This invention relates to a method and means for annealing material, and more particularly to the annealing of wire, cable and the like.

An object of the invention is to provide a simple and efficient method of and apparatus for annealing material and having it in a bright dry condition after the annealing process is completed.

In accordance with a preferred embodiment of the invention herein shown and described, the spool or coil of material to be annealed is placed in a closed induction furnace having steam or a non-oxidizing gas therein during the annealing period and having cooling water circulated there-through during the non-annealing period. The amount of current flowing through the primary or inducing windings of the furnace is automatically controlled by the weight of the wire or cable being annealed and the time of annealing is automatically controlled by time relays which start functioning when the spool or coil is placed in the furnace and the cover placed thereon.

The invention will be better understood by reference to the following detailed description and accompanying drawing of a preferred embodiment of the invention, wherein identical parts are indicated by the same reference numerals and in which:

Fig. 1 is a plan view of the annealing furnace with the cover removed;

Fig. 2 is a sectional elevational view of the annealing furnace with the cover in position, taken along the line 2—2 of Fig. 1, and

Fig. 3 is a schematic view of the electrical control system.

Referring to the drawing, the furnace 11 comprises a container 12 having a cover 13. The container and cover are preferably composed of a non-magnetic material having a high electrical resistance. When made of metal, as shown on the drawing, they may be lined with a heat insulating material (not shown) and will preferably have a strip 15 of non-magnetic material, the entire length of one side of the container and strips 16 and 17 of non-magnetic material in the cover 13 and the bottom of the container 12 to reduce eddy currents to a minimum. Rings 18 and 19 of insulating material are preferably employed around the top and bottom to reduce eddy currents and also to act as a container sealing means. Primary or inducing windings 14 are secured in the container 12.

The spool or coil of wire 20 to be annealed is placed on a platform 21 which is supported on four springs 22. A plunger 23, secured to the platform 21, is attached to and actuates an arm 24 of a rheostat 25 to different positions depending upon the weight of the coil 20 to be annealed. A series of pipes or coils 26 extends around the inside of the container 12 adjacent the walls of the container. An additional section of cooling pipes can be located within the spool or coil 20 and if desired the coil 14 may be constructed from hollow conductors through which the cooling water can be admitted during the non-annealing period. The cooling pipes or coils 26 are connected through the normally open valve 27 to a source of cooling water (not shown). Openings 28 in the sides of the container 12 are connected through a normally closed valve 29 to a source of steam or other inert gas (not shown). Openings 31 in the bottom of the container 12 are connected through a two way valve 30, which is normally open to the atmosphere, to means for producing a vacuum (not shown).

The armature of an electrical solenoid 32 is connected to the water valve 27 and the steam valve 29. The armature of a second solenoid 33 is connected to the vacuum valve 30. An electrical contact 34 is arranged to open when the cover 13 is removed and to close when the cover is placed in position. One side of the contact 34 is connected to one side of a source of current which has been indicated as a generator 35. The other side of the contact 34 is connected to a pilot light 60 to inform the operator when the annealing, cooling and breaking of the vacuum are completed and the cover 13 can be removed, and is also connected to one side of a motor 36. The motor 36 of a time relay 37 is connected from ground through the generator 35, the contact 34, to ground, and actuates commutators 38, 39 and 40. The primary coil 14 is connected from ground through the generator 35, the contact 34, pilot light 60, one of the resistance elements 41, 42, 43 and 44 of the rheostat 25 and the commutator 38, to ground.

The commutator 38 has a conducting segment 45, a non-conducting segment 46, and a brush 47. The commutator 39 has a conducting segment 48, a non-conducting segment 49 and a brush 50. The commutator 49 has two conducting segments 51 and 52 and two non-conducting segments 53 and 54 and a brush 55. The starting ends of the conducting segment 48 of commutator 39 and conducting segment 51 of commutator 40 are arranged to be in contact with their associated brushes 50 and 55 when the motor 36 is in its starting position. The commutator 38 is arranged so that the other end of the conducting segment 51 of commutator 40 leaves the brush 55 as the beginning of the conducting segment 45 of the
commutator 38 makes contact with its associated brush 47. The conducting segment 52 of the commutator 40 is arranged so that the brush 55 makes contact with the beginning of segment 52 at the same time that the conducting segment 45 of the commutator 38 leaves the brush 47. The solenoids 32 and 33 are connected from ground through the generator 35, contact 34, pilot light 60, and commutator 38 and 40, respectively, to ground.

The operation of the system is as follows: The spool or coil of wire 20 is placed on platform 21. The weight of the spool or coil 20 compresses the springs 22 and selects the proper resistance element 41 to 44 inclusive, to be connected in series with the primary coil 14. The cover 13 is placed in its proper position closing the contact 34. When the contact 34 is closed the circuit through the motor 36 of the time relay 37 is completed and the relay starts functioning, the motor 36 rotating in the direction indicated on Fig. 3. Contact 34 when closed also completes a circuit from ground through the generator 35, contact 34, pilot light 60, winding of solenoid 32, brush 55 and conducting segment 48 of commutator 39, to ground, thereby lighting the pilot light 60 and operating the solenoid 32. The operation of the solenoid 32 closes the water valve 27 and opens the steam valve 29, thereby disabling the cooling system and admitting super-heated steam or other inert gas to the furnace 11. At the same time another circuit is completed from ground through the generator 35, contact 34, pilot light 60, winding of solenoid 33, brush 55 and conducting segment 51 of commutator 40, to ground, thereby operating the solenoid 33. When the solenoid 33 operates, the valve 30 closes the air opening and connects the furnace to the source of vacuum to quietly withdraw any air from the furnace as the steam is being admitted through valve 29.

When the motor 36 of the time relay 37 has moved the commutator 40 to the point where the brush 55 breaks its contact with the conducting segment 51, the solenoid 33 is deenergized and a circuit is broken between the furnace and the cover 13. At the same time the brush 47 of commutator 38 makes contact with the conducting segment 45, completing the circuit from ground through generator 35, contact 34, pilot light 60, one of the resistances 41 to 44 inclusive, the primary coil 14, the inducing coil 14, the brush 47 and conducting segment 45 of the commutator 38, to ground.

Current flowing through the primary coil 14 induces a secondary or annealing current in the spool or coil 20 until the motor 36 of the time relay 37 has moved to the point where the brush 47 leaves the conducting segment 45 of the commutator 38, when the annealing current through the coil 14 is disconnected. At this point the brush 50 of the commutator 39 leaves the conducting segment 48 and deenergizes the solenoid 32 which closes the steam valve 29 and opens the cooling water valve 27. At the same time the brush 55 of commutator 40 makes contact with the beginning of the conducting segment 52 to reenergize the solenoid 33 which reconnects the vacuum source to the furnace. The partial vacuum within the furnace vaporizes and removes any moisture which would otherwise produce a liquid condensate as the spool or coil 20 is cooled.

After the coil 20 has cooled and the condensate is removed the brush 55 disconnects from the conducting segment 52 of the commutator 40, the pilot light 60 is extinguished, and the solenoid 33 is deenergized. This operates the valve 30 to break the vacuum in the furnace and to admit air. The cover 13 is then removed and the annealed spool or coil of wire 20 is withdrawn in a bright dry condition.

While a non-oxidizing gas is employed which will produce no liquid condensate in the furnace as the liquid cools the solenoid 33 and its associated commutator 40 may be omitted.

What is claimed is:

1. In a furnace for annealing material, a primary coil for inducing an annealing current in the material to be annealed, a support within the furnace for the material to be annealed, and means for automatically regulating the current through the primary coil in accordance with the weight of the material being annealed.

2. In an annealing apparatus, an induction furnace having a primary coil for inducing an annealing temperature in the product to be annealed, means for automatically regulating the current through the primary coil in accordance with the weight of the material being annealed, means for cooling said primary coil 14 after said furnace, and means actuated by said cover when placed in position over said furnace for connecting said primary coil with a current source and for stopping said cooling means.

3. In a furnace for annealing material, a primary coil for inducing an annealing current in the material to be annealed, a support within the furnace for the material to be annealed, means for automatically regulating the current through the primary coil in accordance with the weight of the material being annealed, means for cooling said furnace after the material has been annealed, means for introducing a non-oxidizing gas in said furnace and a time relay for controlling the intervals in which the annealing current and the cooling means are operative and for controlling the introduction of the non-oxidizing gas.

4. In a furnace for annealing material, a cover, a primary coil for inducing an annealing current in the material to be annealed, a support within the furnace for the material to be annealed, means for automatically regulating the current through the primary coil in accordance with the weight of the material being annealed, means for cooling said furnace during non-annealing periods, means for introducing a non-oxidizing gas into said furnace during the annealing period, and a time relay for connecting the annealing current, connecting said means for introducing the non-oxidizing gas and connecting said cooling means for predetermined periods of time.

5. In an annealing apparatus, an induction furnace having a primary coil for inducing an annealing temperature in the product to be annealed, means for cooling said furnace, means for producing a vacuum in said furnace, means for introducing a non-oxidizing gas in said furnace, a cover for said furnace, and time control means actuated by said cover when placed in position over said furnace for connecting the cooling means, the vacuum producing means, the annealing current and the non-oxidizing gas introducing means to said furnace for predetermined intervals.

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