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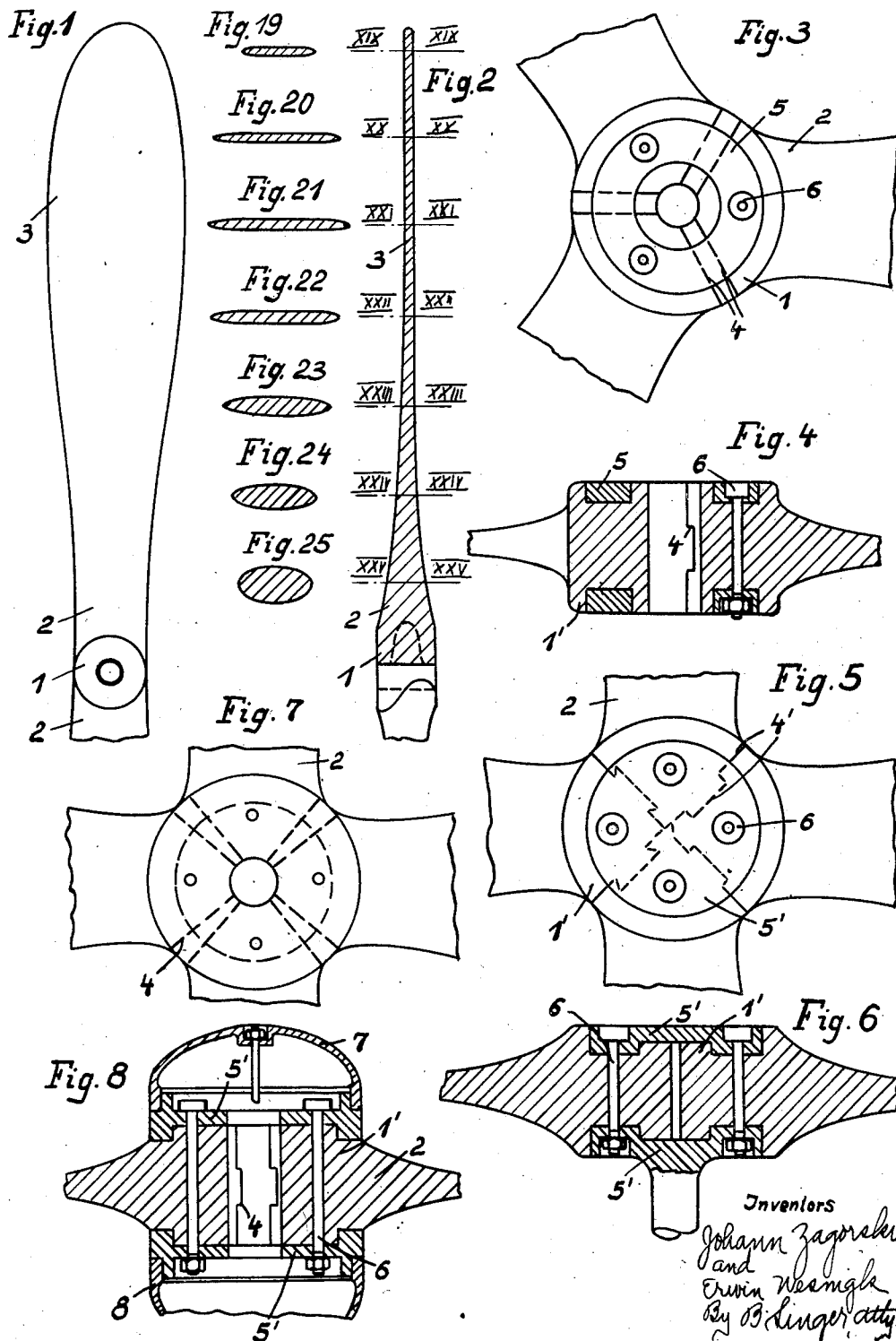
J. ZAGORSKI ET AL

1,900,630

ROLLING MILL

Filed Jan. 25, 1929

3 Sheets-Sheet 1



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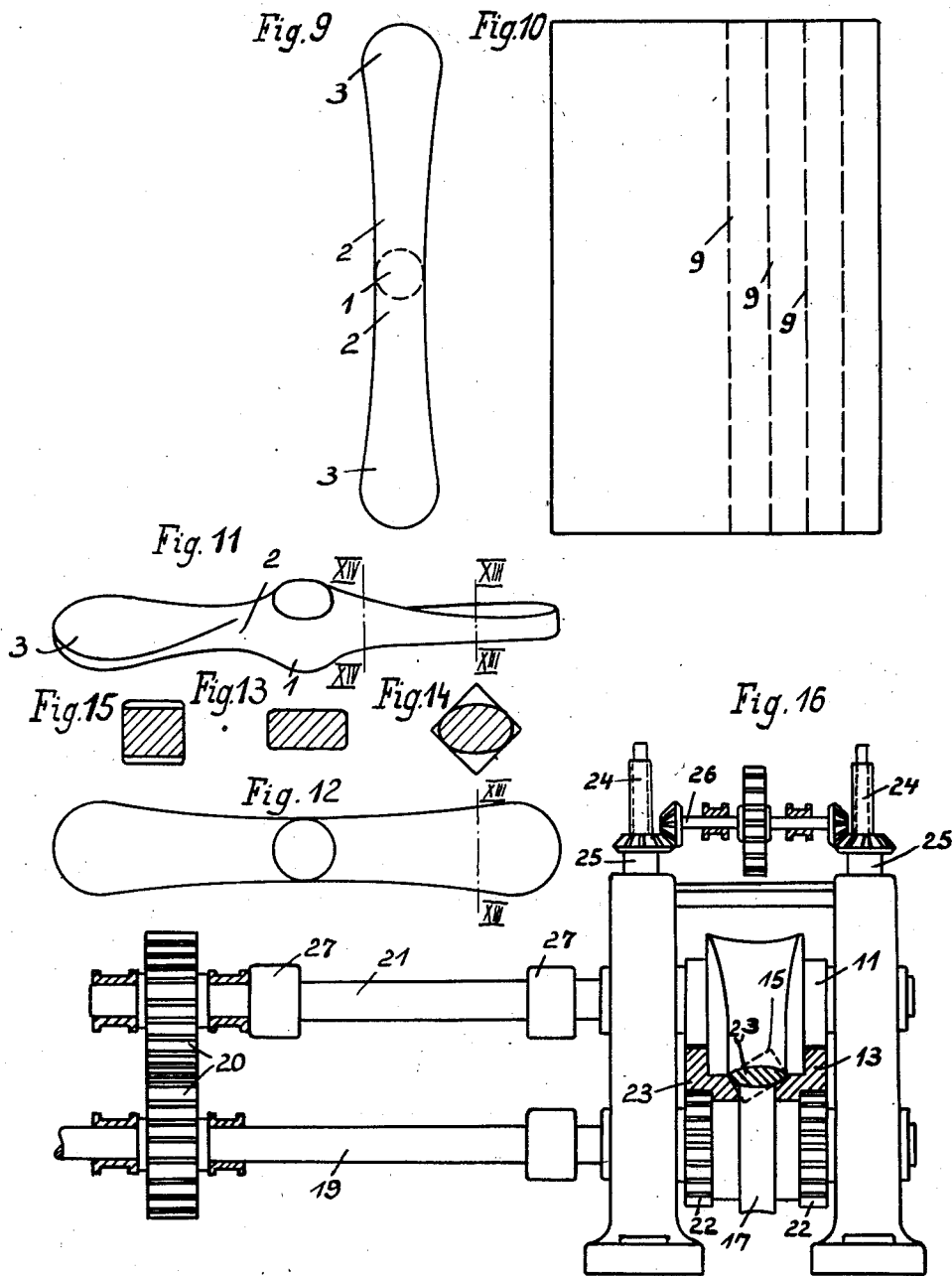
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Inventors
Johann Zagorski
and
Erwin Neumig
By B. Singer, atty.

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Fig. 17

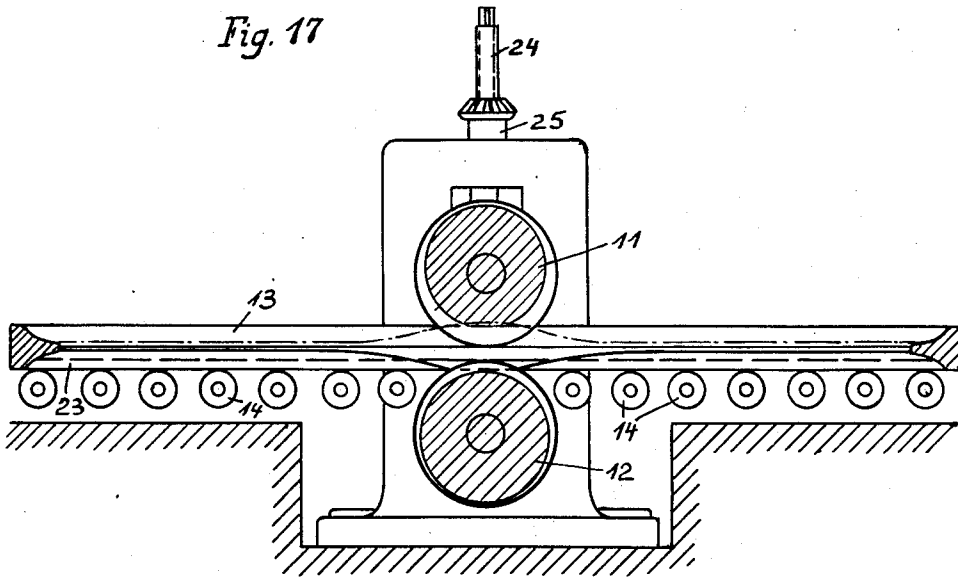
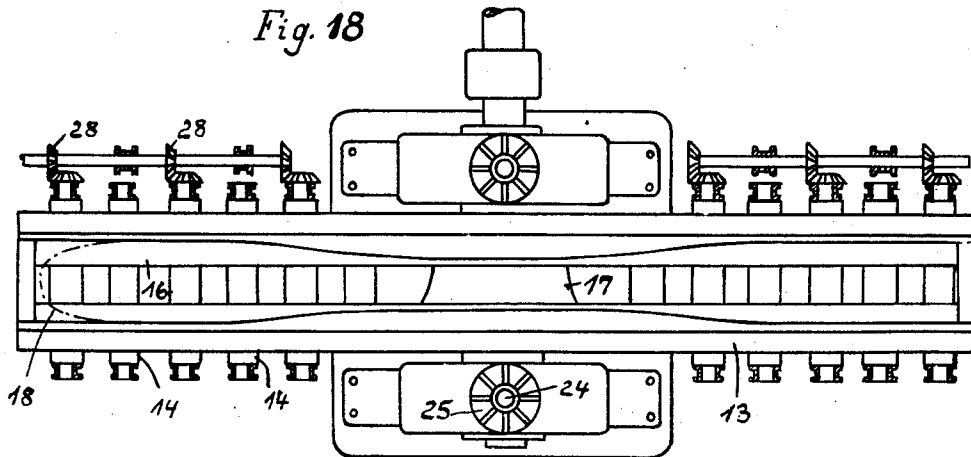


Fig. 18



Inventors
Johann Zagorski
and
Erwin Weisinger
By B. Singer, atty.

UNITED STATES PATENT OFFICE

JOHANN ZAGORSKI, OF FRANKFORT-ON-THE-MAIN, AND ERWIN WESNICK, OF BERLIN,
GERMANY

ROLLING MILL

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In contradistinction to wood propellers, propellers of metal or other material adapted to be cast or forged have been mostly manufactured as hollow propellers composed of several parts or as solid propellers cut out from sheets, which near the hub need a large breadth for sustaining the forces, but nevertheless have no sufficient rigidity against torsional stresses.

The invention consists in forming a propeller of metal or other deformable material with a hub of sufficient dimensions for the transmission of the forces and for immediate mounting on the shaft, and with blades having thick profiles near said hub and flat profiles on their main length. Entire propellers or single blades for composing three or four bladed propellers or variable pitch propellers can be produced in this manner, and a good efficiency is secured in all cases.

For the production of the new propeller the invention concerns a rolling process and a special rolling mill, wherein the entire propeller or a propeller blade is rolled down out of a warm block of material so as to have in all parts the right profiles and near the hub also the right pitches, whereas the pitches on the outer blade parts are regulated by twisting the blades in cold state.

Several details are further concerned in the invention as later described.

The invention is illustrated on the drawings, in which:

Fig. 1 is an axial view and

Fig. 2 a transverse view of a two-bladed propeller, partially in section,

Figs. 3 and 4 are similar views of a three-bladed hub part,

Figs. 5 and 6 are similar views of a four-bladed hub part,

Figs. 7 and 8 are similar views of a four-bladed hub part of another embodiment.

Figs. 9 and 10 are a cross view and a lateral view of a cast block for several two-bladed propellers,

Figs. 11 and 12 are a lateral view and an axial view of a cast block for a single two-bladed propeller,

Figs. 13 and 14 are cross sections corresponding to the lines XIII—XIII and XIV—XIV of Fig. 11 respectively,

Fig. 15 is a modified embodiment of the cross section shown in Fig. 14,

Figs. 16, 17 and 18 are respectively a longitudinal view, a transverse view and a top view of a rolling mill for producing the propellers.

Fig. 19 is a detail transverse sectional view on the plane indicated by the line XIX—XIX of Fig. 1.

Fig. 20 is a similar view on the plane indicated by the line XX—XX of Fig. 1.

Fig. 21 is a similar view on the plane indicated by the line XXI—XXI of Fig. 1.

Fig. 22 is a similar view on the plane indicated by the line XXII—XXII of Fig. 1.

Fig. 23 is a similar view on the plane indicated by the line XXIII—XXIII of Fig. 1.

Fig. 24 is a similar view on the plane indicated by the line XXIV—XXIV of Fig. 1.

Fig. 25 is a similar view on the plane indicated by the line XXV—XXV of Fig. 1.

According to Figs. 1 and 2 the propeller is provided with a hub 1, whose cross-section is

sufficient to sustain the centrifugal and torsion stresses by complete utilization of the

strength of the material used, which particularly is a refinable alloy of aluminium or

magnesium. From this hub part, blade-

shafts 2 extend, which have short thick-

stream-lined profiles, as designed, and are arranged with angles corresponding to the

pitch of the propeller. Further the blades 3 are enlarged against the ends and shaped to a

usual blade contour, the profiles being thin so as to be aerodynamically favourable and

have still sufficient resistance against torsion. All profiles are positioned under oblique

pitch angles in usual manner, but this is not shown for matter of simplicity. For balance-

ing the strains arising from the thrust the straight lined shape shown in Fig. 2 may be modified to a forward bent shape following the line resultant from thrust and centrifugal forces. A similar bent shape may also be provided in the rotation plane according to the line resultant from rotation moment and centrifugal force.

According to Figs. 3 and 4 separate blades are preformed in similar shape, the blade feet 2 extending from hub sectors 1', which by dove tailed or zig-zagged radial surfaces 4 are centered on each other and are secured together by clamping rings 5 embedded in their end faces. The said rings 5 may be shrunk on their seats or fastened under tension in any other way and are held by screw bolts 6.

According to Figs. 5 and 6 a four bladed propeller is composed in a similar manner. The dove tailed or zig-zagged projections 4' of the radial surfaces are here disposed axially. For securing the parts together, discs 5' are provided, one of which is formed as a flange of the propeller shaft.

According to Figs. 7 and 8 a four bladed propeller is formed with radial projections 4 of the contacting radial surfaces of the sectors, and the parts are secured together by clamping discs 5' and bolts 6. The clamping discs 5' serve at once for holding a head cap 7 of the hub and an annular 8 leading to the motor or gear case.

According to Figs. 9 and 10 for the production of two bladed propellers of small sizes and in great numbers, a cast block is employed, of which the part corresponding to the hub 1 and to the blade feet 2 is thinner than the parts corresponding to the blades 3. Said block is cut at 9' into parts, each of which has the described profile and serves as raw block to be milled.

In the case of propellers with a plurality of blades according to Figs. 3-8, a similar block is employed, in which from the hub part 1 only to one direction a part corresponding to the blade feet 2 and blades 3 is extended.

According to Figs. 11 and 12, for large specially heavily loaded two blade propellers or separate blades of propellers with a plurality of blades a separately cast block is employed, in which the hub part 1 has already the round shape, and also the blade feet 2 and blades 3 have already approximately the final profiles and pitch angles so that the further work here extends essentially only to the longitudinal stretching of the blades by milling. For a specially good preparation the blades have the profiles shown in Figs. 13 and 14, whereas for a simpler process the cross section near the hub can be chosen as shown in Fig. 15.

For rolling or milling the described blocks, according to Figs. 16-18 a rolling mill is used,

which contains an upper roll 11, a lower roll 12 and a roll table 13 arranged for easy movement in the direction of rolling. The upper roll 11 is shaped in its circumference as a die or mould corresponding to whole propeller (or a single propeller blade), confined by a line following the contour along the entering and trailing edges of the blades and an adapted connecting line on the hub. If single blades are to be rolled the hub die has advantageously the diagonal arrangement shown by dotted lines at 15 in Fig. 16, so that a diagonal plane of the hub and the blade are essentially parallel to axes of the rolls. The lower roll 12 and the table 13 together contain the remaining part of the die, the table being provided with a longitudinal slot 16, into which projects a die part 17 of the lower roll 17. The dies of both rolls and of the table are preferably so shaped as to produce immediately the final profiles and pitch angles of the propeller or propeller blade, but it is also possible with advantage, to simplify the die so as to roll only near the nave the final pitch angles, whereas the remaining blade parts receive the same pitch angle and are formed as plane parts. The final pitch angles, which decrease against the blade tips, are then adjusted afterwards by twisting the blades in cold state. The tip contour 18 shown in Fig. 18 can be shaped either in the rolling operation or it can be rolled with parallel edges and cut out afterwards.

For driving the rolls, the lower roll 12, 17 is connected to a driving shaft 19, and from the latter by toothed wheels 20 the upper roll 11 is driven. Further toothed wheels 22 of the said lower shaft 19 are in engagement with toothed racks 23 provided on the table 13 so as to drive the latter. All toothed wheels are so adjusted that precisely corresponding parts of the lower and upper rolls end of the table work together. Oblique or arrow shaped teeth are preferably employed for securing uniform running. The bearings of the upper roll are adjustable in height by aid of spindles 24, on which conical wheels 25 run by screw threads, and said wheels 25 are in engagement on a common driving shaft 26, so that the upper roll can be lowered during the rolling operation for rolling the work piece down in a plurality of alternating movements of the mill. Flexible couplings 27 allow the shaft 21 to follow said downward adjustment.

The table supporting rollers 14 are also connected to conical driving gears 28 for specially securing a precise coincidence of the table and roll movements.

As may be seen from the foregoing, the process according to the invention gives the possibility of forming propellers without any remarkable deformations in cold state on the thick parts near the hub, so that damages

to the material are excluded, as only the thinner outer blade parts need very precise pitch angles, but these can be adjusted with small and innoxious deformations. The use of a raw block having already a half finished shape has the advantage that the blades essentially need only to be stretched in their longitudinal direction, so that no splitting of the material occurs, which otherwise would arise especially with refined aluminium or its alloys or with other materials of low ductility. This advantage is attained for small propellers already by the use of a common block cut into several pieces for the production of several propellers, and with special advantage the separate blocks used for large propellers avoid funnels to be included in the raw blocks and excessive rolling strains to arise in the material.

In the rolling mill, the use of the roll table in connection with an upper roll secures a rolling operation without undue bending of the propeller, so that propellers with straight lined center line or with a bend according to the resultant from thrust and centrifugal force can be very precisely produced. Thereby a good balance of the forces and masses in the use of the propeller is attained without the aid of costly finishing work. The table can serve as a complete lower die, but the auxiliary use of the lower roll ensures the material to be essentially equally rolled and stretched on both sides, so that it assumes a uniform distribution of its longitudinal fibres and a uniform elasticity.

If entire two bladed propellers are to be rolled, the dies are so shaped, that the hub plane lies parallel to the table, and the blade cross sections lie obliquely to the table so as to have the right pitches at least on the thick parts near the nave.

We claim:

1. A rolling mill for rolling molded propellers, comprising in combination a roll table having a longitudinal slot, an upper roll arranged above said table, a lower roll so arranged as to project through said slot, and a gear connecting said table and said rolls for common movement, said upper roll, lower roll and table each containing a die cavity which cavities coact to form the propeller blade.

2. A rolling mill for rolling molded propellers, comprising in combination a roll table having a longitudinal slot, an upper roll arranged above said table, a lower roll so arranged as to project through said slot, means for driving said lower roll, and a gear for driving said table and upper roll from said lower roll, said upper roll, lower roll and table each containing a die cavity which cavities coact to form the propeller blade.

3. A rolling mill for rolling molded propellers, comprising, in combination, a roll table having a longitudinal slot, an upper roll

arranged above said table, a lower roll arranged below said table, means for supporting said table so as to be slidable tangentially to said rolls, and propeller forming dies on said rolls and said table, said lower roll being so arranged as to project through said slot and form a part of the lower die.

In witness whereof we affix our signatures.

JOHANN ZAGORSKI.

ERWIN WESNIGK.

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