

May 30, 1939.

E. T. WARD

2,160,467

PROPELLER

Filed Sept. 22, 1937

2 Sheets-Sheet 1

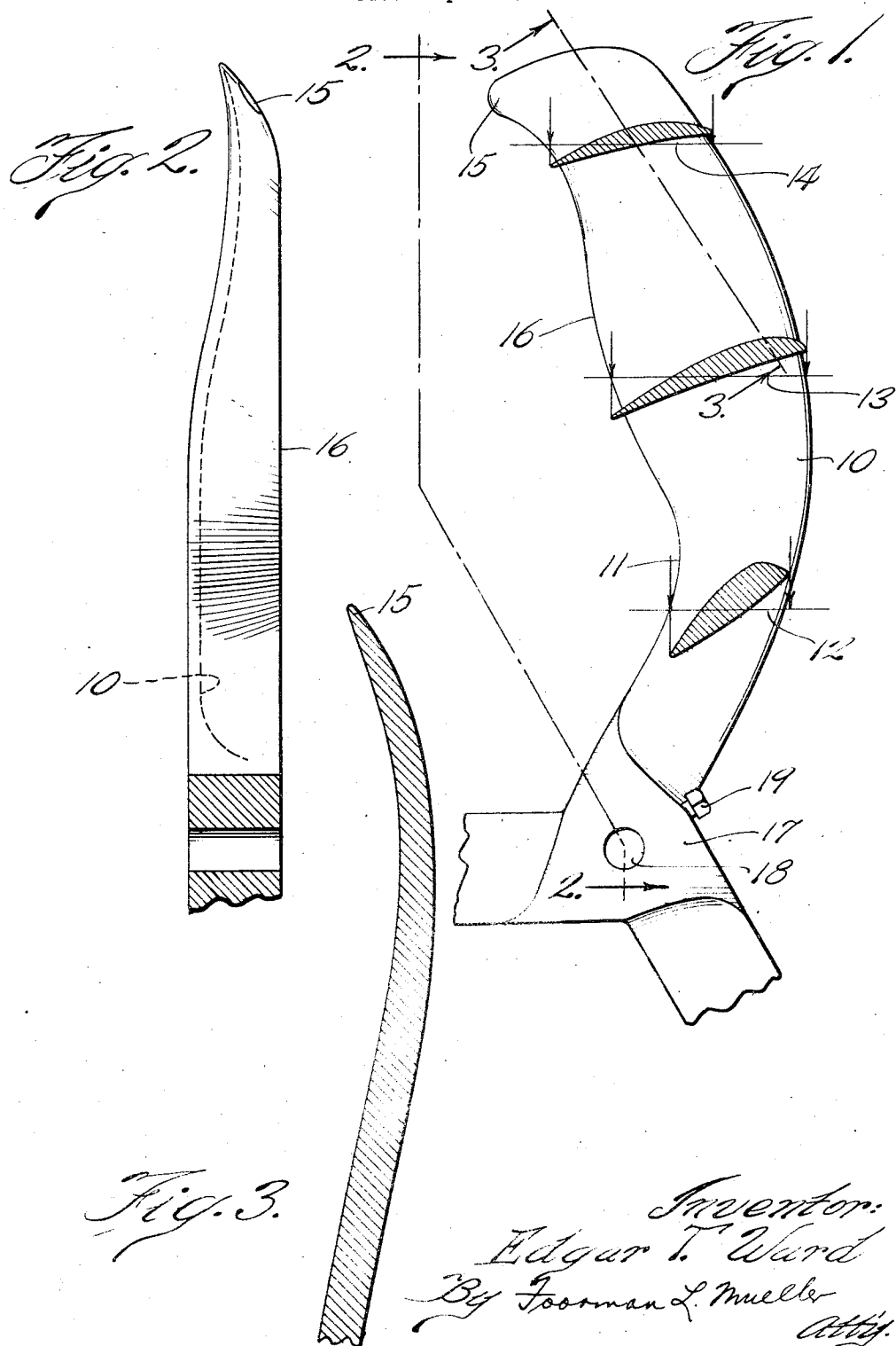


Fig. 3.

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May 30, 1939.

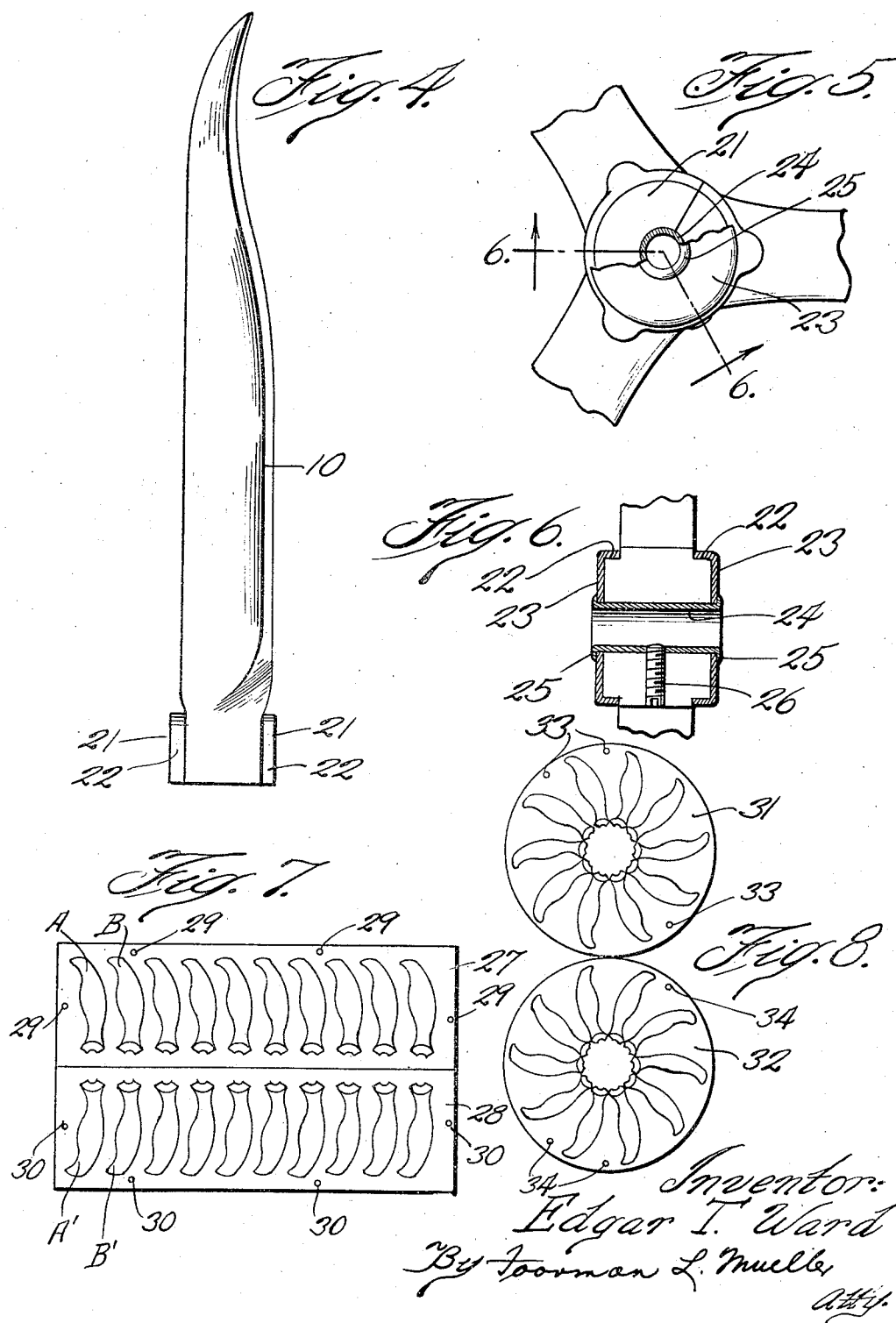
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UNITED STATES PATENT OFFICE

2,160,467

PROPELLER

Edgar T. Ward, Chicago, Ill.

Application September 22, 1937, Serial No. 165,123

4 Claims. (Cl. 170—159)

This invention pertains to propeller blades for ventilating fans and other purposes and, more particularly, to the construction of blades of the air-foil section type. While the invention will be disclosed herein as embodied in a three bladed propeller for fans of the air circulating type, it should be understood as susceptible of embodiment in propellers having any number of blades for use in fans or for other purposes.

Propellers of the air circulating type are usually of relatively large size, that is, have long blades, and are designed to operate at fairly high speed so as to create a considerable volume flow of air over the heads of persons whose comfort is to be increased, thereby to induce secondary air flow toward and along the air column and thereby, in turn, to create a constant circulation of a large body of air. Such fans are particularly useful in the home and office and in places subjected to high temperatures and high relative humidity such as factories, laundries, theatres and the like.

However, one of the chief objections and difficulties encountered with fan propellers of this type is the disturbing noise created by the blades when the propeller is in operation. This difficulty has been well recognized and while many attempts have been made to eliminate it, few, heretofore, have been successful to any substantial degree. Nevertheless, I have found that my specially designed blade so far reduces the noise as closely to approach absolute quietness, the remaining noise, if any being no more than a very minor low pitched hum which is barely noticeable even to the trained ear.

Consequently one of the primary objects of the invention is to provide a propeller blade so constructed and arranged that it will serve to circulate a considerable volume of air per unit of time with substantially total elimination of all objectionable noises so commonly and usually encountered with propellers of the character mentioned.

Considerable difficulty has been encountered in manufacturing the several blades of an air circulator propeller so that such blades are substantially identical in weight, weight distribution, blade spacing, pitch, thrust, and the like. These difficulties are particularly apparent when the propeller blades and the hub are formed as a single unitary structure as by casting. Casting or other forming processes, even though utmost care is used in the process, including the formation of the master pattern, preparation of the match plate and meticulous care in prepara-

tion of the mold, leave much to be desired and considerable time and effort in machining, balancing and matching must be expended upon the cast or otherwise formed unit before the several blades may be said to be equalized or matched and in dynamic and static balance.

I have found that many of the above mentioned manufacturing difficulties may be eliminated, or reduced if not eliminated, and that manufacturing efficiency may be substantially increased by casting each blade of a particular propeller in the same casting mold which must be of a more or less permanent nature, or by molding the blades individually from a plastic composition such as a phenolic condensation product, or one including substantial proportions of rubber, and in the same or in separate more or less permanent molds and thereafter assembling the blades on a pre-formed hub structure which may be made of metal or of molded composition. Under such mode of construction all blades formed in the same mold will be found to be identical or substantially so in weight and balance as well as in conformation, size, etc., in which case those blades molded in the same mold may be arranged in matched sets for use in the manufacture of particular propellers. Then too, by molding or casting the blades individually, it is possible to conserve and to utilize considerable molding press or casting space which would be lost or unavailable were all of the blades and the single hub of a propeller to be molded integrally, for it is thus possible to provide a plurality of molding cavities in a single molding block or casting apparatus.

Therefore another important object of the invention is to provide a blade and hub construction of such character that the propeller blades may be molded or otherwise formed individually from metal or from composition materials and thereafter secured in dynamic and static balance to a hub of metal or composition material, with a minimum of labor and expense.

A further object is to provide a novel and peculiarly efficient method of manufacturing propellers of the character described.

Various other objects as well as the many advantages and uses of the invention will become apparent and understood upon reading the following description of a preferred embodiment and after viewing the accompanying drawings in which:

Fig. 1 is an elevational view of the thrust side of a three-bladed propeller, two blades of which have been broken away and showing at design-

nated section lines, in section, the camber and pitch of the lift or suction and thrust sides of the blade at those sections.

Fig. 2 is a vertical edge elevation taken along the line of 2—2 of Fig. 1 illustrating that the trailing edge of the propeller blade is substantially straight in this view over practically its entire length.

Fig. 3 is a section of a fragment of a blade taken along the section line 3—3 of Fig. 1, and corresponds in the length of the fragment to the length of the line 3—3. The fragment is twice the size of the blade in Fig. 1.

Fig. 4 is a vertical edge elevation viewing the blade from the side opposite that shown in Fig. 2 and showing the leading edge of the blade, the blade of this view having a modified hub construction although being otherwise substantially identical with the blade illustrated in Figs. 1 to 3 inclusive.

Fig. 5 is a plan view of one side or end of the hub of a multi-bladed propeller composed of individually and separately formed blades, such as the blade illustrated in Fig. 4, and illustrating one method by which the blades may be assembled and held in assembled relation with one another.

Fig. 6 is a section taken substantially along the section line 6—6 of Fig. 5.

Fig. 7 diagrammatically illustrates a two part mold for molding or casting a plurality of similar propeller blades at one and the same time, the blade forms being arranged in nested relation to one another, and

Fig. 8 is a diagrammatic view of a two part mold for molding or casting similar propeller blades but differing from the two part mold of Fig. 7 in that the blade cavities are arranged radially or fan-wise.

The blades illustrated in Figs. 1 to 4 inclusive, except for the fact that the blades of Figs. 1 to 3 are illustrated as integral with one another at the hub while the blade of Fig. 4 is illustrated as an individual blade separate from any other blades of the propeller, are identical in contour, proportions and shape and a description of one will apply to the others.

Viewing Fig. 1, it will be noted that the blade has an irregular apparent shape with a sweep-back from approximately the mid-portion of the length of the leading edge 10 to the tip, the trailing edge 11 having a similar but non-conforming sweep-back. The blade is of air-foil section, the camber and pitch of which along line 12 and looking in the direction of the arrows shown thereon, is relatively high, gradually decreasing from the hub portion through the sections taken along lines 13 and 14 (looking in the direction of the arrows applied to those lines) through the tip portion. At the tip on the trailing edge, the blade has a rearwardly (as regards the direction of rotation) and an abruptly projecting portion 15 curving in the path of rotation from the thrust side toward the lift side and also curving more or less radially outward toward the lift side from the thrust side as more clearly illustrated in Figs. 3 and 4.

The trailing edge 16 may be said to lie in a plane perpendicular to the axis of rotation, and the leading edge 10, for substantially half of its radial length, may be said to lie substantially in another and parallel plane perpendicular to the axis of rotation as is most clearly illustrated in Fig. 4. The trailing edge 16 is carried relatively abruptly rearwardly at its tip portion 15 as de-

scribed above, with such tip portion also being curved toward the trailing edge part as shown in Fig. 1 and toward the plane through the principal portion of the leading edge 10 as shown at the right side of the blade in Fig. 4, or at the left side in Fig. 2. Fig. 4 also illustrates that the outer half of the leading edge 10 of the blade is gradually curved for about one-half of its length toward the plane in which the trailing edge 16 has been described as lying and thence curves back toward and somewhat short of the plane in which the major inner portion of the leading edge of the blade lies. The blades as thus constructed and shaped have been found to be relatively noiseless and it would seem that this result may be very largely, if not wholly, attributed to the peculiar projecting and curving tip portion, including the portion 15. High rotational speeds of blades shaped or constructed as above described have failed to produce more than a low pitched unobjectionable hum. As an example of rotational speeds of commercial embodiments of the invention, representative 22-inch propellers rotate from 1140 R. P. M. to 1725 R. P. M. while representative 28-inch propellers operate at speeds from 860 R. P. M. to 1140 R. P. M.

While the three-bladed propeller illustrated in Fig. 1 has blades integrally connected through a hub 17 which is centrally drilled as at 18 for reception of a motor shaft and to which the propeller may be secured as by a set screw 19, the blades illustrated in Figs. 4 to 6 inclusive, are individually formed with mating hub sections which when assembled comprise the entire propeller. This feature of the invention will be described in connection with a three-bladed propeller, but, as will become apparent, two or more bladed propellers may be constructed after the same manner.

Each blade has a hub portion formed as a boss 21 projecting axially at each side. These bosses provide arcuate shoulders or surfaces 22 which, when the three blades of the type illustrated are assembled in mating relation with one another, form a more or less continuous circular outwardly facing shoulder over which cup shaped hub caps 23 may be disposed in tight clamping engagement therewith. The hub caps 23 in turn may be held in place and together by a hollow bushing or ferrule 24, the ends of which may be riveted over the bottoms of the caps, about central apertures therein, as at 25 to hold the assembly together. The motor shaft is adapted to pass through the bushing 24 and may be held thereto as by a set screw 26.

Figs. 7 and 8 illustrate top and bottom portions of multi-cavity molds whereby a plurality of individual blades may be molded or cast simultaneously. However, this is primarily for purposes of convenience. The preferred form comprises a plurality of separate molds as will be explained. Assuming that the platform or the like on the press, or casting apparatus for metal or composition blades is substantially the size of the mold of Fig. 7 or of Fig. 8, separate molds for individual blades may be positioned on such platform in a parallel relation as in Fig. 7, with each two corresponding cavities forming an individual or separate mold. Or, if desired, the separate molds, each of an outside shape approximating the segment of a circle, may be positioned fan-wise on the apparatus. In the form illustrated in Fig. 7, one part of which is designated 27 and the other part 28, irregularly but correspondingly located pins and depressions 29

and 31, respectively, are adapted to interfit when the mold parts are super-imposed upon one another, thereby to dispose the corresponding cavities A, A', B, B', etc., in exact registration with one another. The various cavities are nested in the respective mold parts in order to conserve space in a press or casting machine or the like, and after the individual blades have been formed therein, all blades formed in the mold A—A' will be segregated in a lot separate from all blades formed in the mold cavities B—B', etc., and B—B' from all others in like manner. Thereafter the blades formed in cavities A—A' may be utilized in the manufacture of one or more multi-bladed propellers since each blade, unless defective for some reason, will be substantially identical with every other blade formed in that particular mold cavity. The mold form illustrated in Fig. 8 comprises two parts 31 and 32 adapted to register with one another in predetermined relation when super-imposed one on the other, through pins 33 and 34. In this form or mold the mold cavities are nested in fan-wise or radial array.

While I have illustrated and described a preferred form of the invention and certain alternatives, it should be appreciated and understood that the invention is of broader scope and susceptible of other embodiments wherefore I desire to be limited only by the spirit of the invention and the scope of the appended claims.

I claim:

1. A propeller blade adapted to operate in air comprising, a one-piece air-foil section blade having a sweep-back rearwardly, as regards the direction of rotation, from a portion outwardly of a hub portion toward and to the tip portion, the leading and trailing edges lying between parallel planes perpendicular to the axis about which the blade is to rotate, the trailing edge lying substantially in one of said planes from adjacent to the hub portion to adjacent to the tip portion and thence departing toward the other plane, the leading edge lying substantially in the other of said planes from the hub portion substantially to the beginning of the sweep-back and thence gradually departing for approximately one-half of its remaining length toward the first said plane and thence for the remainder of its length gradually returning toward said other plane, the part of the trailing edge at the tip thereof being relatively abruptly carried rearward as regards the direction of rotation, and the tip portion being curved on relatively short radii toward said trailing edge part and toward said other plane.

2. A propeller blade adapted to operate in air comprising, a one-piece air-foil section blade having a sweep back rearwardly, as regards the direction of rotation, from a portion radially outward of a hub portion and having a pitch and camber decreasing from the hub portion toward the tip, the leading and trailing edges lying between substantially parallel planes perpendicular

to the axis about which the blade is to rotate, the trailing edge lying substantially in one of said planes from adjacent to the hub portion to adjacent to the tip portion and thence departing toward the other plane, the leading edge lying substantially in the other of said planes from adjacent to the hub portion substantially to the beginning of the sweep-back and thence departing gradually toward the first said plane for a portion of its remaining length and thence returning toward the other plane, the trailing edge at the tip portion thereof being relatively abruptly carried rearward as regards the direction of rotation, and the tip portion between the leading and trailing edges being curved from the first said plane toward said other plane.

3. A propeller blade adapted to operate in air comprising, a one-piece air-foil section blade having a sweep-back rearwardly, as regards the direction of rotation, from a portion radially outward of a hub portion and having a pitch decreasing from the hub portion toward the tip, the leading and trailing edges lying between substantially parallel planes perpendicular to the axis about which the blade is to rotate, the trailing edge lying substantially in one of said planes from adjacent to the hub portion to adjacent to the tip portion and thence departing toward the other plane, the leading edge lying substantially in the other of said planes from adjacent to the hub portion substantially to the beginning of the sweep-back and thence departing gradually toward the first said plane for a portion of its remaining length and thence returning toward the other plane, the trailing edge at the tip portion thereof being relatively abruptly carried rearward as regards the direction of rotation, and the tip portion between the leading and trailing edges being curved from the first said plane toward said other plane.

4. A propeller blade adapted to operate in air having an outer or thrust face and an inner or suction face, said blade including a tip portion and a hub portion, and having a leading edge and a trailing edge intermediate said tip portion and hub portion, the camber of such blade decreasing from the hub portion to the tip portion, said blade varying in its width from a relatively narrow width adjacent the tip portion and adjacent the hub portion, to a greater width intermediate said two relatively narrow width portions, with said leading edge following a relatively uniform sweep-back configuration from hub portion to tip portion, and said trailing edge following an irregular line due to said variations in width, and with said tip portion extending relatively abruptly rearwardly as regards the direction of rotation of said blade, and also being curved on a relatively short radius at the end of said tip portion in an inward direction as regards the outer or thrust face of the blade and the inner or suction face thereof.

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