

Sept. 2, 1947.

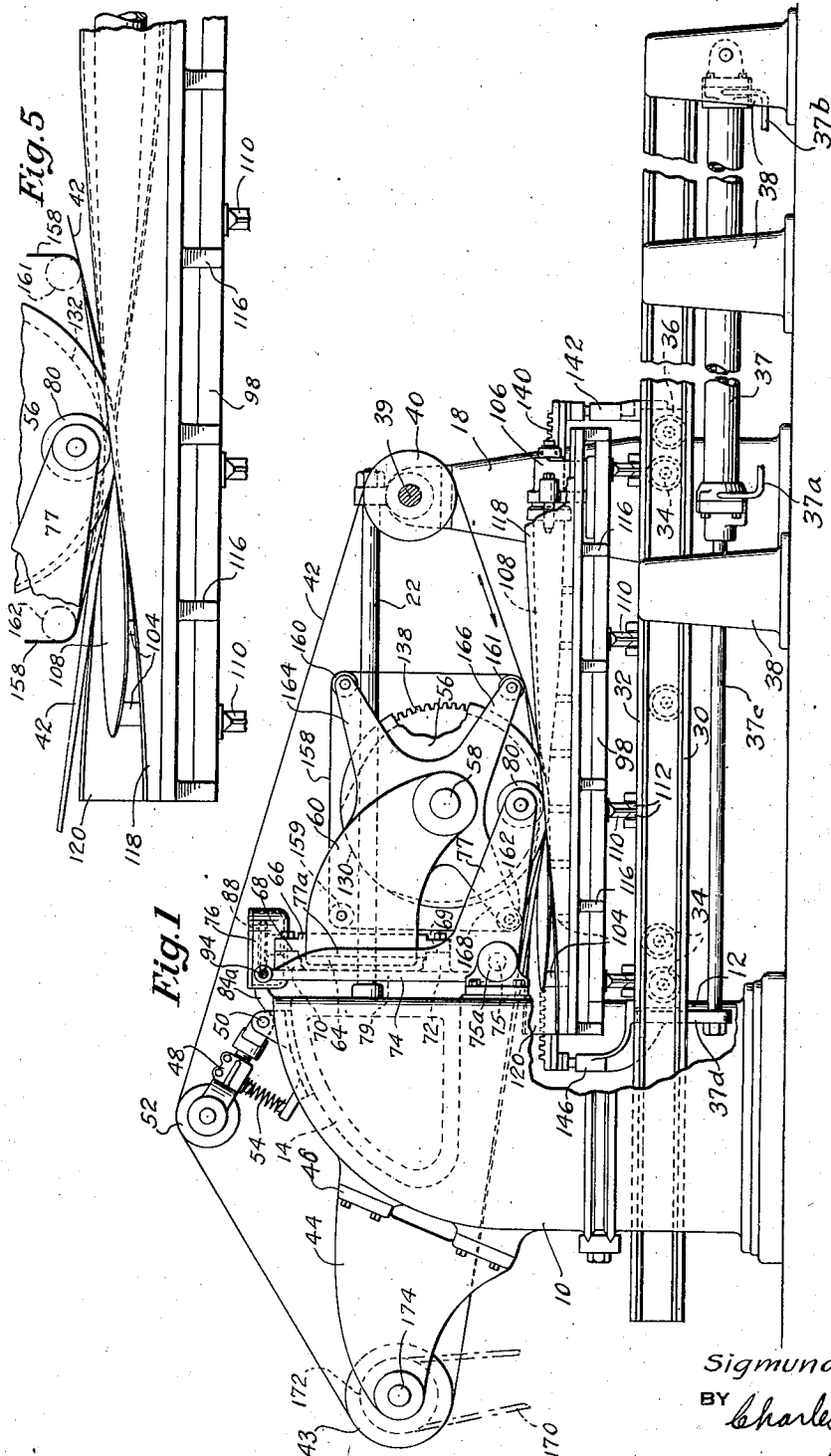
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2,426,764

MACHINE FOR FINISHING IRREGULARLY SHAPED ARTICLES

Filed Oct. 26, 1943

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

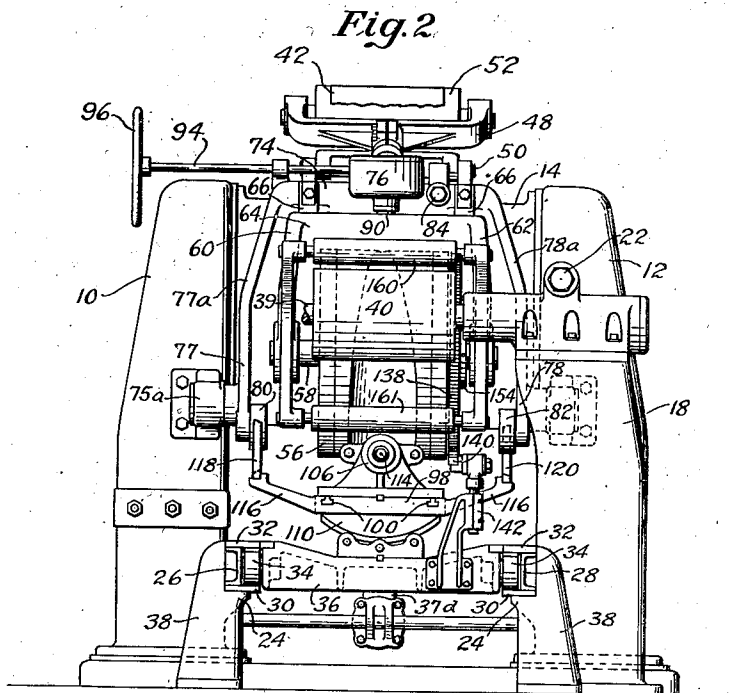


Fig. 3

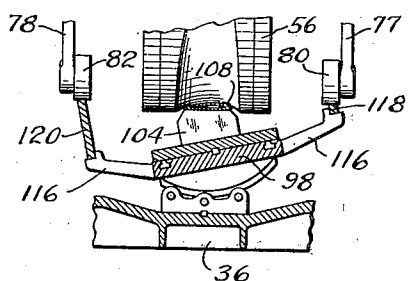
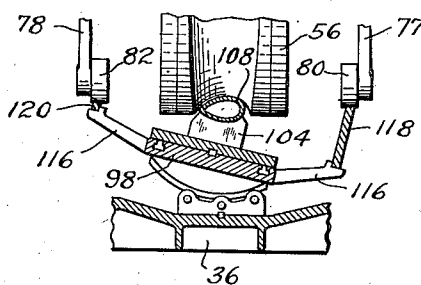


Fig. 4



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3 Sheets-Sheet 3

Fig. 6

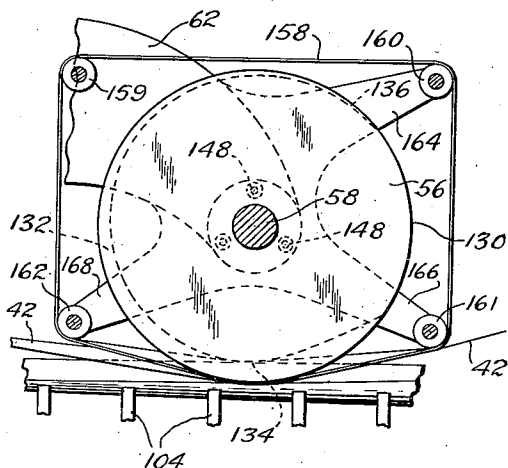


Fig. 7

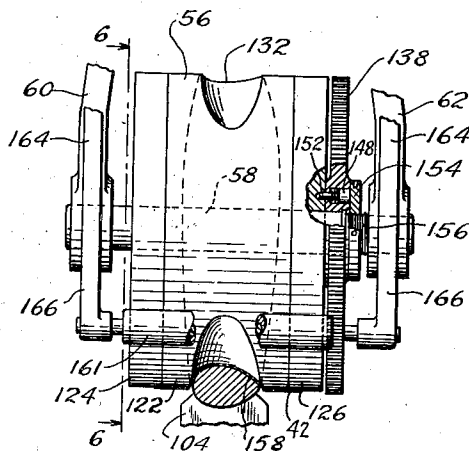


Fig. 8

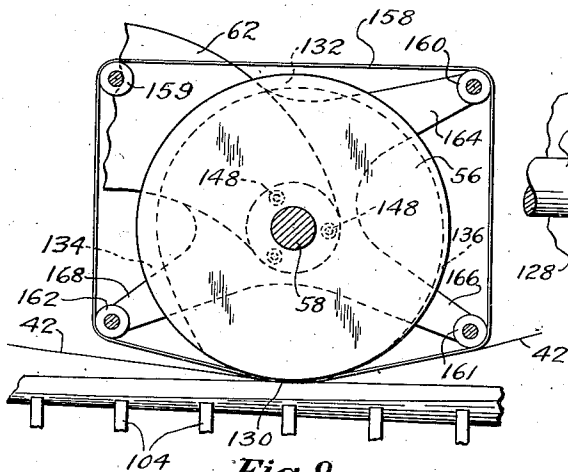


Fig. 10

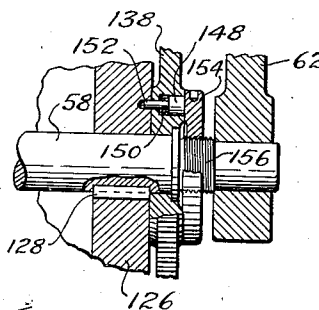
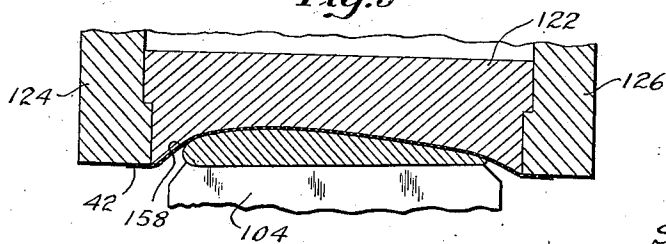


Fig. 9



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2,426,764

MACHINE FOR FINISHING IRREGULARLY
SHAPED ARTICLESSigmund A. Czarnecki, Glastonbury, Conn., as-
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22 Claims. (Cl. 51-143)

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This invention relates to machines for grinding and polishing irregularly shaped articles.

While the features of the present invention may be employed to advantage in the manufacture of numerous articles, they are of particular importance in connection with the grinding and polishing of propeller blades; and for purposes of illustrating a practical embodiment of the invention, the improved features of the invention are described herein in connection with the manufacture of airplane propeller blades.

Propeller blades of this type not only change in pitch from the hub end to the tip end of the blade, but the camber side of the blade also has a constantly changing contour from end to end. It has previously been necessary to grind and polish such blades to finished shape by hand, work requiring great patience and skill and of a very time consuming nature.

An object of this invention is to provide a machine for grinding and polishing irregularly shaped articles, and more particularly to provide a machine capable of grinding and polishing both the flat and camber sides of airplane propeller blades quickly and accurately to finished dimensions.

Another object of this invention is to provide a blade finishing machine having a grinding or a polishing belt beneath which the blade is longitudinally reciprocated for enabling both the flat side and the camber side of the blade to be finished to identical pitch upon movement of the blade about its longitudinal axis to bring the selected side of the blade uppermost.

A further object of the invention is to provide a blade finishing machine of the above type having an accurately formed, or contoured, backing roll for the abrasive belt at its point of contact with the blade which is rotated in a predetermined relationship relative to the longitudinal movement of the blade for accurately determining the finished shape of the camber side of the blade.

A still further object of the invention is the provision of improved cushioning means between the formed surface on the roll and the abrasive belt for preventing crushing of the abrasive particles on the belt.

These and other objects of the invention will be apparent from the following detailed description of a preferred embodiment thereof, shown for purposes of illustration only and not intended to limit the scope of the invention, reference being had for this purpose to the claims presented herewith.

In the drawings, wherein similar reference characters refer to similar parts throughout the several views,

Fig. 1 is a side elevation partly in section of a machine embodying the improvements, certain parts being broken away to facilitate illustration;

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Fig. 2 is an end view of the machine as viewed from the right hand end of Fig. 1;

Fig. 3 is a detail sectional view taken in front of the contact roll showing the tip end of the blade beneath the roll;

Fig. 4 is a similar view showing the hub end of the blade beneath the contact roll;

Fig. 5 is an enlarged detail view showing the cam and rail mechanism for adjusting the blade relative to the contact roll in accordance with pitch changes in the blade;

Fig. 6 is an enlarged sectional detail on line 6-6 of Fig. 7 showing the contact roll in engagement with the hub end of the blade;

Fig. 7 is an end view of Fig. 6, with parts broken away;

Fig. 8 is a view similar to Fig. 6 but showing the contact roll in position for grinding the face, or flat, side of the blade;

Fig. 9 is a sectional detail of the contact roll and blade, and

Fig. 10 is a sectional detail of the clutch for releasing the contact roll.

Referring more particularly to the drawings, it will be observed that the frame of the machine includes main front and back columns 10 and 12 connected rigidly in spaced relation by a transverse frame member 14, and a secondary back column 18 connected at its upper end to column 12 by a horizontal stay rod 22. These columns are further connected adjacent their lower ends by the horizontal bed of the machine including front and back ways which rest on brackets 24 formed integral with the columns adjacent their lower ends. These ways comprise outwardly facing channel members 26 and 28 secured respectively to the front and back columns by bolts (not shown), and lower and upper horizontally disposed flat rails 30 and 32 which project inwardly to form, with the backs of the channel members, inwardly facing right angular channel ways in which rollers 34 of a longitudinally movable carriage 36 are received, certain of these rollers engaging the upper rail 30 while others engage the lower rail 32 in a well-known manner. The carriage 36 is reciprocated longitudinally of the bed by means of a usual hydraulic mechanism including the cylinder 37 having fluid connections 37a and 37b at opposite ends thereof and having a piston (not shown) for reciprocating a connecting rod 37c which is connected at its free end to the bracket 37d fixed to the carriage. The horizontal extensions of the ways beyond the main and secondary columns are supported on brackets 24 formed as integral parts of pairs of connected pedestals 38, suitably located at spaced points therealong.

Column 18 has a transverse shaft 39 journaled therein at its upper end carrying a cylindrical roller 40 for supporting one end of a generally

horizontal endless belt 42 having an outer abrading or polishing surface. The opposite end of belt 42 travels over a similar roller 43 which is journaled between parallel arms 44 of a bracket 46 carried by the frame member 14. Frame member 14 also supports a frame 48 pivoted at 50, which carries a roller 52 smaller than the end rollers 40 and 43 and biased upwardly into engagement with the under side of the belt 42 by a compression spring 54. It will be observed that the lower reach of the abrasive belt passes between the front and rear columns of the frame and beneath the transverse member 14 in a generally horizontal position over the carriage, this lower reach of the belt passing at its lowest point over a large diameter contact roll 56 on a shaft 58 journaled in spaced downwardly extended arcuate arms 60 and 62 of a generally U-shaped vertically adjustable roll-carrying bracket 64.

Bracket 64 is vertically slidable on a pair of spaced vertically disposed guides, one of which is shown at 66 in Fig. 1. The guides 66 have flattened upper and lower ends 68 and 69 by which they are bolted to upper and lower bosses 70 and 72 on a head bracket member 74. The head bracket member, which is of generally bellcrank form is pivoted on trunnions 75 journaled at 75a on the main columns 10 and 12 and includes two widely spaced and horizontally extended arms 77 and 78 having rollers 80 and 82 pivotally supported in their ends. This bracket also includes vertically extended arms 77a and 78a connected by a vertical web 79 carrying the bosses 70 and 72 previously mentioned and engaging at the front face of its upper end a longitudinally adjustable stop member 84 carried by an abutment 84a on frame member 14 to limit the clockwise movement of bracket member 74 about its pivot as viewed in Fig. 1.

The head bracket also carries a gear box 76 centrally disposed between arms 77a and 78a having therein a worm wheel 88 on a vertical shaft 90 which is screw threaded into a central boss (not shown) on the roll carrying bracket 64. The worm wheel is rotated to raise and lower the roll 56 by means of a shaft 94 suitably journaled on the head bracket member 74 and having an operating hand wheel 96 at the front of the machine.

The longitudinally movable carriage 36 carries a long cradle 98 provided with longitudinal T-shaped grooves 100 in its upper face for adjustably positioning a plurality of transverse blade supporting templets 104. This cradle also carries at its right hand end a clamp 106 adapted to engage the cylindrical hub of a propeller blank 108 longitudinally disposed on the work supporting cradle. The blank 108 may, for example, be made of a strong alloy of aluminum forged to approximately the shape of the finished blade. The cradle is supported on the carriage at longitudinally spaced points by depending arcuate rockers 110, which rest on rollers 112 disposed in arcs struck about the longitudinal axis 114 of a propeller blank 108 on the cradle.

The cradle 98 is also provided at spaced points along its length with oppositely laterally extended arms 116 which support rails 118 and 120, adapted to be constantly engaged by the rollers 80 and 82 on the arms 77 and 78 of the head bracket. These rails, as shown most clearly in Fig. 5, vary differently in height from one end to the other of the cradle, the front rail 118 being highest at the hub end of the cradle and lowest at the tip end thereof, while the back rail 120 is correspondingly low at the hub end and high at

the tip end. The difference in elevation of the top of the rails at any station along the length of the propeller is such that a straight line connecting the tops of the rails will represent the angle of pitch of the blade at this station measured from a horizontal line. It will thus be evident that as the rollers 80 and 82 travel along the tops of rails 118 and 120 during the longitudinal reciprocation of the carriage, the cradle 98 will be rocked on rollers 112 so as to maintain the transverse axis of the blade constantly parallel with the cylindrical face of the roll 56. Thus, if the flat face of the propeller is being ground, this face will, at all times, be parallel with the longitudinal face of the roll 56.

The contact roll 56 as shown in detail in Figs. 6 to 10, comprises a hollow, relatively thick cylindrical externally grooved portion 122 suitably secured to annular end plate members 124 and 126, which are fixed as by keys 128 to the shaft 58 for rotation therewith in the arms 60 and 62. The cylindrical portion 122 of roll 56 has a portion 130 of its periphery ungrooved representing a segment of approximately 60 degrees, although the extent of this uncut surface will vary with drums provided for propeller blades of different length. The remainder of the periphery of the contact roll has a central groove 132 cut therein of constantly varying contour, corresponding to the variation in the contour of the camber side of the blade along the length thereof. Thus, at the point 134 the contour of groove 132 corresponds to the contour of the camber side of the blade at the station adjacent the hub of the blade while at the point 136, the contour of groove 132 corresponds to the contour of the camber side at the tip station of the blade. Here it will be noted that from points 134 and 136 the groove is extended tangentially and merges into the uncut portion of the periphery of the roll 56. It will thus be evident that the groove formed in the surface of the roll 56 is a surface impression of the camber side of the blade wrapped around the roll and developed to eliminate pitch changes in the blade.

Cooperating means are provided on the movable carriage of the machine and on the roll 56 for rotating the roll in synchronism with the longitudinal movement of the blade therebeneath so that the portion of the blade which is beneath the roll always corresponds with the groove in the roll. To this end, a gear wheel 138 is journaled for rotation on shaft 58 adjacent the end plate 126 of the roll in position to mesh with a longitudinal rack 140 carried by spaced vertically adjustable uprights 142 and 146 on the carriage. The gear wheel 138 is releasably connected with roll 56 by means of a clutch including a plurality of pins 148 carried by gear wheel 138 which are forced into suitable apertures in the face of the plate 126 against the action of compression springs 150 by the projecting ends 152 of the pins 148 as the spanner nut 154 is rotated on the threaded portion 156 of shaft 58. It will thus be obvious that with the diameter of gear wheel 138 equal to that of the roll 56 the latter will have a peripheral speed equivalent to the linear speed of reciprocation of the blank 108 on the carriage.

Means are also provided for cushioning the abrasive belt 42 where it passes beneath the contact roll 56. This means comprises a freely rotating rubber belt 158 supported on four small rollers 159, 160, 161 and 162. The roller 159 is journaled between the spaced arms 60 and 62 of bracket 64 while the rollers 160, 161 and 162 are

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journaled in extensions 164, 166, and 168, of these spaced arms. It will be noted that the rollers 161 and 162 are disposed substantially in the normal path of the lower reach of the belt 42 so that a line connecting the bottoms of these rollers will pass substantially through the bottom of the groove 132 in roll 56 at its deepest point 134.

The abrasive belt 42 is driven by a motor (not shown) by means of a belt 170 driving a fixed pulley 172 on the shaft 174 to which the roller 42 is suitably fixed, the travel of the belt being clockwise as viewed in Fig. 1 and as indicated by the arrow in that figure.

The operation of the machine to grind or polish the camber side of the blade will be first described. A blank 108 to be ground is placed camber side up on the work supporting carriage 98 with its hub end secured in the clamp 106. It will be understood that the carriage 36 is normally stopped in its extreme right hand position, as viewed in Fig. 1, in which the tip of the blade supported on the carriage is disposed somewhat to the right of the contact point of the work beneath roll 56, this point of course constituting the lowest point of the abrasive belt 42.

The blade is properly positioned relative to its longitudinal axis, by the series of supports 104, which together form a fixture for supporting the blade at a plurality of points, or stations, along the latter in the proper angular relation to the top of the rails 118 and 120. It will be evident that as hydraulic fluid is admitted through connection 37b (Fig. 1) to the cylinder 37 of the hydraulic mechanism, the piston and connecting rod 37c of the latter will move the carriage to the left, as viewed in Fig. 1. The tip of the blade is thus brought beneath the rapidly moving abrasive belt 42 at the contact point of the blade beneath the roll 56. Roll 56 has been rotated by the rack 140 and gear 138 into a position in which the point 136 (Fig. 6) at which the groove 132 corresponds to the tip contour of the blade on the roller 56, is at the bottom or contact point. It will be understood that during the slow rotation of the roll 56 the belt 42 passes therebeneath at a high rate of linear speed.

As the carriage continues to move slowly to the left, the roll 56 slowly moves in a clockwise direction (Fig. 1), the linear speed of the periphery of the roll being equal to the linear speed of movement of the carriage, so that the contour of the ground blade face at each station along the blade exactly corresponds to the contour of the groove at the corresponding station of the periphery of the roll. During this movement of the carriage the rolls 80 and 82 are travelling along the tops of rails 118 and 120 on the carriage. As previously pointed out a straight line connecting the tops of these rails at any station along the blade will coincide with the pitch at that station. Accordingly, as the carriage and the rails move longitudinally relative to the rolls 80 and 82, the cradle 98 will be rocked about a center 114 which coincides with the longitudinal axis of the blade so that the blade face is continuously maintained at the proper angle relative to the face of the roll 56, while the head bracket member 74 will rock about the axis of trunnions 75 as determined by the height of the top surfaces of the rails 118 and 120. This movement continues until the hub of the blade has reached the contact point 134 on the roll 56 as shown in Figs. 4, 6 and 7. Fluid is now admitted through connection 37a to return the carriage,

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during which return movement the roll is slowly rotated in a counter clockwise direction.

The flat, or back, side of the blade can be ground by clamping the blank 108 with the flat side thereof uppermost. In this instance, the gear 138 is freed from its driving connection with contact roll 56 so that the latter is driven freely at high speed by the abrasive belt 42. This is accomplished by backing off the spanner nut 154 which allows the pins 148 under the action of compression springs 150 to be withdrawn from the apertures in the plate 126. Due to the high speed of rotation of roll 56 the flat side of the blade is ground by the uncut portion 130 of the contact roll 56, as if the roll were a continuous uncut roll.

As a result of the improvements above described, it will be evident that a blade grinding and polishing machine is provided which is capable of finishing both the flat and the camber sides of an airplane propeller blade while accurately maintaining the pitch identical on both sides of the blade. It will also be evident that the grinding and polishing of propeller blades can, as a result of these improvements, be carried out more quickly and efficiently than heretofore the losses in man power and spoiled blades being tremendously reduced. It will also be evident that due to the provision of the rubber backing belt 158, which cushions the abrasive belt 42 and prevents crushing of the grit or cutting particles thereon the life of the belt 42 is greatly increased, as well as its speed of cutting.

While the invention has been described with particular reference to a preferred embodiment thereof, it is to be understood that many changes may be made in the construction of the machine without departing from the invention as defined by the following claims.

What I claim as new and desire to secure by United States Letters Patent is as follows:

1. In a machine for finishing irregularly shaped articles, in combination, a belt having an external abrasive surface, a work support, a contact roll for positioning said belt relative to a piece of work on said support, said roll having a peripheral depression therein of varying shape around the periphery of said roll and constituting an impression of a surface of the finished work piece, means for effecting relative movement of said roll and said work piece longitudinally of the latter, and means for rotating said roll about its axis in timed relation with said longitudinal movement.

2. In a machine for finishing irregularly shaped articles, in combination, a travelling belt having an abrasive surface, a work support, a contact roll for positioning the abrasive surface of said belt relative to a piece of work on said support, said roll having a peripheral depression therein constituting a developed impression of a surface of a finished work piece, means for effecting relative reciprocatory movements between said roll and said work piece, and means for oscillating said roll about its axis in timed relation with said reciprocatory movements.

3. In a machine for finishing irregularly shaped articles, in combination, a travelling belt having an abrasive surface, a work support, a contact roll for positioning the abrasive surface of said belt relative to a piece of work on said support, said roll having a surface depression therein about a portion of its periphery constituting a developed impression of a surface of a finished work piece, means for effecting relative reciprocatory

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catory movements between said roll and said work piece, and means for oscillating said roll about its axis through less than a complete rotation thereof in timed relation with said reciprocatory movements.

4. In a machine for finishing irregularly shaped articles, in combination, a belt having an external abrasive surface, a work support, a contact roll for positioning said belt relative to a piece of work on said support, said roll having a peripheral depression therein of varying shape around the periphery of said roll and constituting an impression of a surface of the finished work piece, hydraulic means including a piston rod connected with said work support and having a stroke at least equal to the length of that portion of the work on said support to be finished for effecting relative movement of said roll and said work piece longitudinally of the latter, and means for oscillating said roll about its axis in timed relation to said longitudinal movements.

5. In a machine for finishing propeller blades, in combination, an abrasive belt, a blade support, a roll for positioning said belt relative to a blade on said support, said roll having a peripheral depression therein varying in contour about the periphery of said roll and constituting a surface impression of the camber side of the finished blade, means for effecting relative movement of said roll and blade support longitudinally of the latter, and means for rotating said roll about its axis in timed relation with said longitudinal movement.

6. In a machine for finishing propeller blades having pitch changes between the hub and tip portions thereof, in combination, an abrasive belt, a propeller blade support, a roll for positioning said belt relative to a blade on said support, said roll having a depression of varying contour about a portion of its periphery constituting a developed surface impression of the camber side of the finished blade from the hub to the tip thereof, means for effecting relative movement of said roll and blade support longitudinally of the latter, means for rotating said roll about its axis in timed relation to said longitudinal movement through an angle which subtends said peripheral portion, and means for effecting relative lateral rocking movement between said blade support and roll in timed relation to said longitudinal movement in accordance with pitch changes in said blade.

7. In a machine for finishing propeller blades having pitch changes between the hub and tip portions thereof, in combination, a head, a plurality of guide rollers supported in generally parallel relation about said head, a belt running over said rollers having an outer abrasive surface, a propeller blade support disposed on one side of a generally horizontal reach of said belt, a pressure roll carried by said head on the other side of said reach for engaging said belt with a blade on said support, said roll having a peripheral groove therein varying in contour about the periphery thereof and constituting a developed surface impression of the camber side of the finished blade, means for effecting in timed relation relative reciprocating longitudinal and angular movements between said support and said pressure roll, and means for oscillating said roll about its axis in timed relation to said first mentioned movements.

8. In a machine for finishing propeller blades having pitch changes between the hub and tip portions thereof, in combination, a head, a plu-

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rality of guide rollers supported in generally parallel relation about said head, a belt running over said rollers having an outer abrasive surface, means for driving said belt at high linear speed, a blade supporting carriage disposed on one side of a generally horizontal reach of said belt, a pressure roll carried by said head on the other side of said belt for engaging the latter with a blade on said carriage, said roll having a peripheral groove therein constituting a developed surface impression of the camber side of the finished blade, separate drive means for moving said carriage longitudinally relative to said roll at low linear speed relative to the speed of said belt, cooperating means on said head and carriage for rocking the latter laterally in timed relation to said longitudinal movement, and cooperating means carried by said carriage and roll for rotating the latter about its axis at a peripheral speed corresponding to the linear speed of said carriage and in timed relation to the longitudinal movements of said carriage.

9. In a machine for finishing propeller blades having pitch changes between the hub and tip portions thereof, in combination, a head, a plurality of guide rollers supported in generally parallel relation about said head, a belt running over said rollers having an outer abrasive surface, means for driving said belt at high linear speed, a blade supporting carriage disposed on one side of a generally horizontal reach of said belt, a pressure roll carried by said head on the other side of said belt for engaging the latter with a blade on said carriage, said roll having a peripheral groove therein constituting a developed surface impression of the camber side of the finished blade, separate hydraulic drive means for reciprocating said carriage longitudinally relative to said roll at low linear speed relative to the speed of said belt, cooperating means on said head and carriage for rocking the latter about the longitudinal axis of the blade supported thereon in response to said reciprocating movements including cam track means on said carriage and cam follower means on said head, and cooperating means carried by said carriage and roll for rotating the latter about its axis at a peripheral speed corresponding to the linear speed of said carriage and in timed relation to the longitudinal movements of said carriage.

10. In a machine for finishing propeller blades having pitch changes between the hub and tip portions thereof, in combination, a head, a plurality of guide rollers supported in generally parallel relation about said head, a belt running over said rollers having an outer abrasive surface, a blade supporting carriage disposed on one side of a generally horizontal reach of said belt, a pressure roll carried by said head on the other side of said belt for engaging the latter with a blade on said carriage, said roll having a peripheral groove therein constituting a developed surface impression of the camber side of the finished blade, means for reciprocating said carriage longitudinally relative to said roll, cooperating means on said head and carriage for rocking the latter about the longitudinal axis of the blade supported thereon in response to said reciprocating movements, cooperating means carried by said carriage and roll for rotating the latter about its axis in timed relation to the longitudinal movements of said carriage including a horizontal rack on said carriage and a gear on said roll having a diameter substantially equal to the diameter of said roll.

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11. In a machine for finishing propeller blades having pitch changes between the hub and tip portions thereof, in combination, a head, a plurality of guide rollers supported in generally parallel relation about said head, a belt running over said rollers having an outer abrasive surface, a blade supporting carriage disposed on one side of a generally horizontal reach of said belt, a pressure roll carried by said head on the other side of said belt for engaging the latter with a blade on said carriage, said roll having a peripheral groove therein constituting a developed surface impression of the camber side of the finished blade, means for reciprocating said carriage longitudinally relative to said roll, cooperating means on said head and carriage for rocking the latter about the longitudinal axis of the blade supported thereon in response to said reciprocating movements, cooperating roll driving means carried by said carriage and roll for rotating the latter about its axis in timed relation to the longitudinal movements of said carriage including a gear coaxial with said roll and normally rotatable therewith, and means for disconnecting said gear from said roll whereby to permit said roll to rotate freely.

12. In a machine for finishing propeller blades having pitch changes between the hub and tip portions thereof, in combination, a head, a plurality of guide rollers supported in generally parallel relation about said head, a belt running over said rollers having an outer abrasive surface, a blade supporting carriage disposed on one side of a generally horizontal reach of said belt, a pressure roll carried by said head on the other side of said belt for engaging the latter with a blade on said carriage, said roll having a peripheral groove therein constituting a developed surface impression of the camber side of the finished blade, means for reciprocating said carriage longitudinally relative to said roll, cooperating means on said head and carriage for rocking the latter about the longitudinal axis of the blade supported thereon in response to said reciprocating movements, cooperating means carried by said carriage and roll for reversely rotating the latter about its axis by the longitudinal reciprocating movements of said carriage, means for effecting adjustment of said roll and carriage toward and from each other, and means for maintaining a substantially constant tension on said belt during said adjustments.

13. In a machine for finishing propeller blades, in combination, a frame having a generally horizontal bed, a blade support movable longitudinally on said bed, a head bracket carried by said frame above said bed, a pressure roll adjustably supported on said bracket, guide rollers carried by said frame on opposite sides of and remote from said roll, an abrasive belt running over said rollers having a reach passing between said roll and the blade on said support, a plurality of rollers more closely spaced about said roll in generally parallel relation thereto, and a cushioning belt running over said second mentioned rollers and supported thereby independently of the supporting rollers for said abrasive belt and having a reach thereof passing beneath said roll and above said abrasive belt.

14. In a machine for finishing propeller blades, in combination, a frame having a generally horizontal bed, a blade support movable longitudinally on said bed, a head bracket carried by said frame above said bed and adjustable toward and from said bed, guide rollers carried by said

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frame on opposite sides of and remote from said roll, a pressure roll adjustably supported on said bracket, an abrasive belt having a reach passing between said roll and the blade on said support, a plurality of rollers disposed about said roll in generally parallel relation therewith, said second mentioned rollers being carried by said head bracket and adjustable therewith relative to said abrasive belt and said guide rollers therefor, and a cushioning belt supported on said second mentioned rollers having a reach thereof running parallel with the reach of said abrasive belt and between the latter and said roll.

15. In a machine for finishing propeller blades, in combination, a frame having a generally horizontal bed, a carriage movable longitudinally on said bed having a blade supported thereon in a substantially horizontal position, a head bracket carried by said frame, a roll supporting bracket carried by said head bracket and adjustable on the latter toward and from the blade on said support, a roll journaled in said bracket, means for oscillating said roll in timed relation to longitudinal movements of said carriage, an abrasive belt having a reach passing between said roll and the blade on said support, a plurality of rollers carried by said roll supporting bracket in generally parallel relation to said roll and spaced about the periphery of the latter, and a cushioning belt running over said rollers and having a reach thereof disposed between said roll and the reach of said abrasive belt.

16. In a machine for finishing both the flat and the camber sides of the propeller blades having pitch changes between the hub and the tip portions thereof, in combination, a frame, a head, a plurality of guide rollers supported in generally parallel relation on said frame about said head, a belt running over said rollers having an outer abrasive surface, a blade supporting carriage disposed on one side of a generally horizontal reach of said belt, a pressure roll carried by said head on the other side of said belt for engaging the latter with a blade on said carriage, said roll having a groove cut in its surface extending part way about its periphery and having an uncut portion between the extremities of said groove, said groove corresponding in length to the length of the blade to be finished and having a surface contour corresponding to the contour of the camber side of the finished blade, means for reciprocating the carriage to reciprocate said blade beneath said roll, means for oscillating said roll about its axis in timed relation to said longitudinal movements to bring said grooved portion progressively over corresponding portions of the camber side of said blade, means for clamping said blade to said carriage permitting rotation of the blade about its longitudinal axis to bring either the flat side or the camber side of the blade uppermost, and means for adjusting said pressure roll toward and from said blade to bring either the cut or the uncut peripheral portion of said roll into position to finish the side of said blade which is uppermost.

17. In a machine for finishing both the flat and the camber sides of propeller blades having pitch changes between the hub and the tip portions thereof, in combination, a frame, a head, a plurality of guide rollers supported in generally parallel relation on said frame about said head, a belt running over said rollers having an outer abrasive surface, a blade supporting carriage disposed on one side of a generally horizontal reach of said belt, a pressure roll carried by said head

on the other side of said belt for engaging the latter with a blade on said carriage, said roll having a groove cut in its surface extending part way about its periphery and having an uncut portion between the extremities of said groove, said groove corresponding in length to the length of the blade to be finished and having a surface contour corresponding to the contour of the camber side of the finished blade, means for reciprocating the carriage to reciprocate said blade beneath said roll, means for oscillating said roll in timed relation to said longitudinal movements to bring said grooved portion progressively over corresponding portions of the camber side of said blade including a rack carried by and reciprocable with said carriage and a meshing gear carried by said roll, means for releasably connecting said gear and roll for rotation together, means for clamping said blade to said carriage with either said flat or said camber side uppermost, means for adjusting said pressure roll toward and from said blade to bring the periphery of said roll into pressure relationship with said blade, and means for releasing the connection between said gear and said roll permitting said roll to be driven by said belt when the uncut portion of said roll is adjusted to bear against the flat side of said blade.

18. In a blade finishing machine, in combination, a head, a plurality of guide rollers supported in generally parallel relation about said head, a belt running over said rollers, means for driving said belt at high linear speed, a blade holder located beneath the lower reach of said belt having means for clamping a blade thereon lengthwise of said belt, one of said rollers comprising a contact roller supported on said head on the opposite side of said belt from said blade and having an elongated peripheral recess in the face thereof corresponding to the contour of the camber side of the blade, drive means for effecting reciprocatory movements of said contact roll and blade relative to each other longitudinally of said blade at low linear speed relative to the speed of said belt, means for rocking said contact roll and blade relative to each other about the longitudinal axis of said blade to follow pitch changes in said blade during such longitudinal movement, and means for oscillating said contact roller about its transverse axis by the relative longitudinal movements of said roller and blade and in timed relation to said longitudinal movements.

19. In a blade finishing machine, a frame including a bed, a carriage reciprocable along said bed, means for effecting longitudinal reciprocation of said carriage, a blade holder adapted to have a blade secured thereto longitudinally of said carriage with either face uppermost, means for supporting said blade holder on said carriage for rocking movement about an axis extending longitudinally of said carriage, cooperating cam and follower means on said holder and frame including a cam track extending longitudinally of said blade holder and having a cam surface corresponding to changes in pitch of the blade thereon, an abrasive belt having a reach thereof running longitudinally of said bed over said support, a pressure roll carried by said frame in position above the reach of said abrasive belt to engage the latter with the face of said blade which is uppermost, said roll having a major portion

of its periphery grooved to conform in contour progressively to changes in contour of the camber face of the blade to be finished from hub to tip of the latter, and means for reversely oscillating said roll in timed relation to the longitudinal reciprocations of said carriage.

20. A generally cylindrical pressure roll for pressing a travelling abrasive belt against a longitudinally reciprocating propeller blade to finish the camber side thereof as the roll oscillates in timed relation to said longitudinal movements, said roll including a right cylindrical surface having a circumferential groove formed in a major portion of said surface, said groove being located intermediate the ends of the roll and corresponding in contour to the camber side of the propeller blade, the margins of said groove including both the sides and ends thereof being bounded by continuous portions of said roll surface.

21. A generally cylindrical pressure roll for pressing a travelling abrasive belt against a longitudinally reciprocating propeller blade to finish both the flat and the camber faces thereof, roll driving means for oscillating said roll in timed relation to the longitudinal reciprocating movements of said blade having a releasable connection with said roll, said roll including a right cylindrical surface having a major circumferential portion of its cylindrical surface grooved to provide a surface impression of the camber face of a blade for pressing the belt against the camber face of the blade as the roll oscillates in timed relation to said longitudinal movements and having the remainder of its cylindrical surface between the ends of the groove ungrooved for pressing the belt against the flat face of the blade when said roll is released from said driving means.

22. In a machine for finishing irregularly shaped articles, in combination, a travelling belt having an abrasive surface, a work support, a contact roll for positioning the abrasive surface of said belt relative to a piece of work on said support, said roll having a peripheral depression therein constituting a developed impression of a surface of a finished work piece, means for effecting relative reciprocatory movements between said roll and said work piece, means for oscillating said roll about its axis in timed relation with said reciprocatory movements, and means for effecting relative adjustment of said roll and work support toward and from each other.

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