S. HEATH.

PROPELLER.

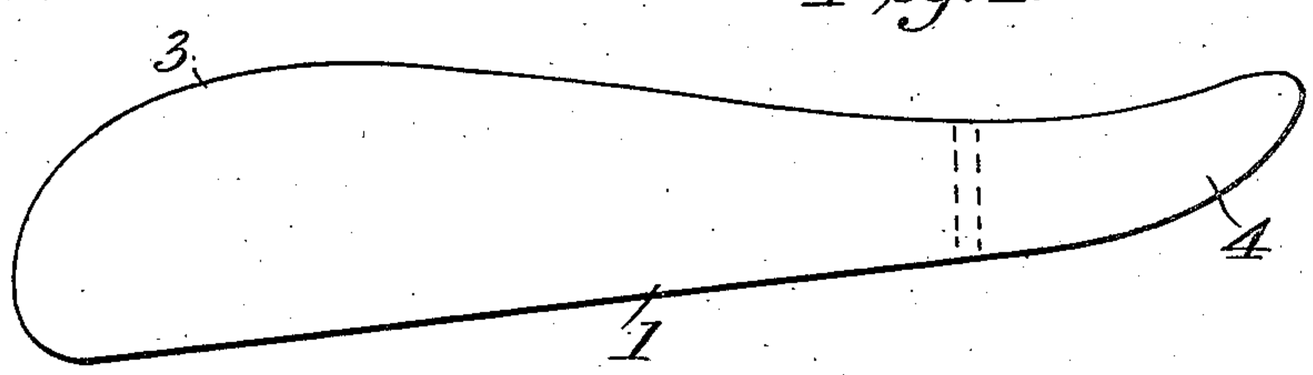
APPLICATION FILED APR. 23, 1912.

1,166,907.

Patented Jan. 4, 1916.

4 SHEETS—SHEET 1.

Fig. 1.



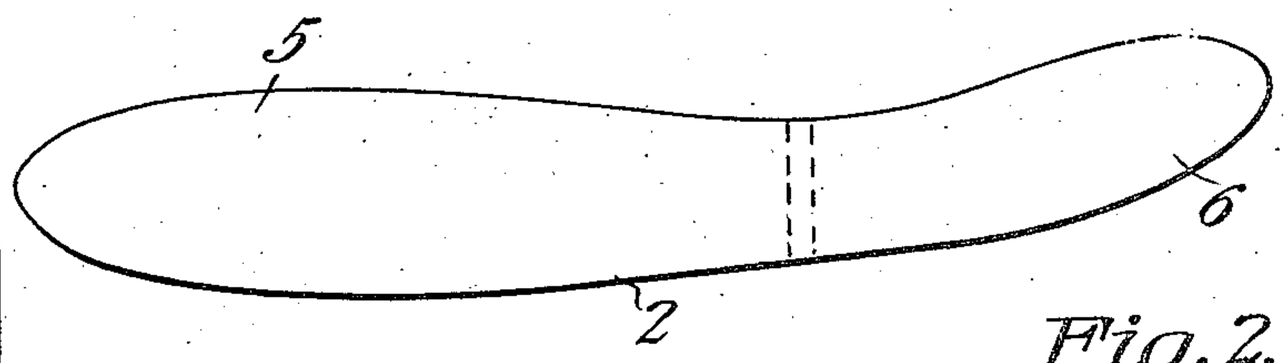


Fig. 2.

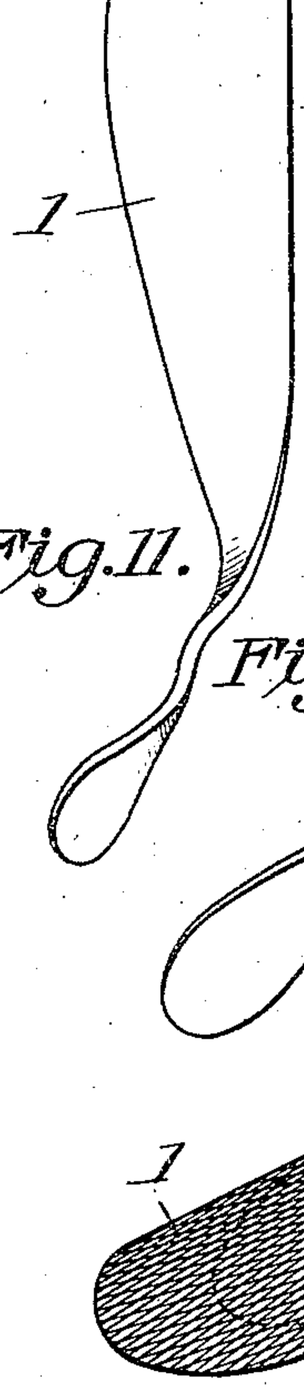


Fig. 11.

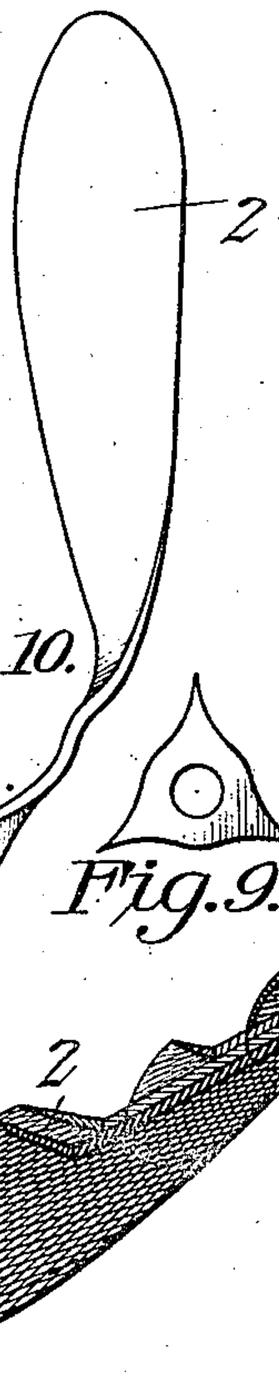
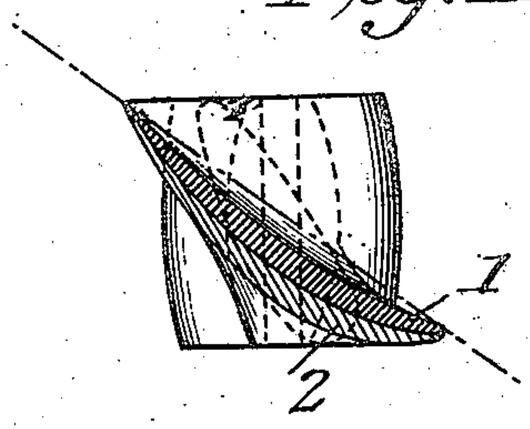


Fig. 10.

Fig. 9.

Fig. 8.

Fig. 12.



Witnesses
E. M. Colford
Oscar Payne.

Inventor
Spencer Heath

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4 SHEETS—SHEET 2.

Fig. 7.

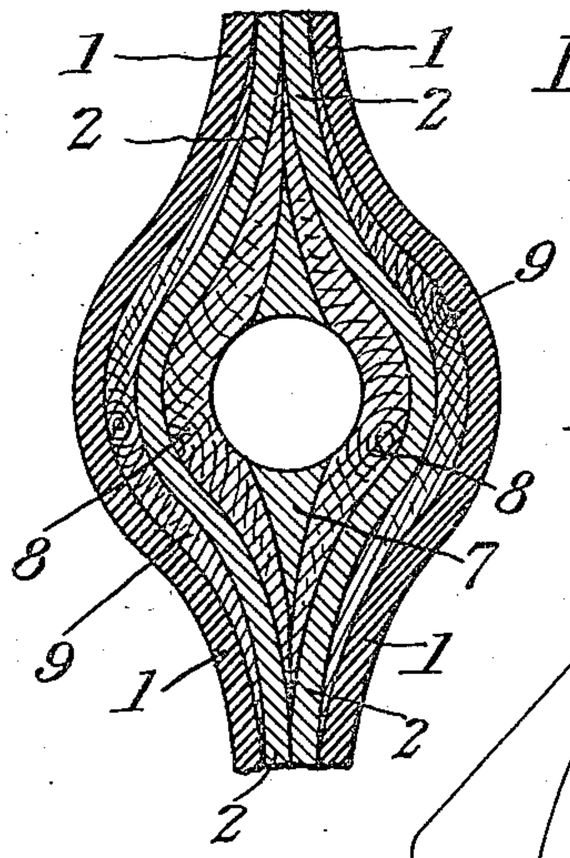
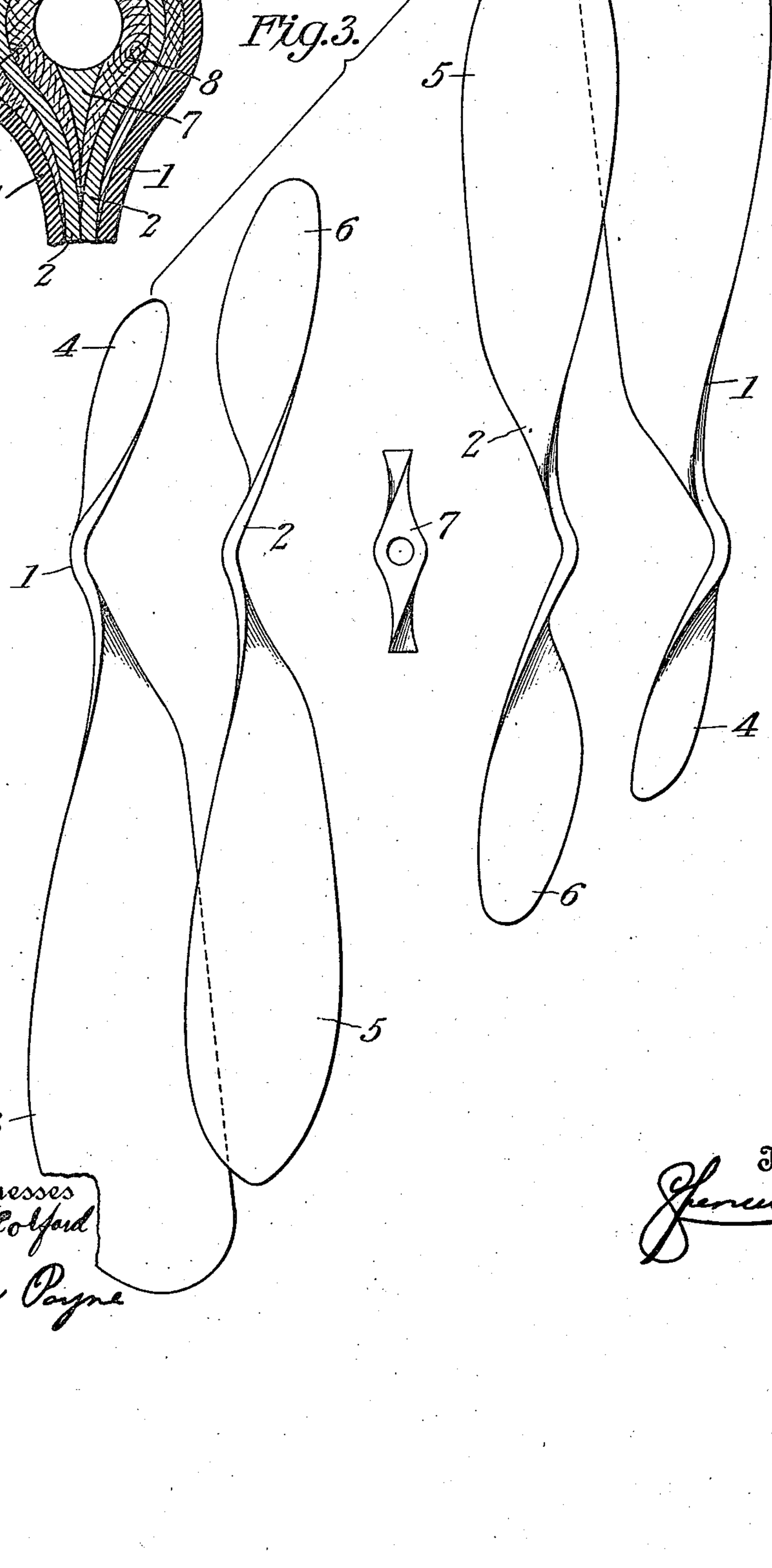


Fig. 3.



Witnesses
E. M. Colford
Oscar Payne

Inventor
Jerem Heath

S. HEATH.

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4 SHEETS—SHEET 3.

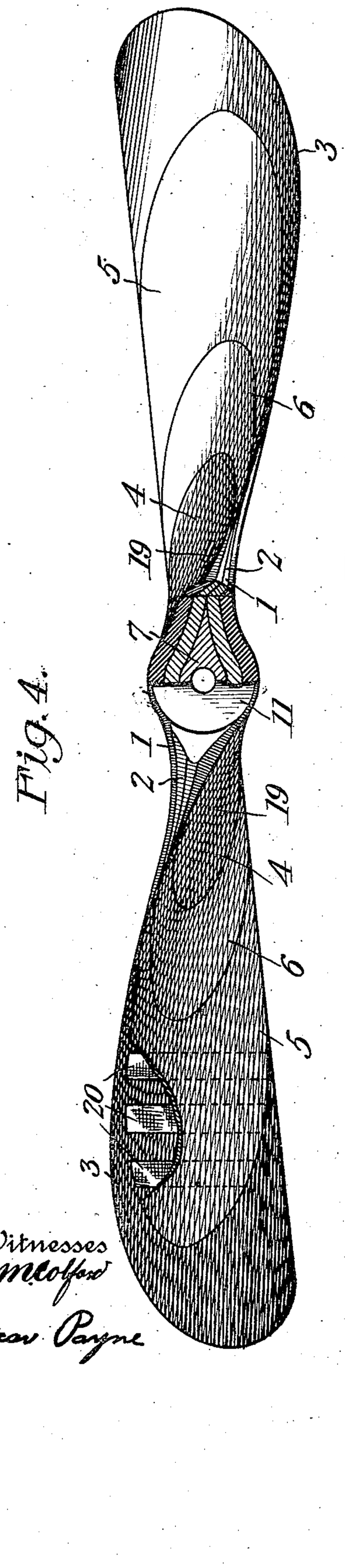

Fig. 4.

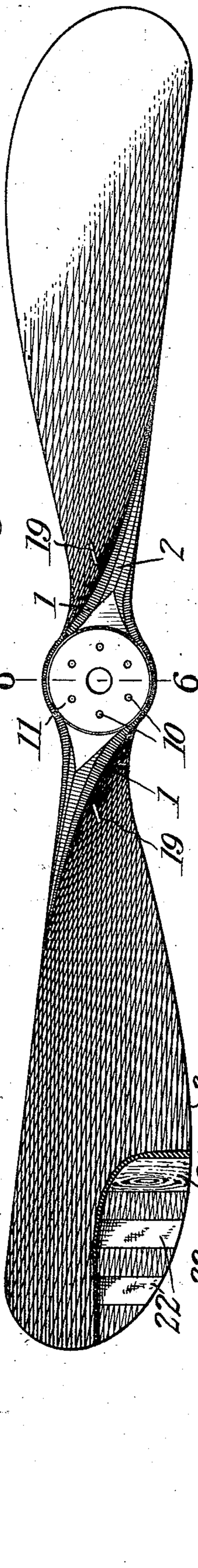

Fig. 5.

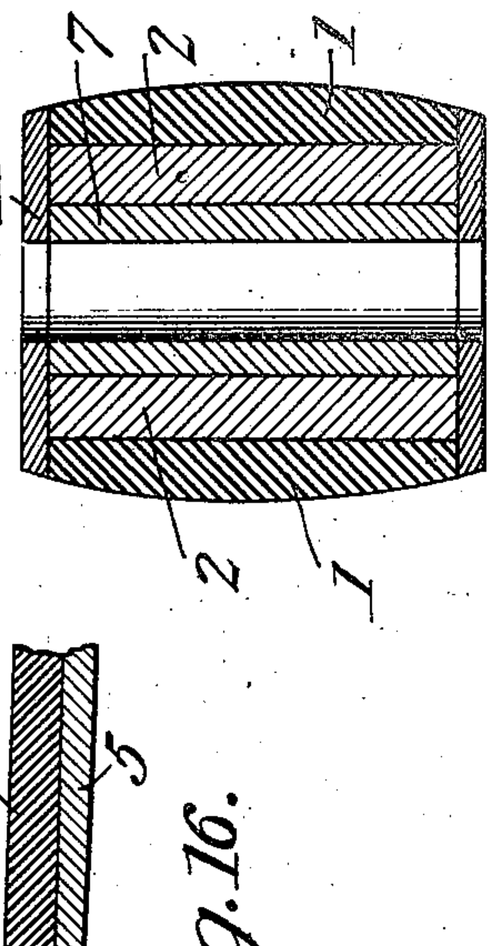

Fig. 6.

Fig. 16.

Witnesses
E. M. Colford
Oscar Payne

Inventor
Spencer Heath

S. HEATH.

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4 SHEETS—SHEET 4.

Fig. 13.

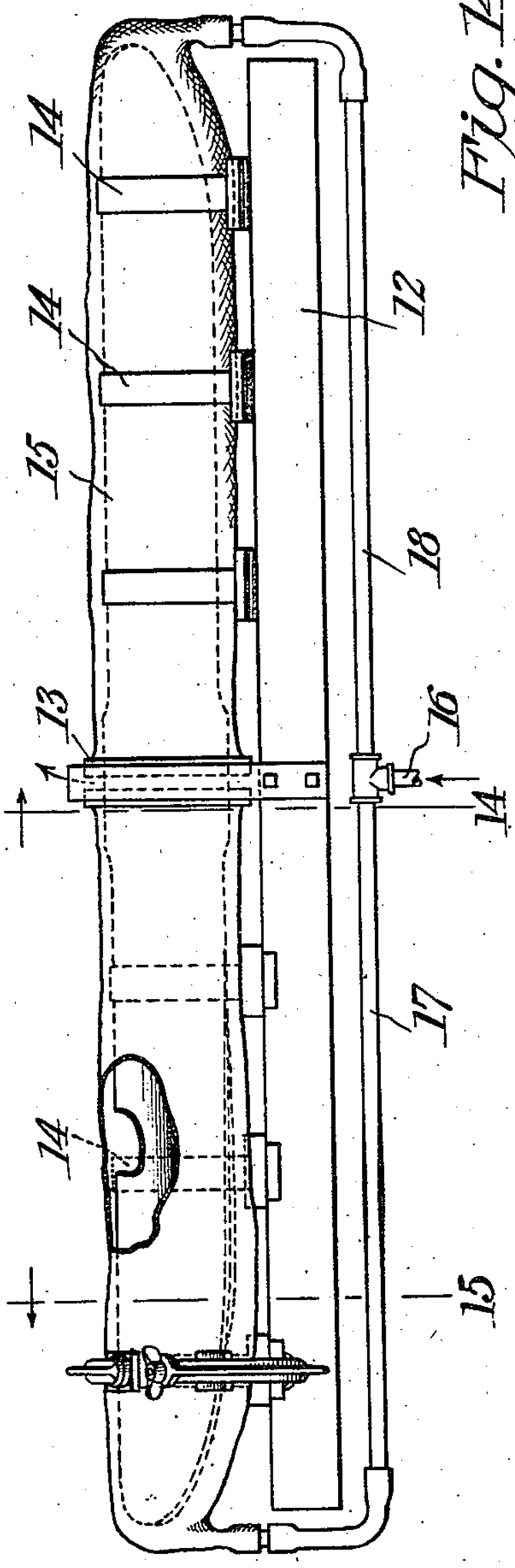


Fig. 14.

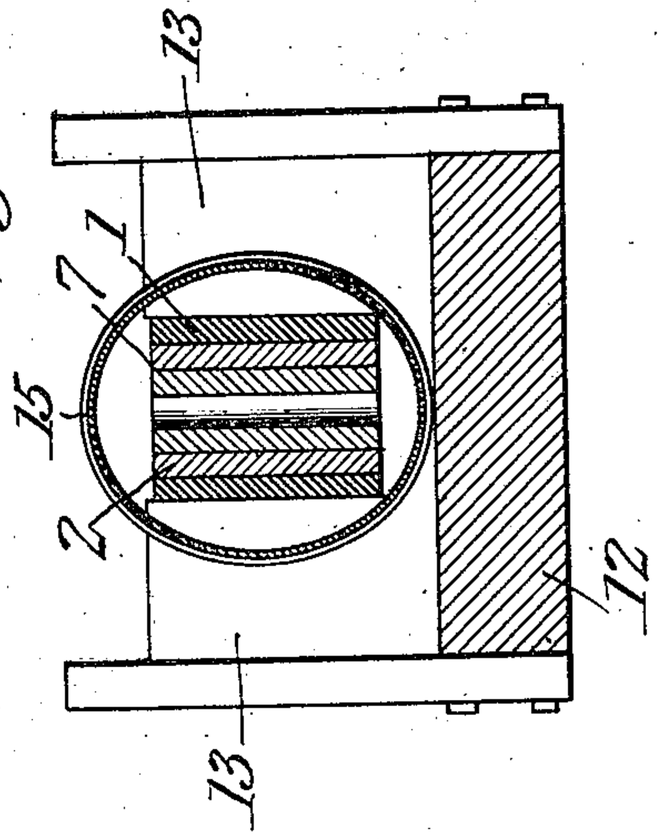
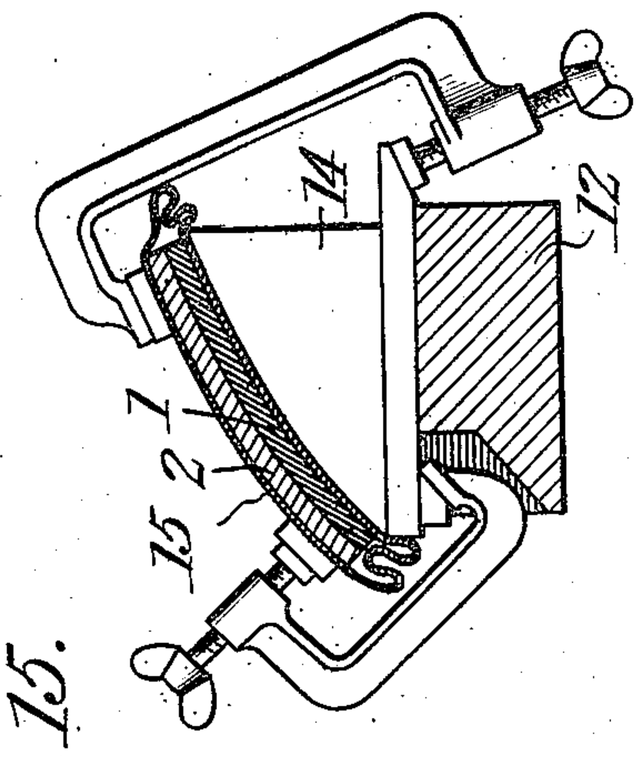


Fig. 15.



Witnesses
E. M. Colford
Oscar Payne.

Inventor
Simon Heath

UNITED STATES PATENT OFFICE.

SPENCER HEATH, OF WASHINGTON, DISTRICT OF COLUMBIA.

PROPELLER.

1,166,907. Specification of Letters Patent. Patented Jan. 4, 1916.

Application filed April 23, 1912. Serial No. 692,684.

To all whom it may concern:

Be it known that I, SPENCER HEATH, a citizen of the United States, residing at Washington, in the District of Columbia, have invented new and useful Improvements in Propellers, of which the following is a specification.

This invention relates to propellers, particularly to propellers for aeronautical use and consists in certain processes, combinations and modes of construction hereinafter fully described.

An object of this invention is to produce a propeller having the most desirable form and disposition of materials with a greater economy of materials and of labor and a greater facility of manufacture than has heretofore been known.

Propellers constructed after this invention may be constructed from various materials, but as wood is most frequently used this description will be made more particularly with that material in view.

A chief requirement of wooden propellers is that the faces and edges of the blades, particularly their extremities shall, without undue weight in the whole propeller, be capable of great resistance to the wear and destructive effects of coming in contact at very high velocity with particles of earth, stone, chips and other detritus or deranged portions of the machine or equipment of which the propeller is a part. This action in a propeller of moderate weight is reduced to a minimum by the modes of construction set forth in the applicant's United States Patent No. 998,897, in which the outer portions and extremities of the blades are formed of a very hard and heavy wood with the interior parts of much softer and lighter material, this construction being the only means, apart from sheathing or swathing the blades in metal or cloth, which has heretofore, within the applicant's knowledge, been employed to give the blades strength and resistance to wear.

The present arrangement of materials differs from the applicant's former construction mainly in the hard wood forming substantially the entire face as well as edges and extremities of the blades, the soft wood being confined to the back and interior portions of the blades.

A further distinguishing feature is that in the present construction the laminæ or laminations are in the form of helicoid surfaces, the contacting surfaces of each of the various laminæ being substantially parallel to the face of the blade and at all parts nearly equidistant therefrom.

A further distinguishing feature is that the lamination forming any part of a given blade is extended beyond the hub portion to form a different or unlike part of the opposite or otherwise adjacent blade. This extended portion, in the case of the face lamination, extends preferably from the face of one blade to form a portion of the back of the adjacent blade but it is to be understood that the extended lamination need not be confined to the back of the adjacent blade but may form or reinforce any portion thereof. The interior laminations are preferably arranged similarly to the face laminations.

The helicoidal laminæ herein employed are a special form of the invention described in my copending application Serial No. 667,657, filed December 26, 1911, in which the laminations are formed or twisted out of a true plane. In the present form the twisting of the laminæ is caused to a degree, in which the pitch of the blade is produced, solely by the "twist" and in which the joints between laminations emerge exclusively on one side of the blade without at all passing through its face. These results are obtained by pressing, binding and forming the laminations under the softening action of steam out of their normally flat shape and into the particular twist, and camber or curvature desired for each part of the propeller, the formed or twisted laminations then being secured together by glue in their proper relations, after which the surplus material about the edges and joints is removed, giving the propeller its finished shape.

In the brief description of the accompanying drawings, which form part of this specification: Figures 1 and 2 are plan developments of propeller laminations. Fig. 3 is a plan projection of the several laminations forming a propeller. Fig. 4 is a plan of Fig 3 assembled. Fig. 5 is an inverted plan of Fig. 4. Fig. 6 is a section on the line 6—6 of Fig. 5. Fig. 7 is a horizontal section of a modified hub. Fig. 8 is a plan

view of a three-bladed propeller. Figs. 9, 10 and 11 are projected views of laminations for forming Fig. 8 when ready to assemble. Fig. 12 is a section on line 12—12 of Fig. 8. Fig 13 is an elevation of a propeller in process of formation. Figs. 14 and 15 are respectively sections on lines 14—14 and 15—15 of Fig. 13. Fig. 16 is a longitudinal section through the end of a propeller blade.

Similar reference numerals refer to corresponding parts throughout.

Each blade of the propeller is formed, in the main, by a pair of laminations 1 and 2 having the developed form illustrated in Figs. 1 and 2 and being shaped or twisted into the form shown in Fig. 3. In each propeller there are as many pairs or sets of laminations 1 and 2 as there are blades in the propeller. In the construction illustrated in the drawings there are two laminations for each blade of the propeller, but it is to be understood that the invention may be practised by the employment of a single lamination for each blade or by a greater number than two laminations in each blade. Fig. 3 shows two pairs of these laminations in position to be assembled for a two-bladed propeller. The portion 3 of lamination 1 forms the face or slightly concave side of the propeller. The portion 4 extends beyond the hub portion of the propeller to form part of the opposing or adjacent blade. The face lamination 1 is reinforced by the portion 5 of lamination 2 which, in a similar manner, extends beyond the hub to form an interior portion of the adjacent blade. The corresponding portions of the second set of laminations form the additional parts making up the back of the given blade, the portion 6 forming an additional interior lamination and portion 4 forming the outermost back lamination. It will be seen that the face portion of one blade extends beyond the center for a portion of the length of the other blade which is thus reinforced while the face portion of the other blade in a similar and reciprocal manner, in its turn, extends beyond the center to reinforce the first. When the laminations of Fig. 3 are brought together about the hub filler and secured together in this relation by glue or cement or any preferred means, and the edges and end of the various laminations are rounded and finished to a regular form the propeller illustrated in Figs. 4 and 5 is produced. From the corresponding numerals of Figs. 3, 4 and 5 the relative position of the several parts will be clearly apparent without further description.

Where it is not necessary to produce a considerable enlargement at the hub of the propeller the hub-forming filler 7 may be reduced or omitted altogether. Where it is necessary to produce a hub of much greater size the hub-forming filler may be increased in size or in the number of its parts.

Fig. 6 shows clearly the filler 7 between the laminations.

Fig. 7 shows an arrangement of fillers for a large hub. In this figure filler 7 becomes divided into two parts by the center hole. Fillers 8 are arranged on each side of filler 7 and fillers 9 are inserted between the hub portions of each of the laminations 1 and 2.

By means of the hub fillers thus described it is possible to provide for the boring of the bolt holes 10, by means of which the propeller is secured to the engine flange or other mounting, without cutting the longitudinal fibers of laminations 1 and 2.

In addition to the glue or cement between them, the laminations are further secured together near the hub and adjacent the extremities of the fillers by keys 19, (Figs. 4 and 5) which may be formed of wood or metal fitted or driven through the laminations as shown or by bands, hoops or wire girding each blade adjacent the hub.

After the propeller has been assembled with the necessary fillers in position the opposite faces of the hub are provided with plates 11 for further security and unity of the hub.

The three-bladed propeller of Fig. 8 is in all general respects similar to the two-bladed form as regards the form of the laminations and their manner of assembling. The main portions of each blade extend beyond the hub to constitute a portion of the back of the adjacent blade while each blade in turn is likewise in part formed by the extended portions of its pre-adjacent blade, coming immediately before.

Figs. 9, 10 and 11, taken in view of Fig. 3, show a slightly modified form which is given to laminations 1 and 2 for adapting them to the three-bladed construction. A view of these laminations renders it obvious that by a suitable further modification of the same kind, they may be readily adapted to form a propeller having four or any other desired number of blades.

The interior laminations 2 are preferably formed of material of less weight and density than laminations 1 since this material is not exposed to the same degree of wear and hard-usage which comes upon the laminations 1 which form the exterior faces, edges and extremities of the blades. This employment of lighter material within and heavier material without leads to the production of a propeller having the maximum resistance to wear and the maximum strength and stiffness with the least possible weight. In practice the most useful materials have been found to be quartered white oak for the exterior laminations 1 and the edge-grain silver spruce for the interior laminations 2. The character of the ma-

terials is indicated on the drawings by light and dark shading.

In the formation of propellers in accordance with the present invention the foregoing has made it apparent that the laminations must before final assembling be given the requisite twist or screw-pitch form indicated in Figs. 3 and 9 to 11 inclusive. This form is obtained as follows: A stout framework 12 (Fig. 13) is fitted with a clamping device 13 in which the hub portions of the laminations in their flat or untwisted condition are secured. The frame 12 is provided at intervals throughout its length with a series of forms 14 having a curve or pitch similar to that desired for the corresponding portion of the propeller blade. The assembled flat laminations held at their centers by the clamping device 13, are inclosed at each end in a bag 15 or similar flexible container formed of oiled or rubberized cloth. The mouths of the bags 15 are provided each with a hoop or ring by means of which they are brought close together at each side of the clamping device 13. By means of a pipe 16 and its branches 17 and 18 communicating with the bottoms of the bags they are filled with steam the action of which upon the wood renders it temporarily flexible to a degree admitting of the laminations being bent down and clamped to the forms 14 in the manner illustrated in Fig. 15, the laminations being under the influence of the steam during the entire operation of bringing them into the desired position whereby a continued softness of the wood is insured throughout the operation. The steaming is now discontinued and after the wood has become cold the bags are removed leaving the former flat laminations now in a condition ready for assembling, as shown in Fig. 3. The laminations are now reassembled with adhesive material between their contacting surfaces, being clamped together, usually upon the same forms upon which they were shaped, until the glue or cement has dried, after which the assembled propeller is ready for such trimming and finishing as may be required for the perfection of its form.

A further feature of the present invention consists in the employment of a transverse reinforcing fibrous material disposed transversely through the blade and between the laminations thereof. In Figs. 4, 5, and 16, 20 shows bands of thin linen or other material having strong longitudinal fibers, which material is stretched between the laminations 1 and 2 and cemented therein under a tension to prevent splitting of the blade. 21 is a band of transverse veneer inserted through the blade in the bottom of a saw-kerf extending a considerable distance into the end of the blade. This veneer is tapered to a thin edge toward the extremity of the blade to admit the kerf being closed and cemented. Bands of tension fibers 22 are inserted with cement in the saw-kerf between the veneer and the end of the blade and the kerf pressed closely together.

It will be obvious from the above described processes and modes of construction that the propeller will be constructed from the least quantity of original material brought together in the simplest and most direct way with the fibers of the wood brought into the position best calculated to withstand the stresses they are required to bear and the least possible amount of tool work being required to bring the propeller into its final completeness of contour and surface. It is further obvious that the disposition of the denser and more durable material in the face and edges of the blade and the employment of the transverse reinforcing fibers in the manner which has been described will give to this propeller the utmost degree of resistance to the severe rigors which an instrument of this character must withstand.

Having now described my improved propeller what I claim is:

1. A propeller formed of assembled laminations, the face lamination of each blade being extended beyond the center portion to form a back lamination for the adjacent blade.

2. A propeller formed of assembled laminations, the face lamination of each blade being extended beyond the center portion to form the outermost back lamination of the adjacent blade and similar interior laminations intervening between the face lamination and the outermost back lamination of each blade.

3. A propeller having similar sets of assembled laminations for the several blades, the laminations forming the several blades being joined at the center portion of the propeller to form the hub and the laminations of each blade being extended beyond the center to strengthen and reinforce the adjacent blade, hub-forming fillers inserted between the laminations where the several sets join and keys inserted transversely through the laminations adjacent the hub fillers to insure against separation of the laminations in this part.

4. A propeller formed of assembled laminations, the face lamination of each blade being extended beyond the center portion to form the outermost back lamination of the adjacent blade and similar interior laminations intervening between the face lamination and the outermost back lamination of each blade, said interior laminations being formed of less durable material than the face laminations.

5. A propeller formed of assembled laminations, the laminations in any portion ly-

ing in a position substantially parallel to the face of the blade and the face lamination of each blade being extended beyond the center portion to form the outermost back lamination of the adjacent blade.

6. A propeller having similar sets of assembled laminations for the several blades, the laminations forming the several blades being joined at the center portion of the propeller to form the hub and the laminations of each blade being extended beyond the center to strengthen and reinforce the adjacent blade, and a hub-forming filler inserted between the laminations where the several sets join.

7. A propeller having similar sets of assembled laminations for the several blades, the laminations constituting the several blades forming the hub of the propeller at its center portion and interior fillers between the laminations giving volume to the hub and adjacent portions.

8. A propeller having assembled laminations each of which laminations extends from one blade to form a portion of the adjacent blade and a hub-forming filler inserted between the laminations at the mid-portion of the propeller.

9. A propeller having assembled laminations, the face laminations of each blade being extended beyond the center portion of the propeller to form the outermost back lamination of the adjacent blade, and a hub-forming filler inserted between the laminations at the mid-portion of the propeller.

10. A propeller formed of laminated blades, each lamination of greater length in one blade being extended beyond the center portion to form a lamination of lesser length in the adjacent blade.

11. A propeller formed of laminations, a single lamination constituting the entire face of each blade and being extended beyond the center portion to reinforce corresponding laminations in the adjacent blade.

12. A propeller formed of laminations, a single lamination constituting the entire face of each blade and being extended beyond the center portion to reinforce corresponding laminations in the adjacent blade, and hub-forming fillers secured between the laminations.

13. A propeller formed of laminations, one of which laminations constitutes the face of each blade, said face laminations being formed of material of greater density and durability than the lamination adjacent thereto and being reciprocally extended beyond the center portion to reinforce corresponding laminations in the adjacent blade.

14. A propeller formed of laminated blades, the face lamination of each blade being formed of material of greater density and durability than its adjacent lamination, the laminations being extended reciprocally beyond the center portion and reinforcing corresponding laminations in the adjacent blade.

15. A propeller formed of laminated blades the face lamination of each blade being formed of material of greater density and durability than its adjacent lamination, the laminations being extended reciprocally beyond the center portion and reinforcing corresponding laminations in the adjacent blade, and hub forming fillers secured between the laminations.

16. The process of manufacturing laminated propellers which consists in cutting a plane development of each lamination from flat material, softening the laminations temporarily by subjecting them to heat and moisture, shaping the softened laminations to their requisite screw-pitch form and assembling and cementing together the screw-shaped laminations thus formed.

17. The process of manufacturing laminated propellers which consists in cutting a plane development of each lamination from flat material, assembling the flat laminations in their proper relative position, treating the assembled laminations to bring them into a temporarily softened condition and shaping the laminations thus under treatment to their requisite screw-pitch form, disassembling the screw-shaped laminations thus formed and reassembling and securing said formed laminations together.

18. The process of manufacturing laminated propellers which consists in cutting a plane development of each lamination from flat material, assembling the flat laminations in their proper relative positions and clamping their hub-portions together, softening the laminations temporarily by treating them with heat and moisture and shaping the laminations thus treated to their requisite screw-pitch form, disassembling the screw-shaped laminations thus formed and reassembling and securing said formed laminations together.

19. The process of manufacturing laminated propellers which consists in cutting a plane development of each lamination from flat material, assembling the flat laminations in their proper relative positions and clamping their hub-portions together, inclosing the laminations of each blade in a flexible and pliant container, treating the inclosed laminations by the application of steam within the pliant containers, shaping the laminations of each blade while thus under treatment to their requisite screw-pitch form, disassembling the screw-shaped laminations thus formed and reassembling and securing said formed laminations together.

20. A propeller blade having its ends reinforced by transverse fibrous fabric stretched transversely through a saw-kerf in the end of the blade and cemented therein.

21. A propeller having its extremities provided with a deep saw-kerf substantially parallel to the blade-face, transverse veneers inserted through the blades at the bottoms of the saw-kerfs and tapering outwardly therefrom and bands of fabric having their fibers stretched transversely through the saw-kerf and cemented therein.

22. A propeller formed of laminated blades, the laminations constituting one part of each blade being extended beyond the center portion to form a different part of the adjacent blade.

SPENCER HEATH.

Witnesses:
N. CURTIS LAMMOND,
NANCY E. LOENTAL.