregnating fibrous sheet material with a phenolic condensation product as a binder, cutting a plurality of layers from the sheet material of proper shapes and sizes, superimposing these layers in proper relative positions, according to their shapes and sizes, to provide a body substantially conforming in shape to that of a propeller and in which the several layers are disposed substantially parallel to the faces of the hub portion of the body and subjecting the body to heat and pressure in a mold to compact it and harden the binder.

6. The method of forming a propeller which comprises superimposing layers of impregnated sheet material between protective layers of unimpregnated sheet material and slightly compressing and heating the plate thus formed to cause adhesion between the several layers, cutting sections of proper shapes and sizes from the plate thus formed, removing the protective coverings from the sections thus provided, superimposing the sections in proper order with regard to their shapes and sizes to provide a propeller-shaped stack and subjecting the stack thus provided to heat and pressure to compact it and harden its binder.

7. The method of forming a propeller which comprises forming compound layers of suitable shapes and sizes, each of which comprises a plurality of superimposed sheets of impregnated fibrous material adhering slightly to each other, superimposing the compound layers thus formed and in the meantime separating the various sheets of the layers and fanning or spreading them, whereby a substantially propeller-shaped body is provided, and subjecting the body thus provided to heat and pressure in a mold to compact it and harden the binder.

8. The method of forming a propeller which comprises providing a plurality of layers of suitable shapes and sizes, each of which comprises a moldable plate section of superimposed sheets of fibrous material impregnated with a phenolic condensation product in an uncured state, superimposing the several compound layers in proper order relative to their shapes and sizes, separating the several sheets of the layers and swinging them laterally or fanning them shape of a propeller, and subjecting the surelative to each other, whereby the supershape of a propeller, and subjecting the superimposed compound layers to heat and pressure in a mold to compact them and harden the binder.

9. The method of forming a propeller

which comprises superimposing a plurality of compound layers of proper shapes and sizes in a suitable relation in accordance with their shapes and sizes to provide a substantially propeller-shaped body, each of the layers comprising a moldable composition having a phenolic condensation product as a binder, and subjecting the body thus assembled to heat and pressure in a mold to compact it and harden the binder.

In testimony whereof, I have hereunto subscribed my name this 21st day of Dec. 1918.

DANIEL ADAM DICKEY.