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METHOD OF HEATING, HARDENING, AND TEMPERING
OF HOLLOW STEEL PROPELLER BLADES
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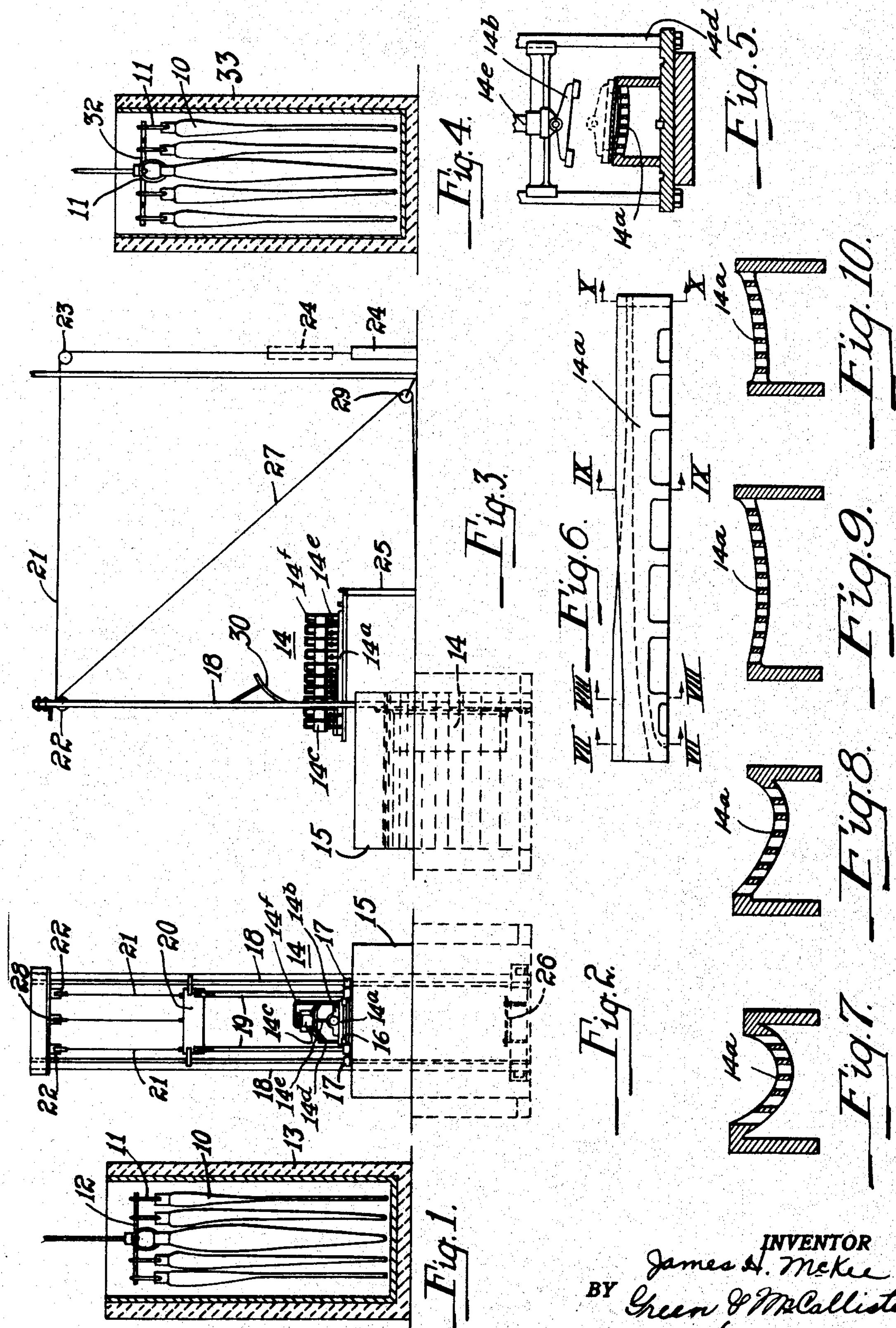

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METHOD OF HEATING, HARDENING, AND TEMPERING OF HOLLOW STEEL PROPELLER BLADES

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4 Claims. (Cl. 148—21)

This invention relates to aeronautical propellers, and more particularly to improvements in the method of hardening and tempering detachable hollow steel propeller blades.

One object of this invention is to provide a method for producing straight propeller blades having the desired hardness and temper.

Another object of this invention is to provide a novel method for tempering and hardening hollow steel propeller blades whereby practically straight blades can be produced.

A further object of this invention is to provide a method for hardening and tempering propeller blades in which the blades are so held during the quenching and cooling operations that warping thereof is prevented.

These and other objects which will be made apparent to those skilled in this particular art are accomplished by means of this invention, the steps of which are described in the following specification and illustrated in the accompanying drawing, wherein:

Figure 1 is a view in vertical section of a heating furnace illustrating the first step in my process;

Fig. 2 is a view in end elevation illustrating the apparatus in which the blade is held during quenching and air cooling;

Fig. 3 is a view in side elevation of the blade holding apparatus;

Fig. 4 is a view in vertical section of a draw heating furnace;

Fig. 5 is an enlarged partial view in section of the blade holding apparatus;

Fig. 6 is an enlarged view in side elevation of the base of the blade holding apparatus;

Fig. 7 is a sectional view taken on line VII—VII of Fig. 6;

Fig. 8 is a sectional view taken on line VIII—VIII of Fig. 6;

Fig. 9 is a sectional view taken on line IX—IX of Fig. 6; and

Fig. 10 is a sectional view taken on line X—X of Fig. 6.

In carrying out my improved process, the hollow propeller blades, designated as 10, to be hardened and tempered have a suitable ring 11 attached to the shank or butt end of the blade in any suitable manner such as welding, for supporting the blades during these operations. After the ring 11 has been secured to the blade 10, it is suspended from a spider 12 and lowered into a vertical heating furnace 13 of any suitable type such as an electric furnace, where it is heated or raised to a temperature of about 1650 to 1700° F. After the blade 10 has been raised to hardening temperature it is removed from the furnace 13 and placed in a straightening jig 14. While the jig 14 may be of any suitable construction I prefer to use a jig, such as is described in my co-pending application Serial No. 603,258, filed April 5, 1932, which comprises a base member 14*a* having a perforated portion shaped to conform in contour to one face of a propeller blade and on which the heated blade is placed. The blade is held on the member 14*a* by a series of yokes 14*b* extending transversely of the plate 14*a* and which are adapted to be moved into engagement with the edges of the blade to securely clamp it against the member 14*a*. The yokes 14*b* are moved into and out of engagement with the edges of the blade by air motors 14*c* mounted on a frame 14*d* supporting the base member 14*a*. The air motors are connected to the yokes 14*b* by piston rods 14*e*. The air motors are supplied with air from a suitable source of supply through pipes 14*f*. After the blade has been heated it is clamped against the perforated plate 14*a* by the spaced yokes 14*b* which engage the edges of the blade only whereby the faces of the hollow blade are not injured thereby. While the blade is held in the air jig 14 it is hardened by submerging in a tank 15 containing oil or other suitable quenching liquid.

In order that the air jig 14 may be readily lowered into the tank 15, when the blade has been clamped therein, the jig 14 is supported on a bar 16 which is journaled in trunnions 17 slidably mounted on uprights 18 which extend downwardly into the fluid in the tank 15. As shown in Figure 3, the air jig 14 is so mounted on the bar 16 that the portion thereof adapted to receive the shank of the blade is over the tank 15 and the center of mass of the jig is substantially over the bar 16.

In order to prevent the weight of the jig 14 from moving the bar downwardly on the uprights 18, the bar 16 is also pivoted in the ends of strap members 19 depending from a counterbalanced cross bar 20. The cross bar 20 is slidably mounted on the uprights 18 and has cables 21 attached thereto which pass over pulleys 22 and 23 and are fastened to counterweights 24. The end of the air-clamping jig 14, when in blade receiving position, is supported on a suitable standard 25.

When the blade has been clamped in the air-clamping device 14 and it is desired to lower the blade and jig into the oil or quenching liquid in the tank 15, the tip receiving end of the air jig is pushed upwardly by the operator so that the bar

16 is turned in its trunnions 17. As the tip end of the air-jig is raised the center of mass of the jig shifts toward the uprights 18, overcomes the counterbalance weights 24 and the bar 16 carrying the jig slides downwardly on the uprights 18 into the tank 15 until it comes to rest on a spring bumper 26 disposed in the bottom of the tank between the uprights 18.

Since the hollow blade is submerged in the tank with the shank end down, it is apparent that the oil or quenching liquid in the tank passes into the interior of the blade as well as around the outer surface thereof and as a result all parts of the blade are given substantially the same degree of hardness.

After the blade has been thoroughly quenched, a cable 27 passing around pulleys 28 and 29 and having one end thereof attached to a suitable winch (not shown) and the other end to the cross-head 20 is wound on the winch and pulls the air-jig 14 out of the tank 15. As the air-clamping device moves upwardly between the uprights 18, the end of the jig 14 engages curved slides 30 mounted adjacent to the uprights 18 and the tip end of the air-clamping device is forced away from the uprights which shifts the center of mass and causes the jig to fall on the support 25.

The blade 10 is then removed from the air-jig 14 and is suspended through the ring 11 from a suitable spider 32 in a vertical draw furnace 33 where it is heated to a temperature of between 900° and 1200° for approximately 3 to 4 hours. After the blade has been thoroughly soaked in the draw furnace 33 it is removed therefrom and placed in another clamping jig similar in all respects to the one in which it was held during the quenching operation where it is allowed to cool slowly in the air to give it the proper temper.

By holding the blade in such a clamping device during the quenching and air cooling operation, it is readily apparent that I am able to prevent the tip end of the blade from curling and the body of the blade from warping since the yokes of the jig are held against the blade by a continuing pressure they follow up the contraction or shrinkage of the blade, and as a result I am able to produce practically straight hardened and tempered propeller blades having the proper curvature for any transverse section thereof.

While I have described one embodiment of my invention, it is readily apparent that certain changes may be made in the steps of my method for hardening and tempering propeller blades without departing from the spirit of my invention or the scope of the appended claims.

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

1. The method of hardening and tempering tubular propeller blades which consists in heating a blade to a temperature of approximately 1650 to 1700° F., quenching the heated blade, applying a continuous pressure to succeeding transverse sections of the blade during the quenching operation, reheating the blade between a temperature of 900 to 1200° F., and then cooling the blade slowly while applying pressure to succeeding transverse sections thereof.

2. The method of hardening and tempering hollow steel propeller blades, which consists in heating a blade to a hardening temperature of at least 1650°, dipping said heated blade shank end first in an oil bath to harden both the inner and outer surfaces thereof, holding the edges of the blade under continuous pressure during the quench to prevent warping, soaking the blade for about three hours at a temperature of at least 900°, cooling the reheated blade in air to temper the same, and applying continuous pressure to the edges of the blade while it is cooling to follow up contraction and shrinkage therein and prevent warping of the blade.

3. The method of hardening and tempering hollow steel propeller blades which consists in heating a blade to approximately 1650°, dipping said heated blade shank end first in a quenching liquid, applying pressure to the solid edges of succeeding transverse sections of the blade while in the quench, raising the quenched blade to a temperature between 900° and 1200°, holding the blade at such temperature for at least three hours, and cooling the blade in air while succeeding transverse sections thereof are subjected to pressure to prevent warping of the blade.

4. The method of hardening and tempering hollow steel propeller blades which consists in heating a blade to approximately 1650°, dipping said heated blade shank end first in a quenching liquid, applying continuous pressure to the solid edges of succeeding transverse sections of the blade while in the quench, raising the quenched blade to a temperature between 900° and 1200°, holding the blade at such temperature for at least three hours, cooling the blade in air, and continuously applying pressure to the solid edges of said blade as it is being cooled to follow up the shrinkage therein and prevent the blade from warping out of shape.

JAMES H. McKEE.