March 7, 1944. G. T. LAMPTON ET AL 2,343,418

METHOD OF MAKING PROPELLER BLADES

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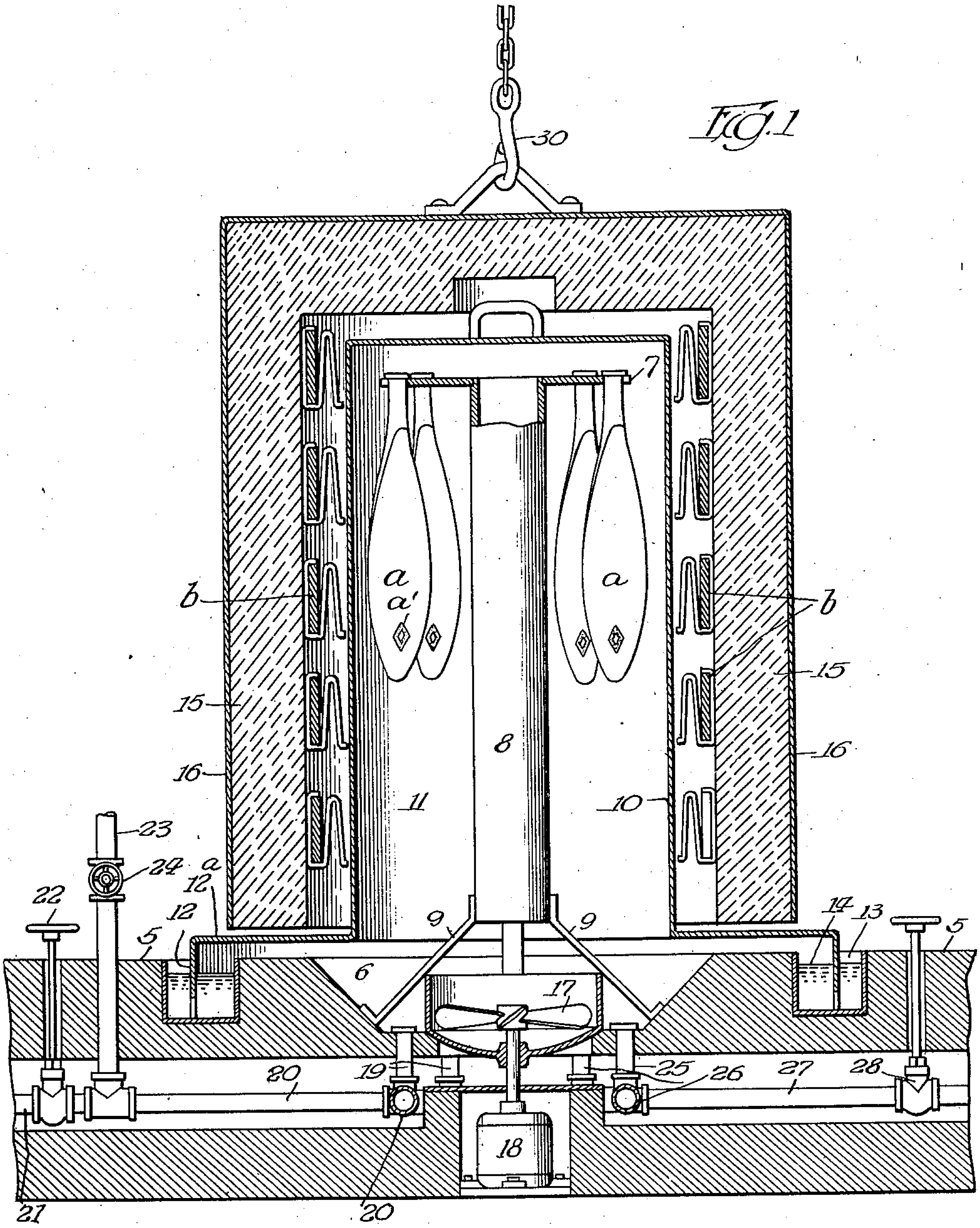
Fig. 1



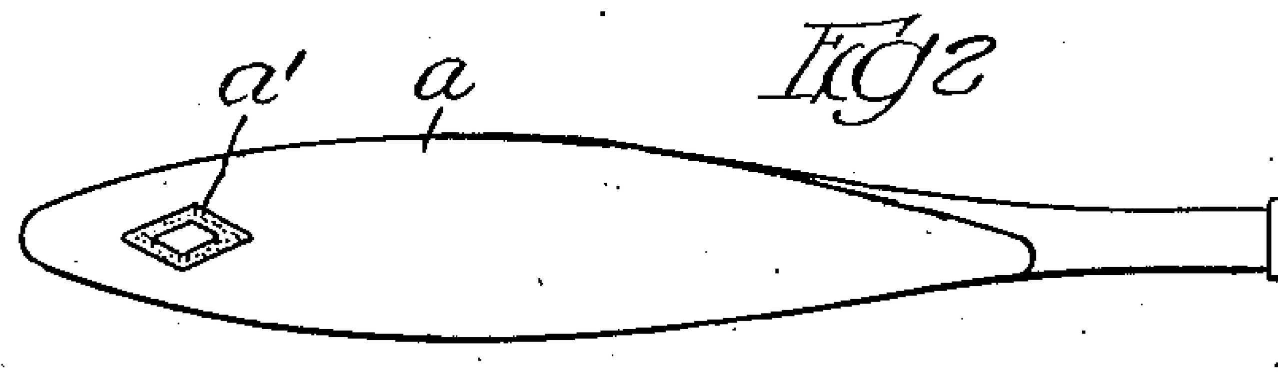


Fig 2

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METHOD OF MAKING PROPELLER BLADES

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11 Claims. (Cl. 148—16)

The invention relates to the manufacture of steel aircraft propellers.

In the operation of modern aircraft the propellers are rotated at a high rate of speed, are generally disposed within the vision of the pilot, and the reflection produced by the outer surfaces of the propeller blades in sunlight is bothersome to the pilot and likely to cause mental fatigue or interfere with proper navigation of the airplane.

One object of the invention is to provide a method of making aircraft propellers, the outer surfaces of which are colored to decrease or eliminate the objectionable reflections of light during high speed operation.

A further object of the invention is to provide a method of producing aircraft propellers with substantially non-reflecting outer surfaces which are also highly resistant to corrosion and abrasion.

A still further object of the invention is to provide a method of marking the blades with trade-names or marks or other technical data in such a manner that the marking will be permanent and the outer surfaces of the blade will be substantially non-reflecting of light and resistant to corrosion and abrasion.

Other objects of the invention will appear from the detailed description.

The invention consists in the several novel features which are hereinafter set forth and are more particularly defined by claims at the conclusion hereof.

In the drawing, Fig. 1 is a vertical section of a furnace and associated apparatus used in carrying out the invention. Fig. 2 is an elevation of the finished blade.

The furnace and apparatus illustrated as an exemplification for carrying out the invention comprise: a foundation or floor 5 which is provided with a well 6; a support for the propeller blades *a* while they are being treated, which includes a plate 7 having notches therein for receiving and retaining the shanks of a series of blades in suspended and separated relation; a post 8 at the upper end of which plate 7 is secured; and legs 9 fixed to the lower end of post 8 and having their lower ends extending into the well 6 and supported on the inclined side thereof; a cylindrical bell-shaped inner shell 10 surrounding the suspended blades and forming a chamber 11 for heat, gas and air treatment of the blades; an oil-seal between the lower end of the bell or shell 10 and the foundation 5 which consists of a depending flange 12 on the horizontal flange 12ª of the shell 10 and an annular well 13 in the fonudation which contains oil 14 in which the lower portion of flange 12 is submerged when the shell is lowered; an outer bell-shaped heater-jacket or casing which includes a refractory lining 15 spaced from the shell 10 and a metallic shell 16 for said refractory and is vertically movable for heat variation; a series of electric heating elements *b* which are wound on the inside of the refractory 15 and movable therewith; a fan 17 centrally mounted in the well 6 for flowing gas and air around the blades in the chamber 11; an electric motor 18 for driving fan 17; a series of inlet pipes 19 for delivering air or gas, as hereinafter described, to the chamber 11 and connected to a header 20; a delivery pipe 20ª leading to header 20; a supply pipe 21 for ammonia gas; a valve 22 for controlling the admission of gas to pipe 21 for delivery into chamber 11; an air pipe 23; a valve 24 connected to pipe 21 for controlling the delivery of air into chamber 11; a series of outlet pipes 25 connected to a header 26; an outlet pipe 27 connected to header 26; and a valve 28 for controlling the outflow of gas or air from chamber 11. The heater jacket, when the furnace is being brought up to the desired temperature, is lowered onto the horizontal flange 12ª of shell 10. The heater jacket 15, 16 with the heating elements therein is adapted to be lifted off the inner shell 10 to provide access to the inner shell and for heat variation of the chamber in the inner shell, by a suitable hoisting element 30. The inner shell 10 is also adapted to be lifted by any suitable means to provide access to the chamber 11 for placing propeller blades *a* into and removing them from chamber 11. The rates of flow for ammonia and air hereinafter specified are by way of example and are those suitable for a furnace having a cubic capacity of 150 cubic feet and in which the oil-seal will hold a maximum pressure of 1½ inches of water. It will be understood that variation in the capacity of the furnace requires variation of these rates of flow.

Before treatment of the blade in accordance with the invention, the surface of the blade is polished to present an even finish, washed with water to remove the effects of the acid or material used in polishing, washed with gasoline or otherwise de-greased, and wiped dry with a cloth. The blades are then hung into the notches in the supporting plate 8, without touching the working surface of the blade with the bare hands so that the outer surfaces of the blades will be thoroughly clean. The furnace is loaded with the blades while the inner shell and heater jacket are raised for access to the blade-support.

The inner shell 10 is then lowered so its flange 12 is submerged in the oil 14 and the chamber 11 will be sealed. Valve 22 is opened and ammonia gas is then delivered at the rate of approximately 100 to 125 cubic feet per hour to replace the air in chamber 11 until the air is reduced to approximately 5%. The heater-jacket with the heating-elements b therein is lowered around the inner shell 10 and the temperature regulators usually provided are set to heat chamber 11 or the blades therein to approximately 900° F. While bringing the temperature to 900° F. the flow of ammonia gas to chamber 11 is reduced to the rate of approximately 10 cubic feet per hour to avoid sufficient increase of pressure to break the oil-seal. This temperature of 900° F. is maintained in chamber 11 for approximately 5, but not in excess of 15, hours. After the temperature has reached 900° F. the rate of flow of the ammonia gas to chamber 11 is maintained at substantially 20 cubic feet per hour so that the dissociation of the gas will be from 3 to 10%, or the ammonia concentration in the chamber is maintained at 90 to 97%. At the end of said treatment the outer surfaces of the blades will be nitrided to render them resistant to corrosion and abrasion.

At the end of this nitriding cycle the heater-jacket is raised until the temperature in chamber 10 drops to about 500° F. and the flow of ammonia gas is increased to prevent drawing of oil from the oil-seal into chamber 11. Next, the heater-jacket is lowered and the heating-elements are actuated and controlled to maintain a stabilized temperature of 585 to 605° F. for about 15 minutes. Next, the flow of gas to chamber 11 is cut off at valve 22. Air under pressure insufficient to blow out the seal, is next admitted under control of valve 24 to chamber 11 through pipe 21, header 20 and pipes 19 and forced through said chamber at the rate of approximately 100 cubic feet per hour. The temperature during this period is very closely held to 585 to 605° F., which may be done by variably raising or lowering the outer shell. The delivery of air to chamber 11 is continued in this manner until dissociation readings show 80% air present. Next, the oil is drawn from well 13 and compressed air under a higher pressure is blown through chamber 11 for about 10 minutes. This treatment of the blade produces a deep blue color in, and uniform finish on, the nitrided surfaces of the blade. The heater-jacket and shell 10 are next lifted above the blades and removed so that the blades can be removed from supporting-plate 7. The blades are then wiped off with a clean cloth saturated with machine oil.

In carrying out the foregoing steps, the outlet valve 28 may be used to control the rate of flow of the ammonia gas and the fan 17 may be operated to flow the gas and air around all portions of the blades.

When markings for trade identification or technical data are desired on the outer surface of the blades, such as a trade-mark a', the markings are etched on the outer surface before they are polished and cleaned preparatory to the nitriding and coloring treatment in the chamber 11.

The heat treatment of the blades at a temperature of approximately 900° F. in the presence of ammonia gas, catalytically breaks down the ammonia into the elements nitrogen and hydrogen and the atomic nitrogen formed acts upon the metal in such a manner as to form nitrides which improve the resistance of the metal to corrosive action and provide it with a hardened surface for preventing abrasive action and corrosion when the propellers are in use. The depth to which this action occurs is a function of the amount of metal in the blades in the chamber 11, the duration of its treatment with heat and ammonia gas, and the amount of ammonia in said chamber. The steel from which the blades are fabricated is usually susceptible to corrosion and abrasion and this nitriding improves the resistance of the metal to corrosion and abrasion. The method set forth contemplates the nitriding of the metal to the depth desired in the finished blade and not the additional depth necessary when the machining is done on the blade after it has been nitrided. The finishing of the blades to their polished and finished condition before nitriding avoids the necessity of nitriding the metal to a sufficient depth to include the metal machined off the blade.

The reduction of temperature from the 900 to 500° F., the stabilization of the temperature of the blades at a temperature between 585 and 605° F. before stopping the flow of ammonia gas and the treatment of the blades with air at that temperature, produce a deep blue color on the surface of the blades. The coloring of the nitrided surface results from the formation of an oxide on the external surfaces of the blade when it is subjected in a heated condition to a reducing temperature. The coloring by this oxide can be controlled within limits by the temperature of the blade. This oxide serves primarily to color the blade but, in addition, augments the non-corrosive characteristics of the nitrided surface without disturbing its resistance to abrasion or other physical properties. This temperature is critical and the resulting color produced on the surface of the blade is substantially non-reflecting of light, which is a desideratum when the blades are in operation. In practice, it has been found that the color of the blades varies with the temperature from that of light straw to a variety of purples, blacks, light blue and gray, and that at the approximate temperature of 585 to 605° F. a deep blue color of the blade is produced which is substantially non-reflecting and that the surface is resistant to corrosion and abrasion.

When markings have been etched on the surface of the blades before they are subjected to the coloring treatment, the etched portions are non-reflecting, legible and permanent.

The invention exemplifies a method of producing propeller blades for aircraft of a surface color such as a deep blue which is substantially non-reflecting of light and which possesses the desired resistance to abrasion and corrosion when the blade is in operation.

The invention also exemplies a method of permanently marking steel propeller blades in such a way that the etched portions will be non-reflecting and will also be resistant to corrosion and abrasion.

The invention is not to be understood as restricted to the details set forth, since these may be modified within the scope of the appended claims, without departing from the spirit and scope of the invention.

Having thus described the invention, what we claim as new and desire to secure by Letters Patent is:

1. That improvement in making steel propeller blades for aircraft, which comprises nitriding the outer surfaces of the blade by subjecting it to heat and a suitable gas, and treating the blade after the blade has been nitrided with gas and air at a suitable stabilized temperature and for a sufficient period to produce a substantially non-reflecting oxidized surface on the nitrided outside of the blade.

2. That improvement in making steel propeller blades for aircraft, which comprises nitriding the outer surface of the blade by subjecting it to heat and a suitable gas, and treating the blade after the blade has been nitrided with gas and air at a stabilized temperature of substantially 585 to 605° F. to produce a substantially non-reflecting oxidized surface on the nitrided outside of the blade.

3. That improvement in making steel propeller blades for aircraft, which comprises nitriding the outer surface of the blade by subjecting it to heat and a suitable gas, and treating the blade after the blade has been nitrided with gas and air at a suitable stabilized temperature to produce a substantially non-reflecting deep blue oxidized surface on the nitrided outside of the blade.

4. That improvement in making steel propeller blades for aircraft, which comprises nitriding the outer surface of the blade by subjecting it to heat and a suitable gas, and treating the blade with gas and air at a temperature of 585 to 605° F. to produce a substantially non-reflecting oxide surface of deep blue color on the nitrided outside of the blade.

5. That improvement in making steel propeller blades for aircraft, which comprises nitriding the outer surface of the blade by subjecting it to heat and a suitable gas, lowering the nitriding temperature of the blade after the blade has been nitrided and stabilizing it at a suitable point in the presence of the gas, and then forcing air around the blades while said temperature is maintained, to produce a substantially non-reflecting oxidized surface on the nitrided outside of the blade.

6. That improvement in making steel propeller blades for aircraft, which comprises nitriding the outer surface of the blade by subjecting it to heat and a suitable gas, lowering the nitriding temperature of the blade after the blade has been nitrided and stabilizing it at substantially 585 to 605° F. in the presence of the gas, and then forcing air around the blades while they are maintained at said temperature, to produce a substantially non-reflecting oxidized surface on the nitrided outside of the blade.

7. That improvement in making steel propeller blades for aircraft, which comprises nitriding the outer surface of the blade by subjecting it to heat and a suitable gas, lowering the nitriding temperature of the blade after the blade has been nitrided and stabilizing it at substantially 585 to 605° F. in the presence of the gas, and then forcing air around the blades until the gas percentage is low, while they are maintained at said temperature, and then forcing air under higher pressure around the blades while said temperature is maintained, to produce a substantially non-reflecting oxidized surface on the nitrided outside of the blade.

8. That improvement in making steel propeller blades for aircraft which comprises nitriding the outer surface of the blade by subjecting it to heat and a suitable gas, lowering the nitriding temperature of the blade after the blade has been nitrided, stabilizing the temperature at substantially 585 to 605° F. in the presence of gas for approximately 15 minutes, and forcing air around the blades to displace the gas while said temperature is maintained, to produce a substantially non-reflecting oxidized surface on the nitrided outside of the blade.

9. That improvement in making steel propeller blades for aircraft which comprises nitriding the outer surface of the blade by subjecting it to heat and a suitable gas, lowering the nitriding temperature of the blade after the blade has been nitrided, stabilizing the temperature at substantially 585 to 605° F. in the presence of gas for approximately 15 minutes, forcing air around the blades to displace the gas while said temperature is maintained, and then forcing air under a higher pressure around the blades, to produce a substantially non-reflecting oxidized surface on the nitrided outside of the blade.

10. That improvement in making steel propeller blades for aircraft which comprises nitriding the outer surface of the blade by subjecting it to heat and a suitable gas, lowering the nitriding temperature of the blade after the blade has been nitrided, stabilizing the temperature at substantially 585 to 605° F. in the presence of gas for approximately 15 minutes, discontinuing the flow of gas to the blades, forcing air around the blades to displace the gas until the gas percentage has been reduced to approximately 20% while said temperature is maintained, and then forcing air under a higher pressure around the blades, to produce a substantially non-reflecting oxidized surface on the nitrided outside of the blade.

11. That improvement in making steel propeller blades for aircraft which comprises nitriding the outer surface of the blade by subjecting it to heat and a suitable gas, lowering the nitriding temperature of the blade after the blade has been nitrided, stabilizing the temperature at substantially 585 to 605° F. in the presence of gas for approximately 15 minutes, discontinuing the flow of gas, forcing air around the blades until the gas percentage is approximately 20%, while said temperature is maintained, and then forcing air under a higher pressure around the blades for a period of approximately 10 minutes, to produce a substantially non-reflecting oxide surface of deep blue color on the nitrided outside of the blade.

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