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ANNEALING FURNACE

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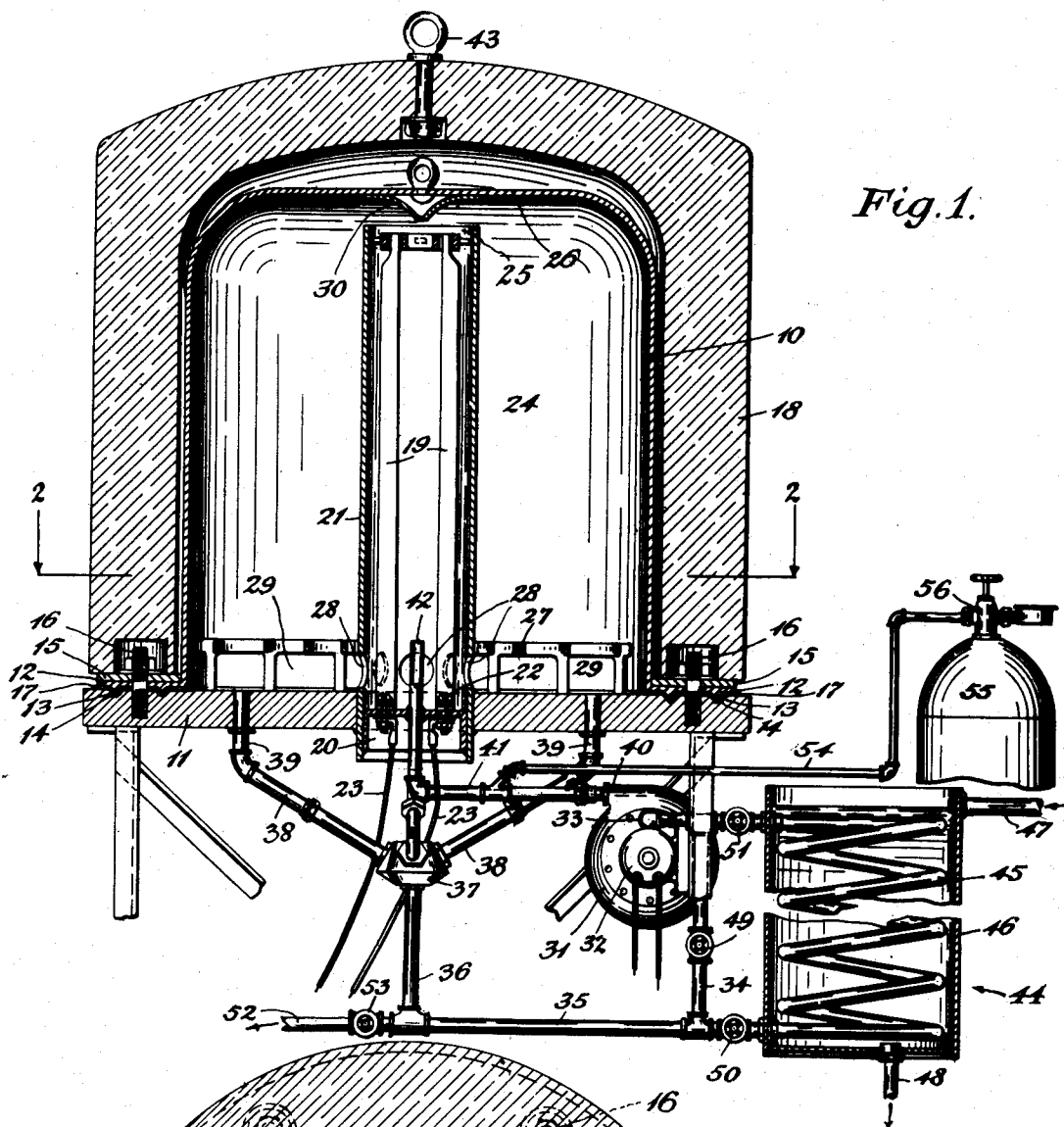


Fig. 1.

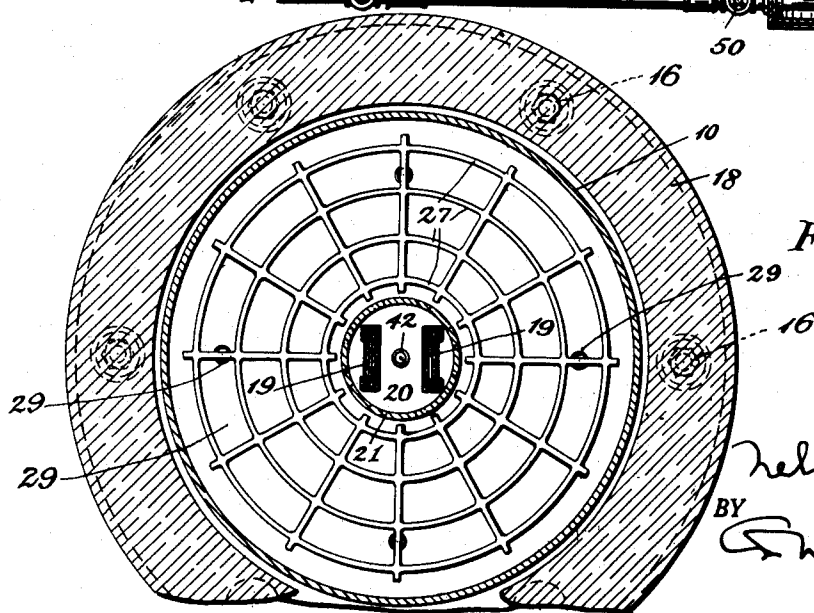


Fig. 2.

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ANNEALING FURNACE

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This invention relates to electric furnaces and the method of operating the same.

In the art of annealing material, particularly wire, it is extremely important, especially where the wire is to be again drawn after annealing, that the surface of the wire be substantially free from oxides. Heretofore, great difficulty was encountered in this connection, for the oxides on the surface of the wire being extremely abrasive in character, the wire could not be redrawn without seriously wearing the drawing dies and requiring frequent substitution thereof. In annealing other materials, it is also important, for one reason or another, to prevent oxides from forming on the surface of the material.

An object of the present invention is to provide an electric furnace and apparatus therefor whereby oxidization is reduced to a minimum heretofore unobtainable. This is accomplished by closely controlling the composition of a non-oxidizing atmosphere within the furnace by preventing atmospheric air from entering the furnace and thereby contaminating non-oxidizing atmosphere within the furnace, and by speeding up the time required for cooling the annealed material and thereby reducing the time available for oxides to form on the surface of the material.

Heretofore, it was suggested to heat the contents within the furnace by radiation alone or by radiation and convection of the heat developed by a resistance element or the like, but in such cases the amount of heat applied to various parts of the material under treatment would not be equal, with the result that those parts in closer proximity to the source of heat would be brought to heat sooner than other parts, would get hotter, and would remain at the desired temperature longer than other parts, resulting in an unevenness of treatment.

This difficulty is avoided, according to the present invention, by heating the material solely by convection and causing the atmosphere within the furnace to circulate through the material being treated. When the material being treated is wire, especially fine wire, this heated circulating atmosphere passes in and out between the strands of wire and heats the same substantially uniformly, and hence all parts of the same roll or bundle of wire will receive the same treatment and accordingly will have a more uniform tensile strength and constant modulus of elasticity throughout its length.

This is accomplished in the form of the invention shown herein, by encircling, the heating elements of the furnace so as to shield the material

being treated against receiving heat from the resistance elements by radiation, and this shield preferably forms a stack or chimney in which the atmosphere within the furnace circulates and becomes heated in its circulation and from which it is directed over the material being treated. In order to increase the speed of circulation where this is desirable, the present invention provides a blower or impeller, the outlet side of which is connected to a point within the stack containing the heating elements and the inlet side of which is located below the material being treated.

In order to facilitate the rapid cooling and hence decrease the opportunity for oxidization during the cooling operation, the present invention provides means for circulating the atmosphere of the furnace through a cooling medium, in addition to permitting the retaining wall to be removed without permitting atmospheric air to reach the interior of the furnace.

Other features and advantages will herein-after appear.

In the accompanying drawing showing one form of this invention, that at present preferred—

Figure 1 is a vertical section of an annealing furnace embodying this invention and showing the means for controlling the atmosphere within the furnace.

Fig. 2 is a horizontal section of the furnace taken on the line 2—2 Fig. 1.

Referring more particularly to the drawing, the furnace embodying my invention comprises preferably a cylindrical metallic shell 10 adapted to rest on a base 11. As shown, the shell has a horizontal flange 12 provided with annular V-shaped ridges 13 adapted to fit similar ridges 14 on the base 11. An annular plate 15 is adapted to be placed over the flange 12 and is bolted down to the base 11 by bolts 16 after a gasket 17 is interposed between the annular flange 12 and the base 11, so as to make the connection between the shell and the base gas-tight. The shell is preferably surrounded by a cylindrical furnace casing 18 of suitable refractory and heat insulating material so that during the application of heat to the material being annealed the loss of heat is avoided.

The heating elements 19 may be of any desired type or kind and preferably are elongated so as to extend substantially the full height of the chamber within the container or shell 10. The heating elements are secured at their lower ends on an inverted cup 20 fitted within a tube 21 passing through a hole in the base 11 of the furnace. This tube 21 is preferably welded to the base so

as to form a gas-tight connection, and, further, the inverted cup 20 supporting the heating elements 19 is preferably welded to the tube 21 for the same purpose. The glowbars are secured to the inverted cup 20 by bolts 22 which are insulated from the cup 20 and separately connected to current supply wires 23.

The tube 21 is centrally located in the furnace chamber 24 within the shell 10 and, according to the present invention, has its upper end 25 extending close to the top 26 of the shell 10 so as to completely encircle and enclose the glowbars 19 and prevent radiation of the heat from the glowbars directly to the material under treatment in the furnace chamber 24. The base 11 of the furnace is provided with a grating 27 of suitable grill work so as to form a support for the material above the base 11 and, at a point between the grating 27 and the base 11, the tube is provided with apertures 28.

Hence, when the resistance elements 19 generate heat, the atmosphere within the tube 21 is heated and rises, passing out of the open end 25 of the tube and down around the outside of the tube 21 over and between the material supported on the grating 27, thence down into the chamber 29 under the grating 27 and through the holes 28 into the tube 21 back up through the tube where it is again heated by the resistance elements 19. In this way, the tube 21, which, if desired, may be made of refractory material, constitutes a stack or chimney in which the atmosphere in the furnace is heated and rises. To facilitate the distribution of the stream of gas rising within the tube 21 to all parts of the chamber 24, the top 26 of the shell 10 may be provided with a deflector 30.

For some purposes, it is sufficient to depend upon this circulation of the atmosphere within the furnace. However, in other cases where it is desired to more quickly bring the material being treated up to heat, the present invention provides means for artificially circulating the atmosphere through the furnace.

In the form of the invention herein shown, for accomplishing this there is provided a blower or impeller 31 which may be driven by a motor 32. The inlet 33 of the blower 31 is connected as shown by a pipe 34, 35, 36, multiple connection 37 and pipes 38 to pipes 39 which pass through the base 11 of the furnace and are preferably welded thereto. These pipes 39 accordingly will draw in the gas forming the atmosphere of the chamber 29 under the grating 27. The outlet 40 of the pump 31 is connected by a pipe 41 to a pipe 42 which passes upwardly through the inverted cup 20 carrying the heating elements 19 and has its upper end disposed within the tube 21 above the level of the holes 28. Hence, when the motor is operated and certain valves hereinafter referred to are opened, the atmosphere within the chamber 24 of the furnace is caused to circulate, the stream of gas rising through the tube 21 and descending on the outside of the tube and over the work passing through the piping 34 to 39 inclusive above described, blower 31, and out through the pipe 42 into the interior of the tube 21 and into contact with the heating elements 19, thus augmenting the natural circulation resulting from the use of the tube 21.

Heretofore, when the work had been brought up to heat and there maintained for a desired given length of time, it was customary to allow the work to naturally cool off. This in some cases was assisted by the removal of the furnace casing 18,

and in the form of the invention shown herein, this is also provided for, the casing 18 having an eye 43 by means of which it may be lifted and set aside while the container or shell 10 is allowed to remain on the base 11.

Notwithstanding the fact that the removal of the furnace casing allowed the container to cool off more rapidly, the operation of cooling off the work required a relatively long time, thus keeping the furnace idle and unproductive for heating purposes and allowing more time for any free oxygen in the atmosphere of the chamber 24 to collect and form a coating on the work.

Accordingly, it is an object of this invention to further accelerate cooling of the work to a temperature at which it may be removed from the furnace without danger of becoming oxidized.

To this end, the present invention provides a gas cooling device 44 through which the gas forming the atmosphere of the furnace may be shunted in the course of its being drawn from and blown into the container 10 by the blower 31.

In the form herein shown, which is more or less diagrammatic, the cooling device includes a coiled pipe 45 connected to the pipe 35 leading to the pipes 39 through which the gas is drawn from the chamber 29 under the work. At its other end it is connected to an inlet 33 of the blower 31. The cooling pipe 45 may be brought in contact with any cooling medium, but, as shown, it is contained in a tank 46 having a water inlet 47 and an outlet 48.

After the work has been annealed and it is desired to rapidly cool the same, a valve 49 in the pipe 34 is closed and valves 50 and 51 connecting the pipe 35 and inlet 33 respectively with the cooling coil 45 are opened, thus causing the gases forming the atmosphere of the container 10 to be drawn through the cooling pipe 45 by the blower 31 before it is blown into the interior of the tube 21 by the outlet pipe 42.

In heating the material, the hot non-oxidizing gases escaping from the opening 25 of the tube 21 and passing down through the work to heat the latter by convection naturally brings the upper parts of the work to heat more rapidly than the lower parts due to the heat absorbed as the gas descends and hence the upper part of the work is brought to heat sooner than the lower part of the work.

Since the heating is by convection, and therefore gradual, this is in many cases unobjectionable. However, according to the present invention, this inequality in heating is overcome by causing the gases cooled by the cooling device 44 to flow in the same direction as the heated gases with the result that the upper part of the work is cooled sooner than the lower part of the work, and accordingly, by regulating the rate of cooling so as to equal the rate of heating, all parts of the work may be caused to receive the same quantity of heat for the same length of time.

In annealing materials in such a way as to prevent oxidization, it is essential that the purity of the non-oxidized gas be maintained at a high standard and for this purpose the present invention provides means for feeding a supply of fresh non-oxidizing gas to the container 10 and the circulating system while the latter is in operation, or in preparation for the operation of the furnace, and also provides an outlet for the escape of a certain amount of gas during the annealing and cooling process if desired. For this purpose, the pipe 36 in the form shown, is connected to an outlet pipe 52 through valve 53 while the pipe 41

has connected to it a pipe 54 leading to a tank or reservoir 55 of non-oxidizing gas, the passage from which is controlled by a valve 56.

In preparing for the annealing operation after the work has been placed on the grate 27 and the container 10 has been clamped in place on the base 11 with the casing 18 surrounding the container and with all of the valves in the system, excepting the gas tank valve 56, open, the latter is opened to allow the non-oxidizing gas to flow into the container and through the regulating system expelling the atmospheric air through the outlet pipe 52 which, being at the lowest point in the system, permits the heavier atmospheric air to be expelled through the valve 53. At this time the blower 31 is operated for a short time to clear it of any atmospheric air that may be trapped therein. When the atmosphere within the casing 10 and circulating system is clear of atmospheric air, the valves 53 and 56 are closed. At the same time, the valves 50 and 51 leading to and from the cooling device 44 are closed and the current is turned on so as to cause the heating elements 19 to operate.

If the circulation of the gas within the furnace is in this particular case a natural circulation resulting from heating of the gas in the tube 21 and the cooling of it outside the tube 21, the valve 49 is closed so as to prevent circulation of the gases through the circulating system. If, however, the circulation is to be artificially augmented, the valve 49 is opened and the blower caused to operate. After the work has been heated to the desired degree, the circuit through the heating elements 19 is broken, the valve 49 closed, and the valves 50 and 51 opened, so as to cause the gases to be circulated through the cooling device 44.

Thus it will be seen that the furnace of the present invention provides very efficient means for obtaining a uniform heat on articles which are to be annealed, provides means for maintaining the atmosphere within the furnace free from oxidizing gases, also provides means for accelerating the work heating or the cooling operation, and particularly provides means to reduce very undesirable work oxidization to a minimum.

In its broader aspects, the invention is not to be limited to annealing, although its greatest application or use will no doubt be for this purpose; but, it should be understood that the present invention may be used, for example, to harden mushet steel, which is accomplished without immersion in an oil or water coolant, but is accomplished in practically the same manner as an annealing operation, for most other materials. Similarly, the furnace of the present invention may be used advantageously to variously heat treat divers materials in controlled atmospheres.

Variations and modifications may be made within the scope of this invention and portions of the improvements may be used without others.

Having thus described the invention, what is claimed as new and for which it is desired to obtain Letters Patent, is,—

1. In an annealing furnace, the combination of a gas-tight container and an electrical resistor supported therein substantially centrally thereof, of means for supporting work to be heated in the space between the resistor and the walls of the container; and means interposed between the work and the resistor and surrounding the latter to prevent the work being heated by radiation.

2. In an annealing furnace, the combination of a gas-tight container and an electrical resistor supported therein substantially centrally thereof, of means for supporting work to be heated in the space between the resistor and the walls of the container; and means interposed between the work and the resistor and surrounding the latter to prevent the work being heated by radiation, said means having openings at the top and bottom and causing the atmosphere within it and heated by the resistor to rise and escape through the upper opening to the space occupied by the work, descending through the work to heat the latter and reenter said means through the lower opening to be again heated by the resistor.

3. In an annealing furnace, the combination of a gas-tight container and an electrical resistor supported therein substantially centrally thereof, of means for supporting work to be heated in the space between the resistor and the walls of the container; and means interposed between the work and the resistor and surrounding the latter to prevent the work being heated by radiation, said means comprising a stack having upper and lower openings through which the atmosphere of the furnace may circulate to be heated and reheated.

4. In an annealing furnace, the combination of a gas-tight container and an electrical resistor supported therein substantially centrally thereof, of means for supporting work to be heated in the space between the resistor and the walls of the container; means interposed between the work and the resistor and surrounding the latter to prevent the work being heated by radiation, said means comprising a stack having upper and lower openings through which the atmosphere of the furnace may circulate to be heated and reheated; and means including a conduit leading from the exterior of the container and entering the stack above the lower opening for cooling the atmosphere to be circulated upwardly through the stack and downwardly through the work after the heating operation has been completed.

5. In an annealing furnace, the combination of a gas-tight container and an electrical resistor supported therein substantially centrally thereof, of means for supporting work to be heated in the space between the resistor and the walls of the container; means interposed between the work and the resistor and surrounding the latter to prevent the work being heated by radiation, a blower, and conduits leading from the container to the blower and from the blower back to the container for causing the atmosphere to be circulated in the container over the resistor and through the work to be heated.

6. In an annealing furnace, the combination of a gas-tight container and an electrical resistor supported therein substantially centrally thereof, of means for supporting work to be heated in the space between the resistor and the walls of the container; a tube interposed between the work and the resistor and surrounding the latter to prevent the work being heated by radiation, said tube having an opening at the top; a blower; and conduits leading from the container and from the blower back to the container and opening into the interior of the tube for causing the atmosphere to be circulated in the container upwardly over the resistor and downwardly through the work to be heated.

7. In an annealing furnace, the combination of a gas-tight container and an electrical resistor supported therein substantially centrally thereof,

of means for supporting work to be heated in the space between the resistor and the walls of the container; a tube interposed between the work and the resistor and surrounding the latter to prevent the work being heated by radiation, said tube having an opening at the top; a blower; and conduits leading from the container and from the blower back to the container and opening into the interior of the tube for causing the atmosphere to be circulated in the container upwardly over the resistor and downwardly through the work to be heated, said conduit leading from the container to the blower having an inlet opening under the work and in the space outside said tube.

8. In an annealing furnace, the combination of a gas-tight container and an electrical resistor supported therein substantially centrally thereof, of means for supporting work to be heated in the space between the resistor and the walls of the container; means interposed between the work and the resistor and surrounding the latter to prevent the work being heated by radiation, said means having openings at the top and bottom and causing the atmosphere within it and heated by the resistor to rise and escape through the upper opening to the space occupied by the work, descending through the work to heat the latter and reenter said means through the lower opening to be again heated by the resistor by natural circulation; and means including a blower and a conduit leading from the bottom of the space in which the work is adapted to be supported to the blower and a conduit from the blower to the container opening into the interior of said means surrounding the resistor to augment natural circulation of atmosphere in the container past the resistor and through the work.

9. In an annealing furnace, the combination of a gas-tight container and an electrical resistor supported therein substantially centrally thereof, of means for supporting work to be heated in the space between the resistor and the walls of the container; means interposed between the work and the resistor and surrounding the latter to prevent the work being heated by radiation, said means having openings at the top and bottom and causing the atmosphere within it and heated by the resistor to rise and escape through the upper opening to the space occupied by the work, descending through the work to heat the latter and reenter said means through the lower opening to be again heated by the resistor by natural circulation; means including a blower and a conduit leading from the bottom of the space in which the work is adapted to be supported to the blower and a conduit from the blower to the container opening into the interior of said means surrounding the resistor to augment natural circulation of atmosphere in the container past the resistor and through the work; a cooling device; and means for shunting the atmosphere impelled by the blower through the cooling device before it again enters the container to accelerate cooling of the work after the latter has been heated.

10. In an annealing furnace, the combination of a gas-tight container and an electrical resistor supported therein substantially centrally thereof, of means for supporting work to be heated in the space between the resistor and the walls of the container; means interposed between the work and the resistor and surrounding the latter to prevent the work being heated by radiation, said means having openings at the top and bottom and causing the atmosphere within it and heated by the resistor to rise and escape through the upper opening to the space occupied by the work, descending through the work to heat the latter and reenter said means through the lower opening to be again heated by the resistor by natural circulation; means including a blower and a conduit leading from the bottom of the space in which the work is adapted to be supported to the blower and a conduit from the blower to the container opening into the interior of said means surrounding the resistor to augment natural circulation of atmosphere in the container past the resistor and through the work; and means for supplying fresh gas to the container through said conduits.

11. In an annealing furnace, the combination of a gas-tight container and an electrical resistor supported therein substantially centrally thereof, of means for supporting work to be heated in the space between the resistor and the walls of the container; means interposed between the work and the resistor and surrounding the latter to prevent the work being heated by radiation, said means having openings at the top and bottom and causing the atmosphere within it and heated by the resistor to rise and escape through the upper opening to the space occupied by the work, descending through the work to heat the latter and reenter said means through the lower opening to be again heated by the resistor by natural circulation; means including a blower and a conduit leading from the bottom of the space in which the work is adapted to be supported to the blower and a conduit from the blower to the container opening into the interior of said means surrounding the resistor to augment natural circulation of atmosphere in the container past the resistor and through the work; a cooling device; means for shunting the atmosphere impelled by the blower through the cooling device before it again enters the container to accelerate cooling of the work after the latter has been heated; and means for supplying fresh gas to the container through said conduits during the cooling process as the gas in the container tends to decrease in volume as it cools.

12. An annealing furnace having a gas-tight container; work-supporting means therein; heating elements therein; and a centrally disposed stack of relatively small displacement enclosing said heating elements for positively forcing the atmosphere in the container to circulate over the heating elements and through the work to be heated.

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