June 12, 1928. 1,673,564

C. E. HATHORN ET AL

PROPELLER TWISTING PRESS

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FIG. 1.

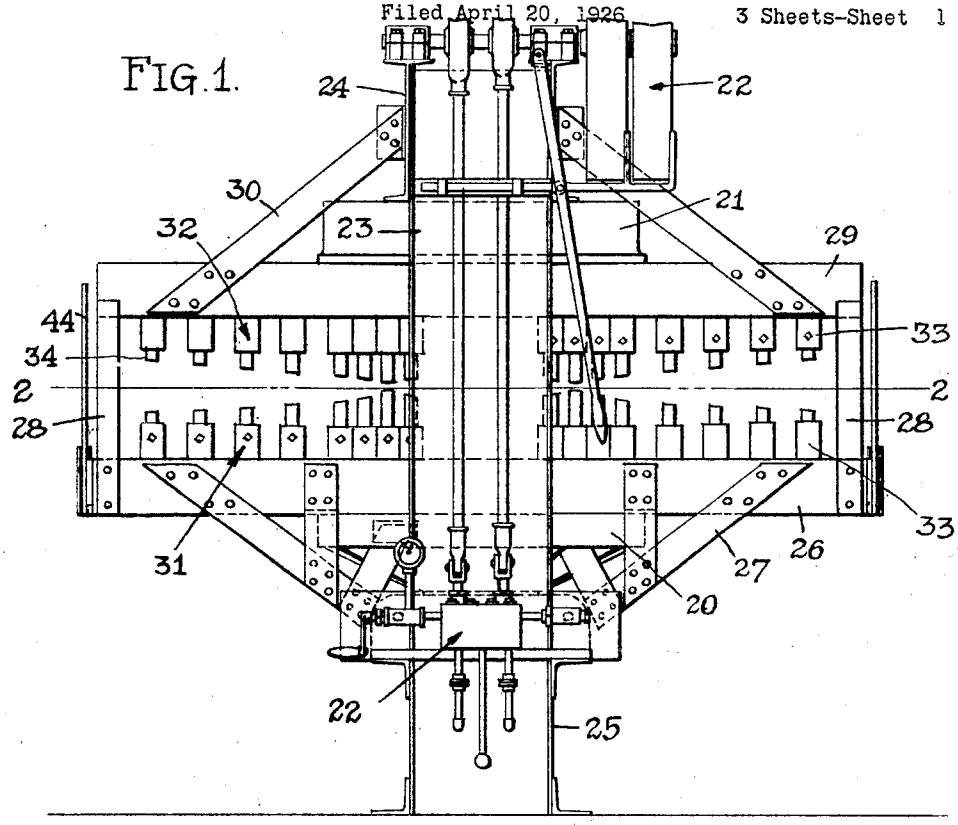
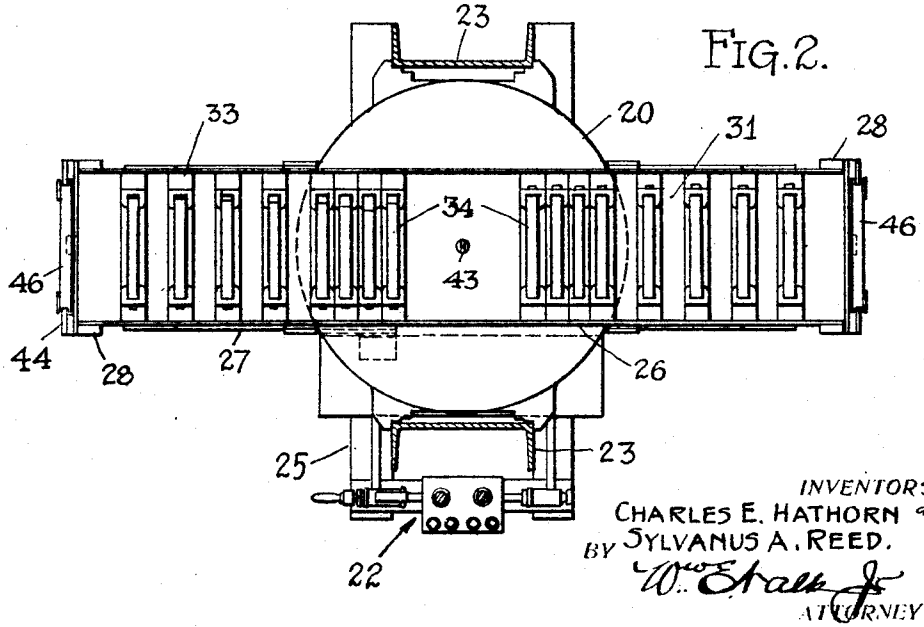


FIG. 2.



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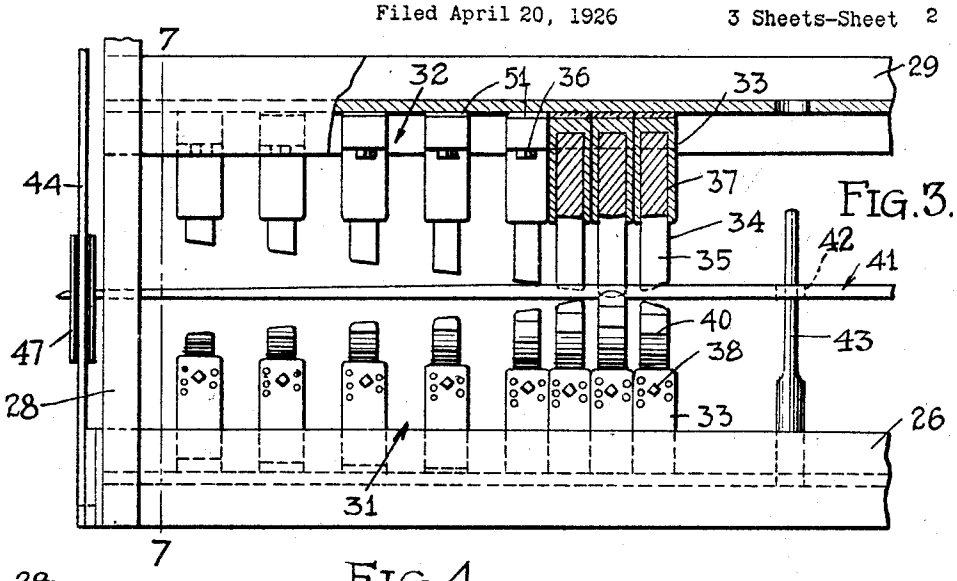


FIG. 3.

FIG. 4.

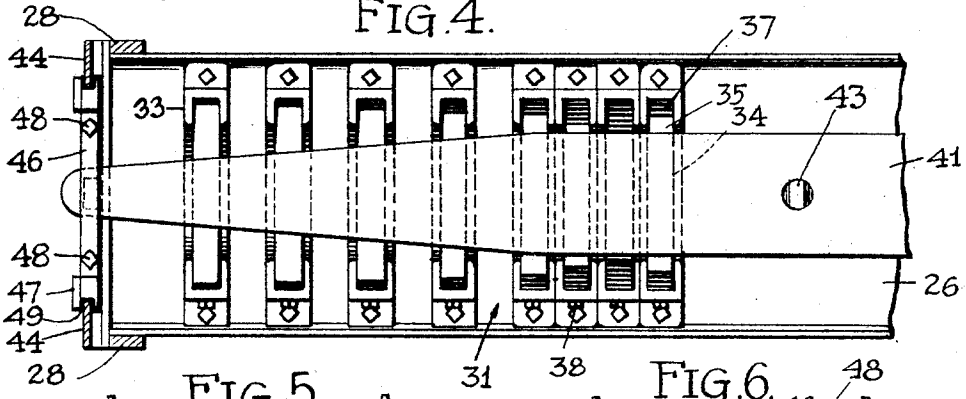


FIG. 5.

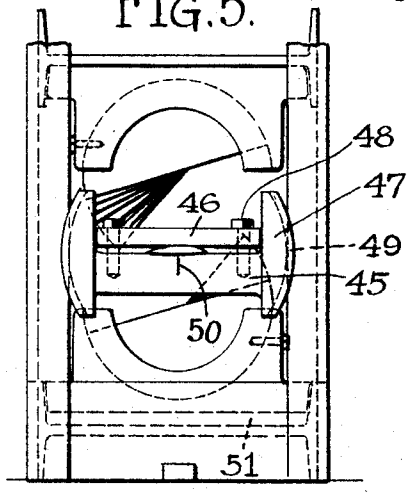
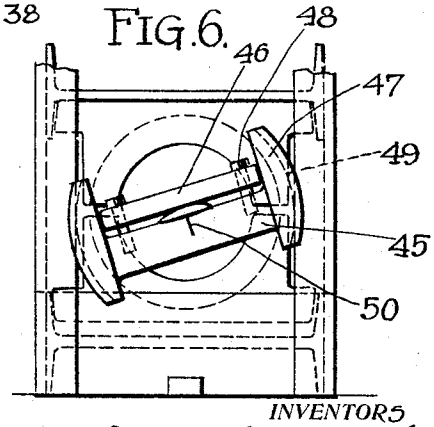


FIG. 6.



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FIG. 7.

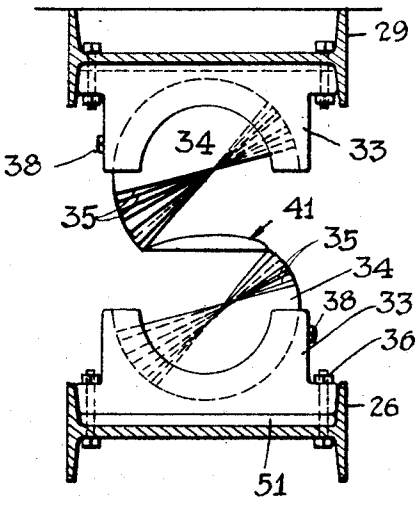


FIG. 9.

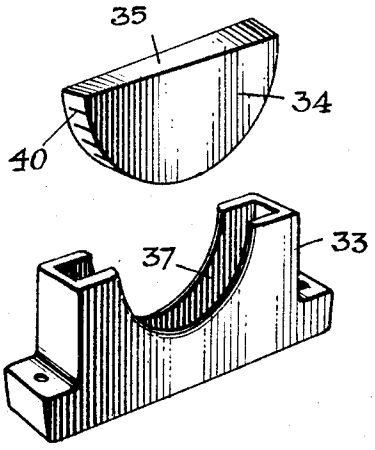


FIG. 8.

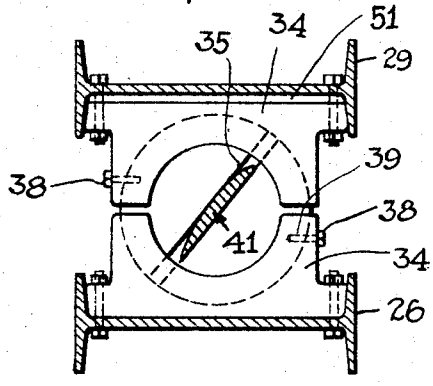


FIG. 11.

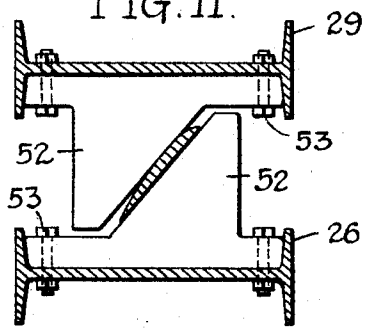
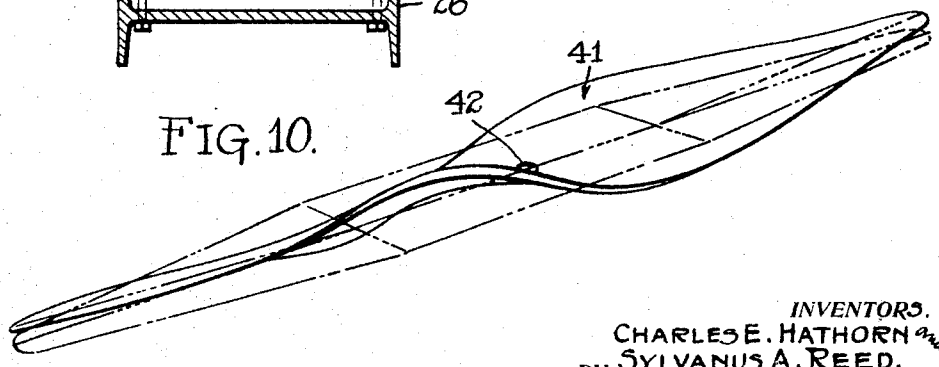


FIG. 10.



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Patented June 12, 1928. 1,673,564

UNITED STATES PATENT OFFICE.

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PROPELLER-TWISTING PRESS.

Application filed April 20, 1926. Serial No. 103,316.

Our invention relates to propellers and more particularly to the method of and apparatus for twisting metal propellers of aircraft.

In the manufacture of metal propellers for aircraft the propeller blank is first milled to change its cross-section from rectangular to approximately aerofoil form. This having been accomplished the propeller blank is ready to be twisted. Heretofore in twisting the propeller blank a rotary twisting machine has been used. Such a machine, while especially designed for twisting and bending the propeller blank, is nevertheless objectionable in that, due to the peculiarity of the twist, a multiple number of separate and wholly independent machine operations are required to be performed. One blade of the propeller blank is first clamped between the jaws of the twisting machine about 12 inches out from the transverse center line of the blank and given an initial twist of approximately 40 degrees. The propeller blank is then unclamped, withdrawn from the machine, and re-set exactly as before except that the opposite or untwisted propeller blade is clamped in place. Thus set, with said jaws engaging said opposite blade at a corresponding point out from said center line, said opposite blade is given an initial or center twist exactly the same as its companion. This initial twist of each blade is in each instance constant, that is to say, if a twist of 40 degrees is given each blade at its 12-inch station out from said center line, each said blade throughout the remaining portion of its length will bear to the untwisted center portion of the blank a 40 degree angle. Unfortunately, however, if properly shaped or twisted, the blade angles of an aeronautical propeller vary. Generally speaking such variation ranges anywhere from approximately 40 degrees at the blade root to approximately 15 degrees at the tip. To obtain this gradually diminishing blade angle a second series of machine operations is required. These operations, of which there are many, the number depending upon the particular propeller design, are usually performed with the same machine as are the initial or center twist operations and are generally designated the reverse or counter-twist operations. Each blade, as it is reversely or counter-twisted, is acted upon repeatedly and separately altho in each instance the repeated operations are the same. At intervals from the innermost station outwardly each blade is marked off at predetermined intermediate stations. These stations indicate the exact spot or point at which the blade should be held between the jaws of the machine during each successive reverse or counter-twist, and, as such stations are usually anywhere from six inches to twelve inches apart, and as the propeller blank must be clamped at every or at least every other station, and a certain degree of reverse twist imparted to each blade after each successive clamping, obviously the operations incident to properly reversely twisting or counter-twisting the propeller blank are numerous. Again unfortunately, the blade angles obtained by thus reversely twisting the propeller blank are only approximately correct and must afterwards be checked and corrected by other means necessitating additional work and the further handling of the propeller blank. Moreover, after twisting the blank and correcting the blade angles, it is further important that the axis of each blade be canted or bent forward slightly to relieve, during actual use of the propeller, certain bending stresses known at this time to exist. This latter bending operation is usually performed by hand.

An object of the present invention is to eliminate the many successive and tedious operations above outlined by providing, instead of rotary twisting machines, a propeller twisting press. Preferably such press comprises co-acting dies, adjustable for different designs of propellers, between which the propeller blank is laid; means for holding the propeller blank in place between said dies; and additional means for bringing said dies together. In bringing said dies together (thru hydraulic or other power means), the propeller blank, in one and the same operation, is initially twisted, reversely or counter-twisted, and bent longitudinally as aforesaid; the initial twist, the counter-twist, and the longitudinal bend, in each instance, being so exact and so perfect as to wholly eliminate the heretofore subsequent check and correction accorded the angle of the propeller blades. By thus performing, in a single operation, the functions heretofore performed by numerous operations, the

manufacturing cost of metal aeronautical propellers is very appreciably reduced.

A further object of the invention is to so form the co-acting dies of the propeller press as to subject the blank to the action of the dies at intervals or stations so relatively spaced as to produce in the blank a substantially uniformly varying angle as distinguished from the more or less successive pronounced angular variations produced heretofore.

A still further object of the invention is the provision of a novel form of holding means whereby the propeller blank is firmly held between the dies and against movement in any direction other than rotary or vertical, such rotary movement, at the ends of the blank, being essential to the completion of the initial as well as the counter-twist operations.

Other objects, advantages and characteristics of the invention will be hereinafter pointed out.

In the drawings, wherein like reference characters denote like or corresponding parts,

Fig. 1 is a side elevation of the press;

Fig. 2 is a horizontal section on the line 2—2 of Fig. 1;

Fig. 3 is a side elevation of a portion of each die and its associated plate showing the relation of the propeller blank thereto as the dies approach one another in a twisting operation;

Fig. 4 is a plan view of the lower die showing the propeller blank ready to receive its various twists;

Fig. 5 is an end view of the die portion of the press showing the manner in which the blank ends are clamped or held in place;

Fig. 6 is a similar view showing the relation of the press parts upon the completion of the various blank twists;

Fig. 7 is a section on the line 7—7 of Fig. 3;

Fig. 8 is a view similar to Fig. 7 with the dies brought together to complete the propeller twist;

Fig. 9 is a perspective view of one of the die pieces and die blocks;

Fig. 10 is a perspective view of a properly twisted propeller blank, the broken lines indicating the configuration of the blank prior to receiving the twist, and

Fig. 11 is a view similar to Fig. 8 illustrating a modification.

In the embodiment of the invention selected for illustration, a hydraulic press of more or less conventional form is shown. Preferably such press comprises a base plate 20, a top plate 21, a ram (not shown) and such other ordinary hydraulic press parts as operating mechanism 22 and supporting frame, the latter consisting of uprights 23, a cross-head 24 and a base portion 25 within which the ram is enclosed. This particular form of hydraulic press, however, is merely illustrative, and a different form of press, other than hydraulic, if desired, may be used.

To each of the plates 20 and 21 of the press a die-carrier is fastened. The die-carrier 26 of the plate 20 is mounted thereon and in cross-section is of approximately channel form. It is laterally braced as at 27 to said brace plate and at its opposite ends is provided with vertically extending guide arms 28. The other of the die-carriers, designated as 29, is fastened to and against the underface of the top plate 21, and like the die-carrier 26, it too is laterally braced. The bracing 30 for the die-carrier 29, however, is carried, not to its supporting plate, but directly to the cross-head 24 of the frame. This difference in the bracing arrangement for the two plates 20 and 21 is made possible by the fact that the plate 21 is fixed in its relation to the supporting frame whereas the plate 20 is vertically movable. Otherwise the die-carriers 26 and 29 are the same. The guide arms 28, of which there are four, two at each end of the die carrier 26, bear at all times directly against the vertical side walls of the fixed die-carrier 29.

Within the facing channels of the two die-carriers 26 and 29 the co-acting press dies are fastened. Both said dies, the lower designated in its entirety as 31, and the upper similarly designated as 32, are substantially identical in size, form and construction. Each die comprises a plurality of die-holding blocks 33 and a similar number of die-pieces or sections 34. These die-pieces 34 are preferably of semi-disc form and except for a slight difference in the configuration of the active substantially straight edge 35 of each, are also identical. The die-holding blocks 33 extend transversely of the die-carriers and are removably fastened within the channels thereof by bolts 36. The top face of each die-block 33 is hollowed out as at 37 to receive in the recess thus formed, one of said die-pieces 34. Said die-pieces fit snugly within said recesses and bear firmly throughout their respective rounded edges directly against the similarly rounded bottom recess walls. Such bearing contact, plus the block side wall engagement, offers sufficient contact area between the die-pieces and the die-blocks to hold the former against both lateral and vertical relative movement under all circumstances. Bolts 38 penetrating the die-block ends and fitting bolt holes 39 formed in the die-pieces, firmly hold said die-pieces against rotational movement when properly set. By graduating the rounded edge of each die-piece in degrees as indicated at 40, each said die-piece may be accurately separately adjusted as desired.

As previously explained, an aeronautical

propeller, if properly shaped, is required to be twisted in a manner such that the blades thereof present to the right angle plane of its longitudinal axis a 45 degree angle or thereabouts at the innermost blade stations which are usually twelve inches out from the transverse center line of the propeller blank; such blade angle gradually lessening from said twelve inch station outwardly to approximately a fifteen degree angle at the blade tip. To obtain this peculiar gradually diminishing blade angle from said twelve inch station outwardly, the active edges of the several die-pieces 34 at opposite sides of the transverse center line of each die present, when viewed from the die ends, (see Fig. 7) slightly different angles at each blade station, the angles increasing inwardly toward the die centers in a like manner and to the same extent from the opposite outer ends of said dies. As the diminishing blade angle is preferably more pronounced in the vicinity of the points at which a maximum twist is desired, the die-pieces, at the inner blade stations are placed closer together than they are at the outer blade ends.

In Fig. 10 of the drawings the propeller blank is illustrated in broken lines as it appears before being pressed or twisted and in full lines it is illustrated as it appears properly shaped. Such blank is designated as 41 and the center opening formed therein is designated as 42. This center opening 42 is formed in the blank at the inter-section of the longitudinal and transverse center lines thereof before said blank is twisted and shaped. With said opening 42 properly located the propeller blank is laid between the dies 31 and 32 of the press. To center the blank relatively to said dies a spindle 43 is provided. Said spindle projects vertically upwardly from the exact center of the lower die 31 and is adapted to snugly engage in said center opening 42 of the propeller blank. By providing a comparatively snug fit between said spindle and said center opening the propeller blank is firmly held against rotational and lateral movement in the vicinity of its transverse center line, against longitudinal displacement under all circumstances, and in a manner such that, during the twisting operation, other than a corresponding twist at opposite sides of said center line cannot possibly occur.

As a further means for holding the propeller blank during a twisting operation, end clamps or devices are provided. These end clamps are mounted between vertical guide rails 44 (two for each clamp) fastened to the die-carrier 26 at its opposite ends. Each clamp comprises a fixed jaw 45, a movable jaw 46, clamp ends or head portions 47, and clamping bolts 48. The head portions 47 (see Figs. 5 and 6) of each clamp are preferably formed integrally with the fixed jaw 45 thereof and are adapted to bear on and fit between the guide rails 44 as indicated. Said head portions 47 are also provided with arcuate end grooves 49 within which said guide rails 44 engage. In this manner said end clamps are held against transverse or endwise movement tho movable freely both vertically and rotationally. A mark 50 on each clamp indicates the exact longitudinal center line of the co-acting dies of the press.

In operation, a propeller blank is laid longitudinally of and between the co-acting dies 31 and 32 of the press with the spindle 43 extending vertically thru the center hole 42 of the propeller blank. The ends of the propeller are then clamped between the jaws 45 and 46 of the end clamps with the markings 50 on said clamps in registry with the longitudinal center line of the propeller blank. Thus positioned and securely clamped between the press dies the blank 41 is ready to be twisted or shaped. As the dies 31 and 32 are brought together the innermost die pieces 34 at opposite sides of the transverse center line of the blank first bear thereon to positively twist it as said dies approach each other. This first twist, due to the high angle of the die pieces at said innermost blade stations, constitutes what has heretofore been designated the initial or center twist and it, the initial or center twist, continues uninterruptedly until the desired blade angle at said innermost blade stations is obtained. The reverse or counter-twist operation, as intimated, is obtained while and during the initial twist operation, tho commencing only after such initial twist operation is under way. The counter-twist operation, however, is completed at the same moment as said initial twist operation and due to the varying angles of the outer die pieces is variable throughout the respective blade lengths. To longitudinally bend or cant the propeller blank shim 51 of different thickness may be inserted beneath the outer die blocks as illustrated. No re-check or correction is required if and when the die-pieces are properly set. All bends or twists are obtained by the one operation, i. e., the bringing of the dies 31 and 32 together.

In the modification of Fig. 11, instead of providing adjustable die-pieces, die pieces 52 of a given configuration are provided. Such die-pieces are fastened between the die-carrier of the press by bolts 53 and are preferably interchangeable. For shaping or twisting propeller blanks of different design, where non-adjustable die-pieces are used, a different set of such die-pieces must be provided for each design that is different.

While we have described our invention in detail in its present preferred embodiment, it will be obvious to those skilled in the art after understanding our invention, that

various changes and modifications may be made therein without departing from the spirit or scope thereof. We aim in the appended claims to cover all such modifications and changes.

What we claim is:

1. A press for twisting propellers including dies between which the propeller is laid, rotatable clamps for holding said propeller in place between said dies, and means for bringing said dies together.

2. A press for twisting propellers including dies between which the propeller is laid, guides mounted at the die ends, clamps carried by and rotatable within said guides for holding the propeller in place between said dies, and means for bringing said dies together.

3. A press for twisting propellers including dies between which the propeller is laid, freely rotatable clamps mounted at the die ends to hold said propeller in place between said dies, means for holding each said clamp against movement transversely of said dies, and means for bringing said dies together.

4. A press for twisting propellers including dies between which the propeller is laid, each die comprising a plurality of separately adjustable die-pieces, means for holding each die-piece in its adjusted position, a center spindle for holding the propeller in place between said dies, relatively movable end clamps likewise engageable with said propeller to hold it in place between said dies, and means for bringing said dies together with the propeller held therebetween.

5. The method of twisting metal aeronautical propellers which consists in progressively bringing to bear on the opposite faces of the propeller blank at different stations throughout its length a plurality of individually formed die-pieces each having an engaging surface set at an angle calculated to produce in a finished product that particular twist deemed correct for that particular station at which said die-piece bears.

6. A press for twisting propellers comprising dies between which the propeller is laid, each die including a plurality of transversely extending die pieces adapted to be individually adjusted to present toward the propeller a working face, the angularity of which may be varied by such adjustment, means for holding said propeller in place between said dies and means for bringing said dies together.

7. A press for twisting propellers comprising dies between which the propeller is laid, each die including a plurality of transversely extending die pieces individually rotatable about an axis extending longitudinally of said die to vary the angle of the working face thereof, means for holding said propeller in place between said dies and means for bringing said dies together.

8. A press for twisting propellers comprising dies between which the propeller is laid, each die including a plurality of freely removable transversely extending die pieces adapted to separately engage, each within a recess formed within said die, means for holding said propeller in place between said dies and means for bringing said dies together.

9. A press for twisting propellers comprising dies between which the propeller is laid, clamps for said propeller rotatable during the twisting thereof, and means for bringing said dies together with the propeller held in place by said clamps.

In testimony whereof we hereunto affix our signatures.

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SYLVANUS A. REED.