

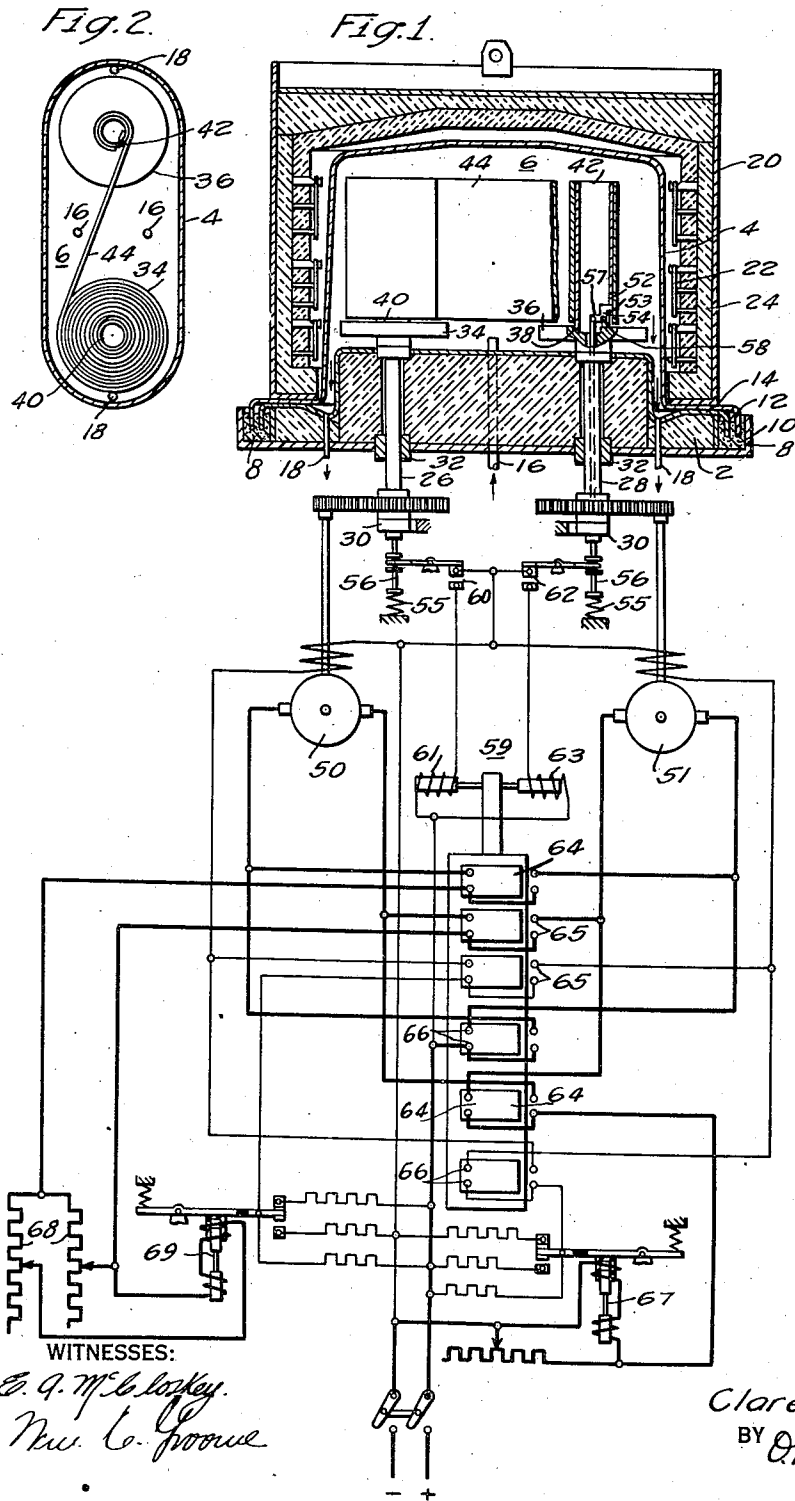
June 20, 1944.

C. LYNN

2,351,987

HEAT-TREATING

Filed Dec. 3, 1942



UNITED STATES PATENT OFFICE

2,351,987

HEAT-TREATING

Clarence Lynn, Pittsburgh, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application December 3, 1942, Serial No. 467,726

6 Claims. (Cl. 263—3)

This invention relates to the heat-treatment of material which is wound into coil form, and has for its main object a rapid end uniform heat-treating, more particularly bright annealing, of a coil of metal wire or strip by repeatedly unwinding and rewinding the coil during the heat-treatment.

A form of furnace in which the teachings of my invention may be carried out, to which form, however, I am not necessarily limited, comprises a base removably carrying an outer metal hood which cooperates with the base to provide a substantially gas-tight heat-treating chamber in which the coiled strip is completely enclosed. An insulated heating bell carrying any suitable heating means may be placed about the hood for heating the chamber. Rotatably mounted inside this chamber are a pair of reels or spools on one of which the coil of strip is initially placed. The coil is unwound from this reel onto the other reel and when the coil is thus substantially transferred to this other reel it is again unwound and rewound on the first reel. This process is repeated so that the strip passes to and fro between the reels whereby each element of the strip is repeatedly exposed in turn to the heat of the furnace without being shielded by other outer layers of the coil through which heat would have to pass for heating inner layers of the coil. Preferably the strip is moved back and forth at a substantially uniform linear speed so that the strip is evenly heated-up to annealing temperature.

The repeated windings and unwindings of the strip being heated reduce the time required to bring the coil of strip up to annealing temperature, and reduce temperature gradients through the coiled material so that a considerable saving in the time of annealing and an improvement in the quality of the annealed strip are obtained in comparison with prior strip-annealing furnaces.

Many other objects, features and innovations of my invention will be discernible from the following description thereof which is to be taken in connection with the accompanying drawing. In the drawing which schematically illustrates only a sufficient number of parts necessary for an understanding of my invention:

Fig. 1 is a view in vertical section, showing an annealing furnace embodying my invention, and further schematically showing a wiring diagram of a control means for controlling the

winding and unwinding of the strip by the reels; and

Fig. 2 is a horizontal section view, on a different scale and with parts omitted, of the heat-treating chamber of the furnace, for further illustrating the coil winding and unwinding reels.

While the teachings of my invention may be applied to the heat-treatment of any coiled metals, for example, wire or strip, in any suitable form of furnace, I illustrate, as a preferred form embodying my invention, a bell furnace which comprises a metal-jacketed base 2 adapted to cooperate with a removable metal hood 4 to provide a heat-treatment chamber 6 in which one or more coils of strip may be placed for heat-treatment, although the furnace is shown herein for simplicity as adapted to heat-treat a single coil.

The chamber 6 is preferably gas-tight and is gas-sealed by a gas-sealing means comprising a base-trough 8, around the periphery of the base 4, containing a gas-sealing medium 10, such as sand, into which a peripheral flange 12 depending from a skirt 14 of the hood 4, depends. Any desired controlled atmosphere may be continually conveyed into the heat-treatment chamber 6 through one or more gas-inlet pipes 16 passing through the base 2, near its center; and furnace atmosphere may be vented from the chamber through one or more gas-outlet pipes 18 at the ends of the chamber, for keeping the atmosphere about the strip clean and pure.

The heat-treatment chamber 6 may be raised to annealing temperature and maintained thereat for some time, if necessary, by any suitable heating means, but in the form of furnace herein described this means comprises an outer metal-jacketed heating bell 20 comprising electric heating means 22 carried by its heat-insulating and refractory walls 24; the bell being removably placeable on the horizontal skirt 14 of the hood 4 and being supported by the base 2.

Two spaced shafts 26 and 28 pass through the base 2, being rotatably supported in lower bearings 30 and upper gas-sealing bearings 32, these shafts being preferably hollow for this particular embodiment, for reasons which will later be apparent. Coiling-turntables 34 and 36 are secured for rotation respectively with the shafts 26 and 28. Each turntable is provided with a central non-circular mandrel-receiving indent which receives a mating protruding end 38 of a coil-winding mandrel. Such a mandrel 40 is provided for the turntable 34 and a similar

mandrel 42 is provided for the turntable 36. The mandrels may be of any suitable form having means for securing an end-edge of a strip thereto.

Assuming that a coil of strip 44 on the mandrel 40 is to be annealed, the outer free end-edge of the strip is secured to the mandrel 42 and while the heat-treating means or bell 20 is raising the temperature of the heat-treatment chamber 6, the shaft 26 is revolved in a direction to unwind the strip from the mandrel 40 and wind it as a coil on the mandrel 42. After the winding is substantially completed the shaft 26 is rotated to rewind the strip on the mandrel 40; and the transfer of the coil, by winding, from each mandrel to the other is repeated, during the time the temperature of the strip is being raised, as often as desired, but preferably the strip should make a few passes between the two mandrels during a heating-up treatment. During cooling of the strip, with the heating bell removed, the unwinding and rewinding of the strip can be continued if desired. Where soaking at a fixed temperature is necessary, the strip may obviously be caused to similarly travel back and forth between reels, or may be stationary.

The heating of stationary coiled strip from about room to annealing temperatures in conventional furnaces is commonly considered to require about an hour and a half per inch of radial thickness of the coil so that an eight inch thick coil, on this basis, requires about twelve hours to be brought up to annealing temperature. By causing the strip to be passed back and forth repeatedly and successively between the coil winding mandrels 40 and 42 this time is decreased considerably, to as little as four hours and less, as a particular but not limiting example, other conditions being the same. The strip need not be moved at a high rate of speed, and as little as 15 feet per minute and even less is satisfactory; although it is obvious that the higher the linear speed of the strip the more uniform will be the temperature throughout the coil unless the speed is so high that the strip-span does not have time to heat significantly. For the same size coils, the strip speed should be somewhat higher with thinner strip; but about four passes of the strip between mandrels are generally satisfactory for annealing although the number of passes can obviously be considerably more, and even less, dependent, to some degree, on the capacity of the strip to absorb heat and the tolerable temperature gradient through the coil.

Heating the strip in the manner described has the further advantage of more rapidly removing burnable or volatile substances from the surface of the strip.

The coil winding and unwinding operations may be carried out by hand or automatically by any suitable control means. When an automatic control means is provided it is also desirable to choose one which will move the strip at a substantially constant linear speed.

In Figure 1, a control means is shown which controls both the direction of rotation of the different shafts 26 and 28 and the linear speed of travel of the strip. This means comprises a direct-current dynamo-electric machine 50 geared to the shaft 26, and a similar dynamo-electric machine 51 geared to the shaft 28. When the shaft 26 is rotating in a direction to wind the strip on its mandrel 40 the machine 50 acts as a motor and the machine 51 as a braking generator; and conversely when the coil is being wound

on the mandrel 42 driven by the shaft 28, the machine 51 acts as a motor and the machine 50 as a braking generator.

The control means for selecting the function of the dynamo-electric machines and controlling them so that the linear speed of movement of the strip is substantially constant comprises limit switch means operable for interchanging the functions of the machines when the strip is substantially unwound from a mandrel. A specific form of such travel limit switch means is herein disclosed comprising a switch operating device associated with each mandrel. Each such device comprises a small slot 52 in the associated mandrel, in which an edge 53 protruding from a bell-crank 54, is urged or forced outwardly by a compression spring 55 acting upwardly through a rod 56, passing through the associated hollow driving shaft, the rod being pivoted to one end of an arm 57 of the bell-crank, the other end of the arm being pivoted as at 58. So long as there is strip around the mandrel, as shown at the right of Fig. 1, the protruding edge 53 on the bell-crank cannot pass beyond the slot 52. However, when the strip is substantially unwound so that the strip no longer obstructs movement of the bell-crank, the spring 55 will force the rod 56 upwardly, closing a pair of contacts which energizes a coil of a two position relay 59; a pair of contacts 60 and a coil 61 being controlled by the rod 56 associated with the mandrel 40 and machine 50, a pair of contacts 62 and a coil 63 being controlled by the rod 56 associated with the mandrel 42 and the machine 51.

When strip is being wound on a mandrel, the first turn or part turn of the strip pushes the bell-crank back against the action of the associated spring 55, opening the associated pair of contacts 60 or 62, thereby deenergizing the associated coil 61 or 63 of the relay 59. The relay 59 includes a plurality of bridging contact bars 64 movable to bridge the right hand (with respect to Fig. 1) pairs of contacts 65 when the coil 63 is energized, the bars 64 remaining in such position until the coil 61 is energized whereupon they are moved to the left, in the position shown, bridging the pairs of contacts 66.

In one position of the two position relay 59 the dynamo-electric machine 51 operates as a motor for winding the strip onto the mandrel 42, the speed of operation of the motor being controlled by a vibrating relay 67 and a plurality of current controlling resistors in the motor circuit; and the dynamo-electric machine 50 operates as a braking generator feeding a load 68, the generator power being controlled by a vibrating relay 69. In the other position of the two position relay 59 the functions of the dynamo-electric machines 50 and 51 are reversed, the machine 50 acting as a motor the power of which is controlled by the vibrating relay 67, and the machine 51 acting as a braking generator the power of which is controlled by the vibrating relay 69.

The motor-controlling vibrating relay 67 and the circuits controlled thereby cause the machine acting as a motor to deliver a substantially constant amount of power irrespective of the varying diameter of the coil of strip being wound thereby, and in the same way the generator-controlling vibrating relay 69 and associated circuits cause the braking power of the machine acting as a generator to be substantially constant irrespective of the varying diameter of the coil of strip on the unwinding mandrel to which it is mechanically coupled. Thus the tension on the

strip is controlled for causing a substantially constant linear speed of travel of the strip between the mandrels.

A control means of the type mentioned is more completely shown, described and claimed in the 5 W. H. Landerberger Patent No. 1,869,900 of August 2, 1932, assigned to the Westinghouse Electric & Manufacturing Company.

While I have described my invention as applied to a specific form of furnace, which I consider a desirable preferred form, it is obvious that the teachings of my invention are of considerably greater general application and may be applied to other forms of furnaces and with reels disposed other than vertically.

I claim as my invention:

1. Annealing equipment for annealing a coil of strip, comprising, in combination, a substantially enclosed chamber means, heating means for heating said chamber means, coil winding and unwinding means comprising a pair of rotatable means in spaced relation in said chamber means, said pair of rotatable means being subject to the heat in said chamber means, each of said rotatable means being of a size sufficient to carry a coil of material to be heat-treated in said chamber means, and tension control means associated with said coil winding and unwinding means for controlling the tension of the material being passed between said pair of rotatable means.

2. Means for annealing coiled strip, comprising the combination of substantially enclosed heat-treating chamber means for the strip, a pair of spaced rotatable means in said chamber means, adapted to have different end-edges of the strip respectively secured thereto, and means for causing rotation of said rotatable means in a manner to unwind strip coiled on a first of said rotatable means and wind it on the other of said rotatable means, the last said means including control means for causing the strip to move between said rotatable means at a substantially constant linear speed, whereby said strip will be more uniformly heat-treated.

3. For a furnace for annealing coiled strip, means comprising the combination of a heat-treating chamber for the strip, said chamber

having a base, a pair of spaced rotatable means in said chamber adapted to have different end-edges of the strip respectively secured thereto, and means for causing rotation of said rotatable means in a manner to unwind strip coiled on either of said rotatable means and wind it on the other of said rotatable means, the last said means comprising control means automatically operable when the strip is substantially unwound from either of said rotatable means to cause the strip to rewind thereon, whereby the strip is repeatedly passed back and forth between said pair of rotatable means during a heat-treatment in said chamber, the said control means including means for causing the strip to move at a substantially constant linear speed while passing between said rotatable means.

4. The structure of claim 3 characterized by the last said means including means for rotating said rotatable means in a manner for controlling the tension on the strip spanning said rotatable means.

5. A bell furnace for rapidly and uniformly annealing coiled strip, comprising, in combination, 25 a base, a removable metal hood associated with said base to provide an enclosed heat-treating chamber, a removable heating bell associated with said hood for causing said chamber to be heated, a pair of spaced shafts passing through said base, each of said shafts having a coiling-mandrel rotatable therewith, driving means for rotating said shaft whereby strip initially coiled on one of said coiling-mandrels will be automatically and successively passed between said coiling-mandrels, said driving means including control means for controlling the rotation of said coiling-mandrels in a manner for controlling the tension on the span of strip between the coiling-mandrels.

6. The method of annealing coiled strip inside of a gas-filled heating chamber which comprises repeatedly coiling and uncoiling the strip inside the chamber with the strip portions extending between the coiled and uncoiling parts of the strip moving at substantially a constant linear speed.

CLARENCE LYNN.