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METHOD OF UNITING NICKEL CHROME STEEL TURBINE BLADES

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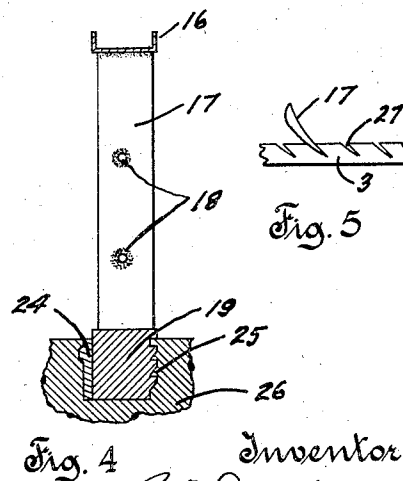
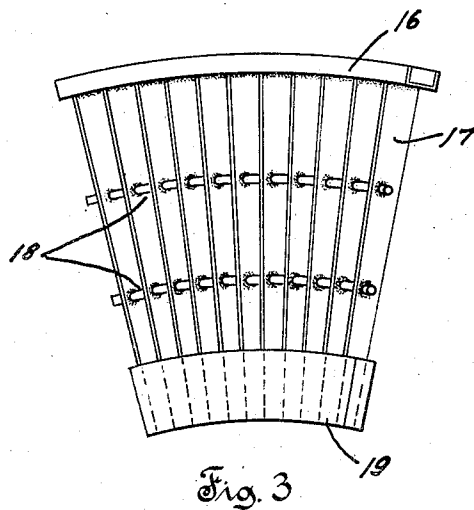
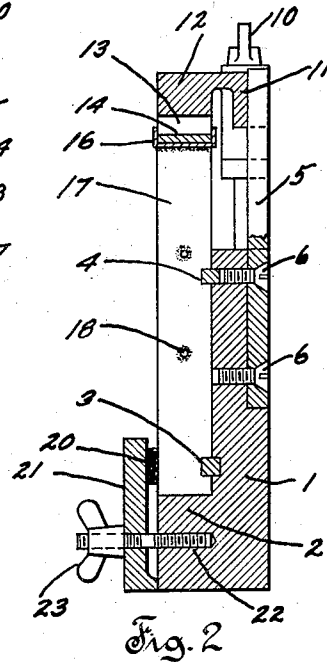
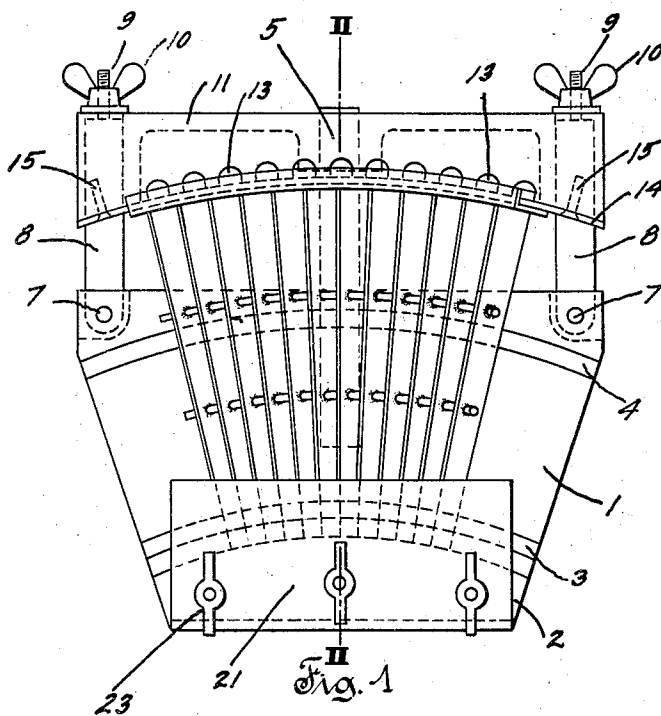


Fig.

Fig. 4

Fig. 3

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METHOD OF UNITING NICKEL CHROME
STEEL TURBINE BLADES

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4 Claims. (Cl. 29—156.8)

This invention relates generally to the art of manufacturing steam turbine blade segments or the like and more particularly to a method of uniting nickel chrome steel turbine blades to form a blade segment.

Processes heretofore successfully practiced in uniting steam turbine blades of copper nickel composition or of similar material have been found to be quite inadequate when followed in attempting to unite blades of stainless nickel chrome steel. Such alloys as silver solder which are ordinarily utilized for the purpose of uniting blades do not adhere readily to nickel chrome steel. Further, it has been found that the strength of nickel chrome steel may be seriously impaired by reason of grain growth in the steel if it is heated, during the uniting process, materially above the minimum temperature at which union with the alloy may be effected.

It is an object of the present invention to provide a method of uniting an alloy to a nickel chrome steel turbine blade securely and without detrimentally affecting the internal structure of the nickel chrome steel.

According to the present invention, a nickel chrome steel turbine blade element is united to an alloy element, as, for example, silver solder, by first electroplating the nickel chrome steel blade with silver, then heating one of the elements to a temperature which is not materially higher than that which will cause the silver plating to fuse and not so high as that which might cause grain growth in the steel, and then bringing the elements together to join them.

Referring to the drawing:

Fig. 1 is a plan view of a blade spacing and angling jig utilized in manufacturing turbine blade segments.

Fig. 2 is a central vertical sectional view of the showing in Fig. 1, taken on line II—II thereof.

Fig. 3 is a view showing in elevation a completed blade segment.

Fig. 4 is a longitudinal section of a blade segment together with a portion of a blade segment supporting element.

Fig. 5 is an elevation of one of the blade spacing and angling strips with a blade positioned in one of the notches provided therein.

This invention contemplates the use of nickel chrome steel, stainless steel, as a material from which the blades may be made. This steel is very tough and is especially suitable for turbine blade construction. In order, however, to produce a more effective and firmer union between the blades and the adjacent portions of the co-

operating shroud, lacing wire and foundation segments than has heretofore been possible, this invention contemplates plating of the nickel chrome blades with a suitable metal. Silver has been found to be a suitable plating metal for this purpose. Since the art of electroplating is well developed no further disclosure of this feature of the invention, is necessary, as any of the well known electroplating methods may be used in carrying out this step of this invention.

According to this invention after the blades have been electroplated with silver, they are arranged and held in segmental formation in a blade spacing and angling jig which will later be described. A shroud segment is then attached to corresponding ends of the blades by fusion of metal, as for instance by brazing. The brazing material may be silver solder which fuses at a temperature considerably below 1760° Fahrenheit, the melting point of silver. It has been observed that when the nickel chrome steel of which the blades are made is heated above 1700° F., grain growth may occur therein. This change of structure of the blade material greatly affects the strength of the blades, making the same much weaker than before the heat treatment. To avoid this condition, the operator doing the brazing observes the action of the flame used in brazing the silver solder against the blades and when the silver plating begins to vanish by fusion he is aware that the flame is of such a high temperature that the further use of the flame will result in great injury to the blades, and that he should therefore adjust the flame to a safe working temperature. This is one of the advantages of the step of silver plating the nickel chrome steel blades.

If relatively long blades are being formed into blade segments, the step of providing lacing wire to the blades to join them intermediate their lengths by fusion of metals such as the silver soldering described above, may also be resorted to.

If the nickel chrome blades are not coated with a metal, soldering of the shroud or lacing wire thereto effects an insecure union not having the firmness of the unions contemplated for the blade segments of this invention. In order to provide nickel chrome blades with a metal coating, applicant has dipped them in a hot bath of molten silver solder, a step referred to later in this specification. This dipping, aside from the fact that an oxide was found to have formed on the nickel chrome blades, has the other disadvantage, namely, that many blades become cracked because of

the high temperature of the bath in which the blades were dipped for coating purposes, and thus had their strength impaired, an impairment of the strength of the nickel chrome blades just as undesirable as that due to grain growth therein.

The blades now firmly connected and assembled by the end shroud and the intermediate lacing wires, are next subjected to the step of casting on a foundation segment. This step may be carried out by an apparatus such as disclosed in Patent No. 1,620,974 to Klenk, dated March 15, 1927. Although the specific apparatus for carrying out this step is not material as far as the present invention is concerned, the specific character of the metal of which the foundation segment is made is important. When using steel for casting in nickel chrome steel blades it was found to be difficult to machine the steel foundation because a very tough and hard crust appears to form thereon. A composition of metal consisting of nickel and copper has been found to be very satisfactory as a foundation segment and it has practically the same co-efficient of expansion as steel. While the nickel copper foundation was found to be more suitable than a foundation of steel as far as machining properties were concerned, it had the objectionable characteristic of having blow holes formed therein. When the nickel chrome blades are, however, electroplated as stated above with silver and thus have a silver coating on the root portion of each blade, the formation of blow holes in the foundation segment is practically eliminated. In dipping as suggested in applicant's prior Patent No. 1,641,745, nickel chrome blades, preliminarily heated to a temperature of approximately 1200° F., in a hot bath of molten silver solder at the required temperature of approximately 1500° F., the surfaces of the blades so treated were found to become coated with an oxide. Since the temperature of the molten nickel copper alloy which forms on cooling the preferred foundation segment of this invention, is as high as the above described dipping temperature, it may be that an oxide similarly tends to form on the root portion of the blades in casting a nickel copper foundation segment to the blades resulting in the formation of blow holes and pores in the foundation segments. But electroplating the blades with silver at room temperatures it seems precludes the formation of an oxide on the blade roots during the casting in process and consequently the objectionable blow holes in the foundation segments are found to be almost entirely eliminated. The metal must of course be poured at the proper temperature and the mold must be dry and free from moisture. This is another advantage of silver plating the nickel chrome steel blades.

The improved blade spacing and angling jig, already referred to, will now be described in detail. Referring to Figs. 1 and 2 it will be seen that the jig consists of two frame portions, 1 and 11 cast of a suitable metal. The cooperating jig frame 11 is slidably associated with the main jig frame 1 by being provided with a rectangular slot which receives the rectangular bar 5 secured to the mid portion of the base of frame 1 by screws 6-8. Frame 1 is provided with arc shaped recesses to receive arc shaped and notched strips 3 and 4. The strips are so constructed and arranged in the frame 1 that when the proper edges of the blades are positioned in the notches in the strips, the opposite edges of the blades will be parallel to the base of the frame 1 and will be disposed about as high as the top of the arc

shaped stop portions 2 and 12 of the frames 1 and 11 respectively. The arcs of these stop portions are concentric with the recesses in which strips 3 and 4 are received. The arc shaped stop portion 2 of the main jig frame is provided with a plurality of threaded bores for receiving studs 22 on which a clamping plate 21 is slipped for the purpose of adjustably pressing the root ends of the blades when positioned in the jig against the strip 3, by turning the wing nuts 23 on the studs 22. In order to avoid damaging the blades it is well to place a strip of asbestos 20 between the clamping plate 21 and the adjacent edges of the blades.

The cooperating jig frame 11 is slidably removable from the main frame 1 by reason of the bar 5 already described. In order to hold the frame 11 in a desired position with respect to the frame 1 or on the bar 5, the frame 1 is provided with transversely directed pins 7 which form the axes of links 8 having at their other ends threaded tenons which receive wing nuts 10. These nuts engage the outer or straight portion of the frame 11. The inner edge of frame 11 is arc shaped and a plurality of holes 13 are provided to decrease the arc surface of this edge for purposes of heat dissipation, during the brazing operation. A metal strip 14 is secured against this edge of the frame 11 by means of screws 15. The frame 11 has an inner outline as shown by the dotted lines in Fig. 1 for the purpose of reduced cost and weight of the jig.

The operation of the device is as follows: The clamping plate 21 is first removed and the frame member 11 sufficiently withdrawn to enable the positioning of the previously silver plated blades 17 in the notches 27 in the strips 3 and 4. The clamping plate 21 is then applied to the frame 1 so as to press slightly against the blades. The frame 11 carrying a shroud ring segment 16 is then slid closer to frame 1 by operating wing nuts 10 until the root ends of the blades uniformly bear against the stop portion 2 and the other end of the blades uniformly bear against the proper portions of the shroud 16 as correctly determined by the notched strip 4. The notched strip 4 used for spacing and angling the blades at the shroud end thereof is similar to the strip 3 at the root end of the blades. The advantage in using the strip 4 resides in the fact that a plain shroud may be used instead of one that has been provided with pressed out portions that conform to the shape and desired angling and spacing of the blades in which the shroud end of the blades were formerly held. For the shroud when provided with the necessary depressed portions is strained and the presence of the strain is later found to be detrimental and injurious to the shroud when heat is supplied thereto to unite the blades and shroud by fusion of metals as for instance by silver soldering.

Lacing wires are then laid in notches in the edges of the blades or pushed through openings in the blades as shown. The blades are then brazed or soldered as by silver soldering to the shroud and lacing wire. The uniform fillets now obtained in brazing or soldering the lacing wire to nickel chrome steel blades after they have been silver plated according to this invention are illustrated by the stippled areas surrounding the lacing wire in Figs. 2, 3 and 4. After the shroud has been soldered to the blades the blade segment is removed from the jig by first removing the clamping plate 21 and then withdrawing frame 11 from its engagement with the shroud 16.

A foundation segment is then cast on the root end of the blades by using any suitable apparatus as for instance that disclosed in the patent to Klenk No. 1,620,974 already referred to. A com-

5 position metal consisting of nickel and copper is preferable to steel as the foundation metal, because it is more easily machined. The specific machining of the foundation may take the form shown by 25 in Fig. 4 to cooperate with similar
10 machining in the final supporting element 26. After these machined portions of the foundation segment and supporting element have been brought into engagement, calking strips 24 may
15 be used to hold the assembled blade segments in proper position.

It should be understood that it is not desired to limit the invention to the exact steps of the process and to the exact details of construction and operation of the apparatus herein shown and described, for various modifications within the scope
20 of the claims may occur to persons skilled in the art.

It is claimed and desired to secure by Letters Patent:

25 1. The method of making a steam turbine blade segment, comprising shaping a plurality of turbine blades from nickel chrome steel, electroplating said blades with silver, arranging said plated blades in position to constitute a segment
30 of turbine blading, disposing a shroud ring segment in contact with the ends of said blades, heating the contacting end of each blade and the adjoining shroud ring portion to a temperature

not materially greater than that at which the silver plating on the blade end fuses, and applying silver solder to said heated blade end and said shroud ring portion to join them.

2. The method of uniting a nickel chrome steel 5 turbine blade element to an alloy element, comprising electroplating said blade with silver, heating one of said elements to a temperature above the melting point of the silver plating but below that which might cause grain growth in said
10 nickel chrome steel blade, and then bringing said blade and said alloy element into close contact to join them.

3. The method of uniting a nickel chrome steel turbine blade to an alloy, comprising electroplat- 15 ing said blade with silver, fusing said alloy, and casting said fused alloy on to said plated blade at a temperature above the melting point of the silver plating but below that at which grain growth might occur in the nickel chrome steel
20 blade.

4. The method of joining a cooperating element to a nickel chrome steel turbine blade, comprising electroplating said blade with silver, applying
25 said cooperating element to said blade, heating said blade at the point of juncture with said cooperating element to a temperature not materially greater than that at which said silver plating begins to fuse, and then applying silver solder
30 to said heated point of juncture to unite said cooperating element to said nickel chrome steel blade.

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