

W. E. MOORE.
ELECTRICALLY HEATED STRIP AND WIRE TEMPERING AND ANNEALING DEVICE.
APPLICATION FILED SEPT 23, 1919.

1,386,645.

Patented Aug. 9, 1921.

2 SHEETS—SHEET 1.

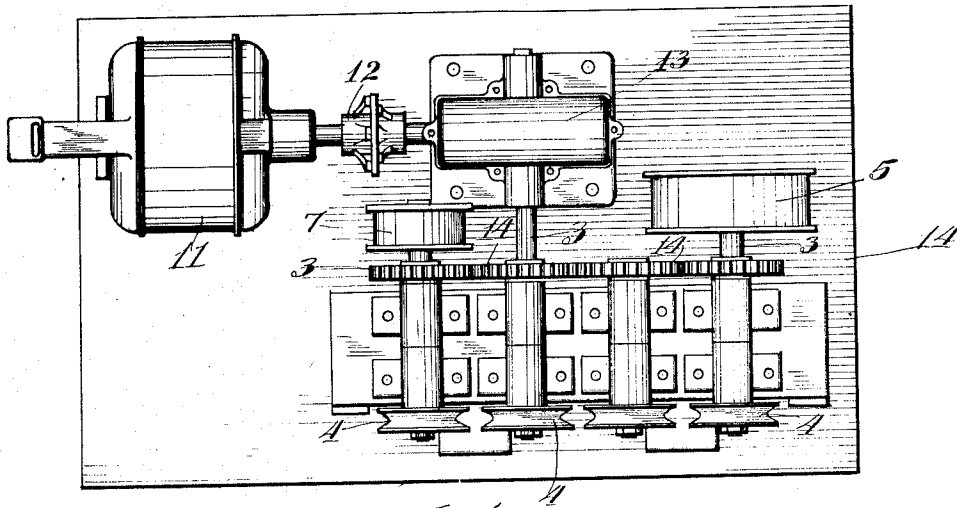


Fig 1

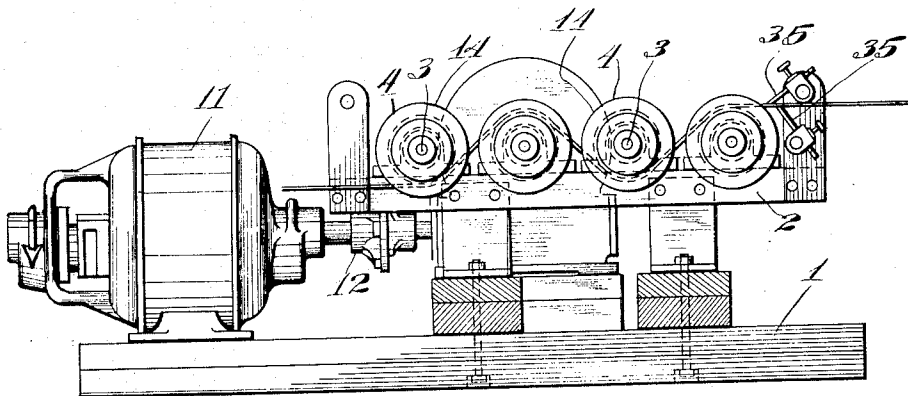


Fig 2

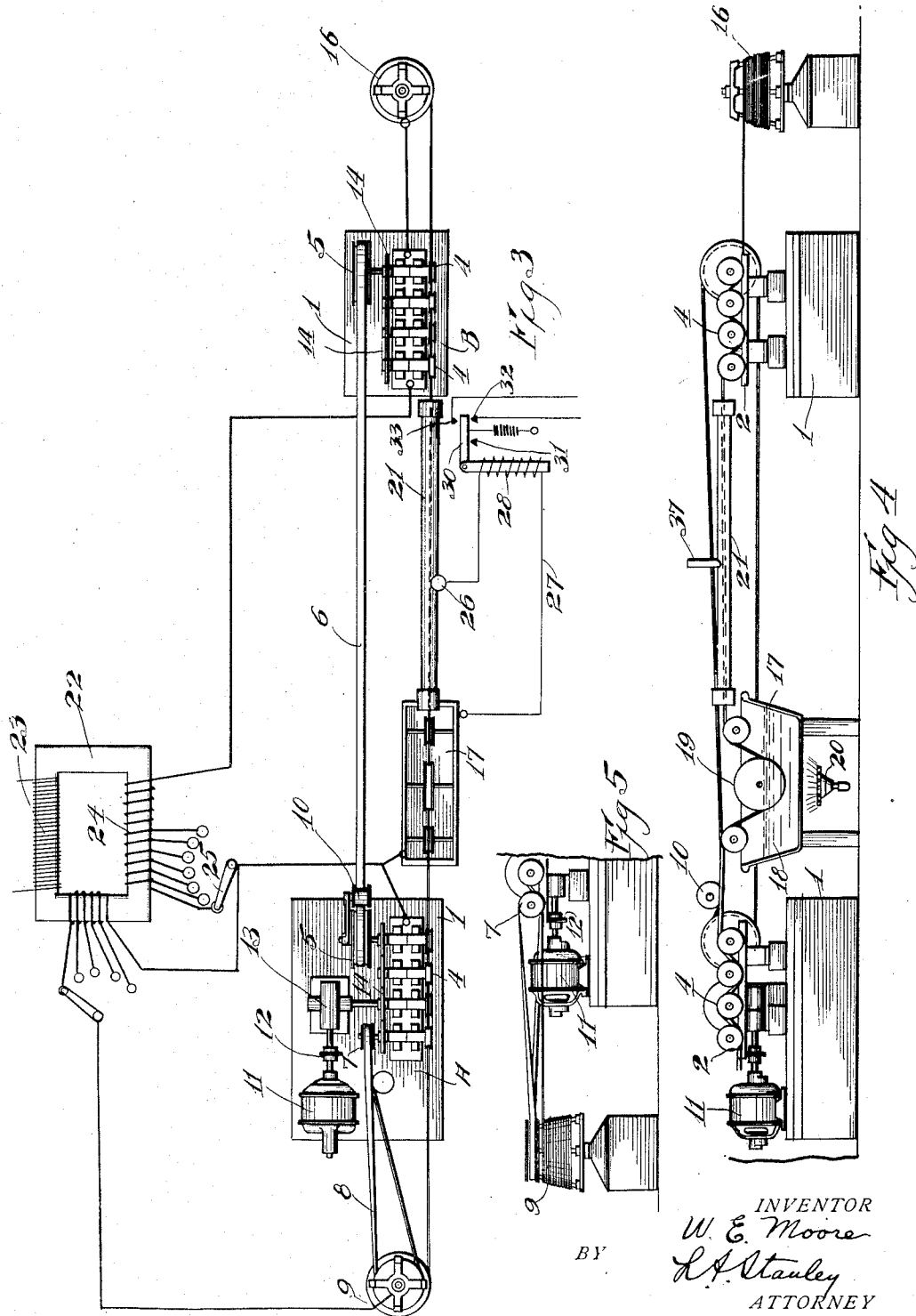
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UNITED STATES PATENT OFFICE.

WILLIAM E. MOORE, OF BEAVER FALLS, PENNSYLVANIA, ASSIGNOR TO THE PITTSBURGH ENGINEERING WORKS, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

ELECTRICALLY-HEATED STRIP AND WIRE TEMPERING AND ANNEALING DEVICE.

1,386,645.

Specification of Letters Patent.

Patented Aug. 9, 1921.

Application filed September 23, 1919. Serial No. 325,698.

To all whom it may concern:

Be it known that I, WILLIAM E. MOORE, a citizen of the United States, residing at Beaver Falls, county of Beaver, and State of Pennsylvania, have invented certain new and useful Improvements in Electrically-Heated Strip and Wire Tempering and Annealing Devices, of which the following is a specification.

My invention relates to electrical tempering and annealing devices, and it consists in the constructions, combinations and arrangements herein described and claimed.

An object of my invention is to provide a device by means of which the heating and subsequent cooling of the strip or wire may be more readily regulated and controlled than in fuel fired furnaces.

A further object is to provide an electrical machine by means of which a greater quantity of wire may be annealed or tempered in a given time than by the ordinary processes.

A further object is to provide a machine which will produce a more uniform product, with less oxidation.

Other objects and advantages will appear in the following specification, and the novel features of the invention will be particularly pointed out in the appended claims.

The machine which forms the subject of the present invention is designed for annealing or tempering wires and strips, as for instance, those used in wire rope, piano wire, strips, springs, safety razor blade steel, etc., and hereafter it will be understood that where the word "wire" is used, reference is made to wire sheet strip of any width, or strand.

My invention is illustrated in the accompanying drawings, forming part of this application, in which—

Figure 1 is a plan view of a portion of the device;

Fig. 2 is a side view of the parts shown in Fig. 1;

Fig. 3 is a plan view of the entire machine, and

Figs. 4 and 5 are side views of the parts shown in Fig. 3.

In carrying out my invention, I provide two machines A and B which are substantially alike. Each machine includes a base 1 upon which is mounted a frame 2 carrying

a series of transverse shafts 3. At one end of each shaft is a flanged roller 4. One shaft of each machine bears a drive pulley 5, the two pulleys 5 being connected together by a belt 6. The machine A is also provided with a pulley 7 which is connected by means of a belt 8 with a reel 9. The tension on the belt 6 is regulated by means of a weighted idler 10, which allows the belt to slip when the allowed tension on the wire is exceeded.

The device is driven by a variable speed motor 11, which is conveniently variable within the ratio of 4 to 1. A flexible coupling 12 which is preferably of an insulating type connects the motor 11 with a worm speed reducing gear shown diagrammatically at 13 on one of the shafts 3. Movement is imparted to the other shafts by gearing 14 so arranged as to drive adjacent shafts 3 in opposite directions. The machine B has a similar arrangement of driving gears 14.

The wire 15 is stored on a reel 16 and is fed to the flanged rollers of the machine B, these rollers constituting contact and tensioning devices, the wire passing under one wheel and over the adjacent one, as seen in the drawings, being thus frictionally gripped by the wheels. At the opposite end of the device the wire passes over and under the flanged rollers 3 of the machine A being wound on the reel 9. The machine B is adjusted to run slightly slower than the machine A to give proper tension to the section of wire 15 between the two machines.

At 17 I have shown a cooling or quenching tank, in which is a lead bath 18 having a roller 19 under which the wire 15 runs so as to submerge it in the bath. The lead bath may be kept at the proper temperature by any suitable means as by the burner 20.

Between the lead bath and the machine B is a tube 21 through which the wire 15 may pass, as explained hereinafter. This tube is preferably lined with some heat insulating material as asbestos, not shown.

A transformer 22, with its primary coil 23 receiving high tension power delivers low tension power to its secondary 24, which is adjustable in voltage by a dial switch 25, one end of the secondary being connected to the metal portions of the machine B while the other is connected to the machine A.

From the foregoing description of the

various parts of the device, the operation thereof may be readily understood. The wire is drawn forward and the portion between the machine A and B is heated by the electric current. It is quite desirable to maintain the temperature of wire between machine B and quenching tank 17 or quenching wheels or rollers of the machine A at just the right temperature. Any excessive temperature tends to coarsen the grain and weaken the wire, while insufficient temperature does not give the proper tempering effect to the wires. I, therefore, prefer to maintain this temperature constant by means of an automatic regulator, operating by the variation of temperature in the wire to either adjust the speed of wire travel between the machines and, therefore, its temperature, or adjust the heating transformer voltage and, therefore, the temperature of the wire.

This may be done by any of the well known temperature indicating means as by a suitable thermostat or thermocouple adjacent to the wire, or for instance, by means of an expansion wire, which is adjacent to and heated by radiations from the wire being heated, and arranged to operate through well-known electro-magnetic relays and switches to the switch voltage taps on the transformer, or to adjust the speed of driving motor 11 by well-known means, as by varying its field strength.

In some cases, I prefer to use a temperature indicating device, which is governed by the resistance of the wire, which ordinarily increases with the temperature. Such device may consist of a voltage regulator, as for instance the well-known "Tirel" vibrating voltage regulator, ordinarily used to regulate the voltage on electric generator fields. In this case the controlling coil of the "Tirel" would be connected to bridge a suitable length of the wire being heated near the hottest portion of its length, as for instance by a contact making brush or roller 26 and a connection 27 from lead tank 12, as shown in Fig. 3. These connections supply to the coil or solenoid 28 a voltage that varies as the temperature of the wire is varied, thus causing the plunger 29 to move the rocking beam 30 on its pivot 31 and making contact through 32 or 33 leading through suitable relays to the means for adjusting the field strength of the variable speed motor to increase or decrease the speed of the wire in transit through the heating circuit, as may be required to maintain the proper temperature.

Heretofore, in tempering wire, which process is sometimes known as "patenting," the wire was heated by being drawn through perforations in a heated refractory arch of a long fuel fired furnace, generally 40 feet in length, the purpose of the refractory arch,

through perforations in which the wire is drawn, being to save the wire burning due to the direct contact with the flame. This usually results in a very slow travel of the wire and a protracted period of heating, during which the wire badly scales, generally 4 to 10%.

The wire as it leaves the "patenting" furnace, through which it has been drawn at an adjustable speed to have it leave the furnace at near the correct temperature, is then generally cooled by contact with the atmosphere or by an air blast, requiring a still further length of travel, during which the wire is further oxidized.

With the old fashioned fuel fired "patenting" furnaces, oxidation is quite objectionable and it is difficult to attain the correct heat in the wire. The tempering effect is never maintained at a maximum, as the wire is quenched (or cooled) too slowly from the upper critical temperature to the lower critical temperature, and is thereafter cooled too rapidly to leave it in the best annealed condition.

My invention provides electric means of continuously heating and quenching the wire and by which the wire may be quite rapidly heated, so as to allow a high speed of transit through the machine and only a short length and period of exposure to oxidation during the heating and quenching processes. As the granular structure of the wire is greatly improved by rapid reduction of temperature between the upper and lower critical temperatures, it is quite desirable that the temperature reduction, whether by means of contact with cooling rollers, lead bath or otherwise, should be as rapid as possible. It is also equally important, after the lower quenching or critical temperature has been attained, that the wire should be cooled as slowly as possible to eliminate strains and unnecessary hardness, which interferes with the later operations in the wire mill.

I have, therefore, arranged to quench or cool the wire by means of the bath 18, maintained at the proper critical temperature, by external means, as for instance, by oil, fire, or other mediums capable of proper temperature control. At other times, I prefer to do the quenching on the flanged contact wheels or rollers 4, cooled merely by contact, the rollers in turn being maintained at proper temperature by oil or water sprays or other well-known means.

The wire having been heated to a temperature above its upper critical temperature, by the time it reaches the first grooved contact wheel or roller of the machine A, is there rapidly chilled by coming into contact with said roller, and still further chilled by passing the successive rollers. When the lead bath is used it is kept at a suitable tem-

perature by electrical or combustion heat or otherwise, for quenching the wire at a temperature that is somewhat below the critical temperature of the metal being treated.

The wire entering the lead bath is immediately "quenched" from a temperature above its upper critical temperature to a temperature below its lower critical temperature. It may then be carried on through machine A to reel 9 and may be heat insulated while in transit, by such means as asbestos lined chutes, or similar devices, allowing it to further cool at a slow rate. In some cases, machine A may be eliminated entirely and material wound direct onto reel 9, in which case the immediate heat of the wire may be readily conserved; in such cases machine B may be driven at the desired speed.

The wheels or rollers 4 will ordinarily give ample contact to the wire, without auxiliary devices, but where desirable to do so, I also add contact brushes 35, see Fig. 2, made of suitable material, as for instance, leaf copper, to reinforce the contact. This, under some conditions, is necessary when on account of too rapid chilling of the wire, it may be essential to use heat insulating rollers, such as asbestos flanged rollers.

In some cases where a large quantity of large wire is being fed through the tank, the heat in the wire being tempered may be more than sufficient to maintain the temperature of the tank, in which case it becomes necessary to cool it by external means, as for instance, by water spray to keep it at the proper quenching temperature.

Machines A and B may be set at any suitable distance apart, though generally speaking, I prefer to keep them as close together as possible to avoid loss of heat and to avoid oxidation. When the machines are spaced far apart I prefer to keep the wire, while being heated, passing through the heat insulating tube 21, having asbestos insulation and fitted with a closely fitting seal at each end of the tube where the wire enters and leaves, and then I prefer to inject into the tube 21 through the pipe 37, inert or non-oxidizing gases, as for instance producer gas, or an oil spray, so that the wire is kept practically free from oxids until it is quenched on the rollers of machine A or in the lead bath 18.

In some cases, it is desirable to cool the wire very slowly after heating, as when annealing low carbon steel, or non-ferrous metals, or after quenching high carbon steel, it is often desirable between the lead tank or other quenching means to add means for insulating the wire while in transit to the take-up reel, so as to cause a very slow rate of cooling or annealing, such means consisting in the application of heat insu-

lating covering, or non-heat conductive rollers, such as asbestos, or in some cases, it is essential to apply a lower voltage of an electric current between the feed-out device and the take-up reel, as indicated at the left in Fig. 3, so as to maintain an annealing temperature on the wire, until it is coiled on the take-up reel, where the mass being coiled generally cools at a slow enough rate, or to still further prevent it from too rapid cooling, suitable heat insulating housings may be provided.

This device is not only applicable to wire and narrow strips, but by means of broader rollers or feed-in and feed-out devices generally in combination with contact-making brushes, it is suitable for treating wider pieces of thin material, such as are known as sheets. In such cases, the contact-making devices would be placed quite closely together, so as to minimize the length of wire, strip or sheet left unheated when separate lengths are passing from one contact-making device to the other.

My invention is a great improvement over the old method of tempering or "patenting" wire, due to the much more rapid travel of the wire through the machine, the shorter time and length of wire exposed to oxidation, and the more rapid "quenching," and by means of the protecting tube for the protecting of hot wire by a flow of non-oxidizing gases, it is quite possible to entirely obviate oxidizing the wire surface, thus eliminating the operations ordinarily known as "pickling," "liming" and "baking."

I do not necessarily limit my claims in this invention to the exact forms of apparatus shown, for having described my invention, it will be evident to one skilled in the art that numerous variations and devices may be added by the means described to produce the results desired.

I claim:

1. An annealing and tempering device comprising a holder for a metal strip, means for drawing the strip from the holder, means for passing an electric current through a portion of the strip while in transit, whereby said portion is heated, and means for automatically varying the speed of transit in accordance with the heating requirements.

2. An annealing and tempering device comprising a holder for a metal strip, means for drawing the strip from the holder, means for heating the strip while in transit, and automatic means for maintaining the temperature to which the strip is heated substantially constant.

3. An annealing and tempering device comprising a holder for a metal strip, means for drawing the strip from the holder, means for passing an electric current through a portion of the strip while in transit to heat the same, and means controlled by the cur-

rent flow for automatically maintaining substantially constant the temperature to which the strip is heated.

4. An annealing and tempering device comprising a holder for a metal strip, means for drawing the strip from the holder, means for passing an electric current through a portion of the strip while in transit to heat the same, and means controlled by the current flow for automatically governing the speed of transit, so that, when the voltage remains the same, the temperature to which the strip is heated is maintained substantially constant.
5. An annealing and tempering device comprising a holder for a metal strip, means for drawing the strip from the holder, means for passing an electric current through a portion of the strip while in transit whereby said portion is heated above the upper critical temperature and means for suddenly cooling the strip to the lower critical temperature.
6. An annealing and tempering device comprising a holder for a metal strip, means for drawing the strip from the holder, means for passing an electric current through a portion of the strip while in transit, whereby said portion is heated above the upper critical temperature, means for suddenly cooling the strip to the lower critical temperature, and means for thereafter controlling the rate of cooling below such last mentioned temperature.
7. An annealing and tempering device comprising a holder for a metal strip, a pair of strip-gripping and contact-making machines, each of said machines including a plurality of grooved wheels or rollers arranged to receive and frictionally grip the strip, means for rotating the rollers of one of said machines at a predetermined adjustable speed, means for rotating the rollers of the other machine at a slightly less speed whereby the strip is placed under tension in passing from one machine to the other, and means for heating the strip during transit between the machines.
8. An annealing and tempering device comprising a strip-holding reel, a pair of strip-gripping and contact-making machines, each of said machines including a plurality of wheels or rollers arranged to receive and frictionally engage the strip, said machines being spaced apart, means for rotating the rollers of one of said machines at a predetermined speed, means for rotating the rollers of the other machine at a slightly less speed, whereby the strip is placed under tension in passing from one machine to the other, means for limiting the amount of such tension to protect the strip from breaking, and means for passing an electric current through the portion of the strip between the machines to heat the same.

9. In an electric wire-tempering machine, a wire-holding reel, a wire take-up reel, a pair of wire-gripping and contact-making machines disposed between said reels and spaced apart from one another, each of said machines including a plurality of rollers for frictionally engaging the wire, means for rotating said rollers to cause a forward movement of the wire, a source of current, connections from said source of current to each machine whereby the current is passed through the portion of the wire between the machines, and auxiliary contact-making means in engagement with the wire.

10. An electric wire tempering and annealing device comprising a pair of wire-gripping and contact-making means spaced apart, means for causing a progressive movement of the wire from one of said pair of means to the other, means for passing a heating current through the strip while in transit and means for independently regulating the speed of transit of the wire and the voltage of the current.

11. An electric wire tempering and annealing device comprising a pair of wire-gripping and contact-making machines spaced apart, means for causing a movement of the wire from one machine to the other, means for passing an electric current through the portion of the wire between said machines to heat it while in transit, and means disposed between the machines for quenching the wire after it passes beyond the heating effect of the current.

12. An electric wire tempering and annealing device comprising a pair of wire-gripping and contact-making machines spaced apart, means for causing a movement of the wire from one machine to the other, means for passing an electric current through the portion of the wire between said machines while in transit, and a liquid bath disposed between the machines for quenching the wire, said bath serving as a contact electrode by which current is conducted through the wire.

13. An electric wire tempering and annealing device comprising a pair of wire-gripping and contact-making machines spaced apart, means for causing a movement of the wire from one machine to the other, means for passing an electric current through the portion of the wire between said machines while in transit, a liquid bath disposed between the machines for quenching the wire, and means disposed between said bath and one of said machines for preventing the oxidation of the wire.

14. An annealing and tempering machine comprising a feed-in device, a feed-out device, means for causing a movement of the wire to be treated from one device to the other, means for heating the wire in transit, means for quenching the wire at the point where the heating means ceases to act, and

means for passing an electric current through the wire to again heat the same while in transit after leaving said quenching means.

15. An annealing and tempering machine comprising a feed-in device, a feed-out device, means for causing a movement of the wire to be treated from one device to the other, means for causing an electric current to flow through a portion of the wire in transit between the two devices to heat the same, means for quenching the wire as it passes beyond the heating effect of such current, and means for again heating the wire while in transit after passing through said quenching means.

16. An electric wire tempering and annealing device comprising a pair of wire-gripping and contact-making machines spaced apart, means for causing a movement of the wire from one machine to the other, means for passing an electric current through the portion of the wire between said machines while in transit to heat the wire, and means disposed between said machines for quenching the wire, said quenching means serving

as one contact electrode for conducting current through the wire.

17. The herein described method of annealing metal strip which consists in heating it while in transit through a non-oxidizing medium, quenching it to a definite temperature immediately after issuing from such medium, and thereafter controlling its temperature as required.

18. The herein described method of annealing metal strip which consists in heating it while in transit through a non-oxidizing medium, quenching it to a definite temperature immediately after issuing from such medium, and thereafter again subjecting it to the action of heat.

19. The herein described method of annealing metal strip which consists in heating it while in transit to a point above its upper critical temperature, suddenly quenching it to a point below its lower critical temperature, and thereafter controlling its temperature during a definite period by applying or removing heat as required.

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