Oct. 27, 1964 M. A. NYE ETAL 3,154,443

APPARATUS AND PROCESS FOR CONTINUOUSLY HEAT TREATING WIRE AND THE LIKE

Filed May 19, 1961 2 Sheets-Sheet 1

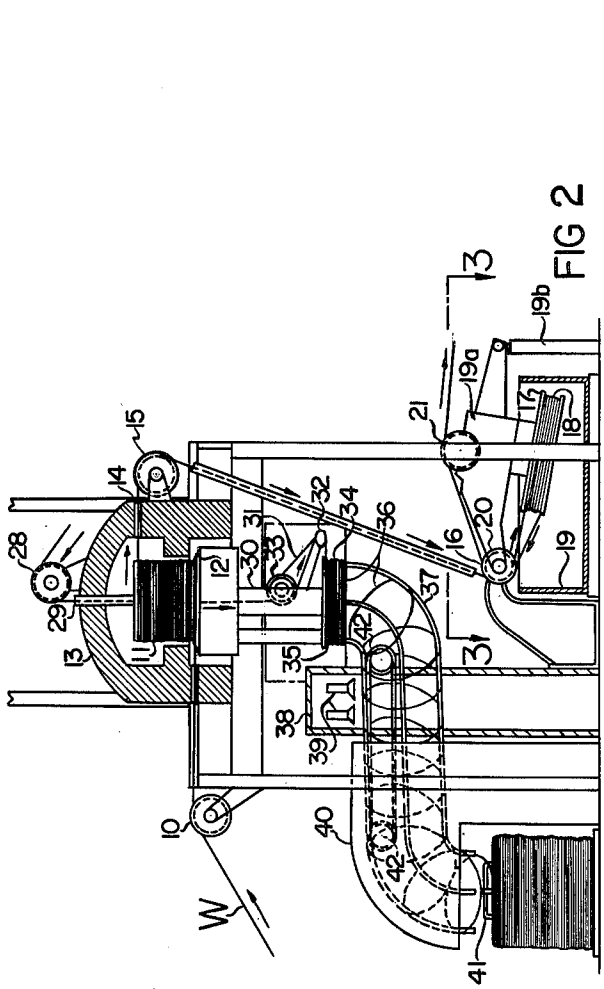


FIG 2

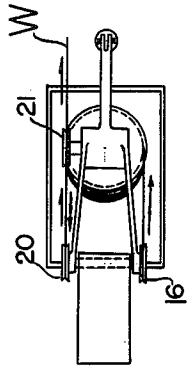


FIG 3

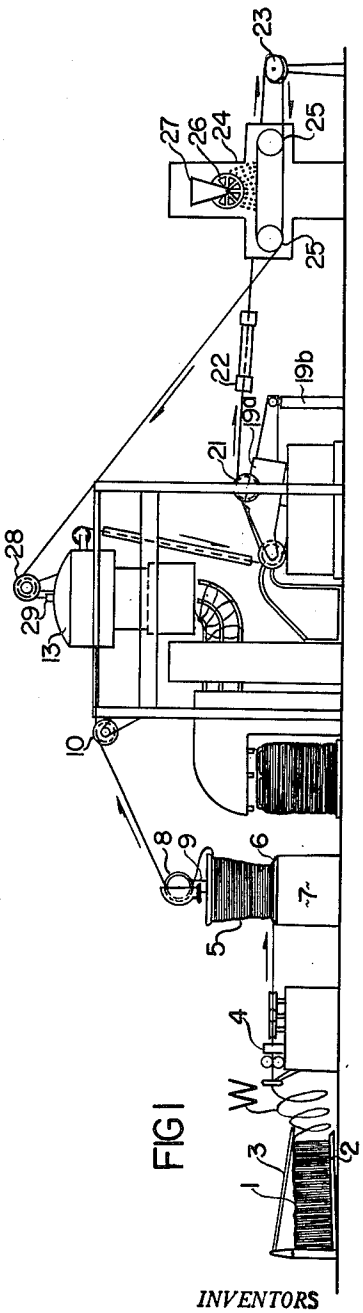


FIG 1

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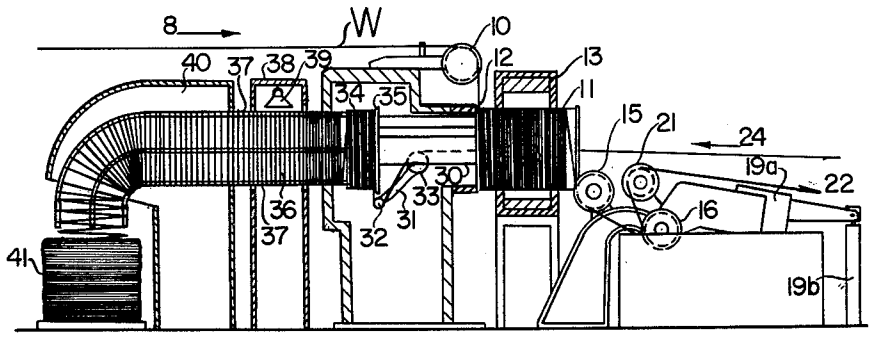


FIG 4

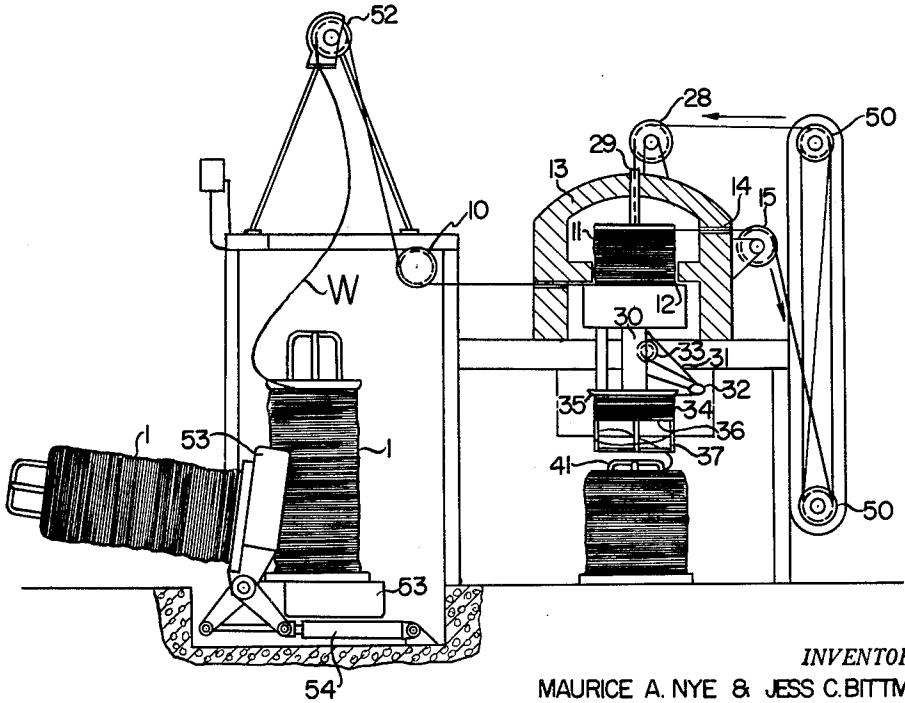


FIG 5

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3,154,443

APPARATUS AND PROCESS FOR CONTINUOUSLY HEAT TREATING WIRE AND THE LIKE

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Filed May 19, 1961, Ser. No. 111,245
9 Claims. (Cl. 148—144)

This invention relates to the continuous patenting and treating of steel wire and, more particularly, to a novel apparatus and method for the accomplishment thereof.

Patenting is defined in the art as a heat treatment applied to steel wires and rods having a carbon content of 0.25 percent and higher to obtain a sorbitic structure having high tensile strength, ductility and the ability to withstand hard drafting. Patenting is generally conducted as a continuous process and consists in first heating the material considerably above its critical temperature, then cooling through the critical temperature at a comparatively rapid rate. The cooling step may be conducted in open air or by immersion of the wire into a lead bath. The lead bath method has been generally preferred in the art for the reason that it is easier to control and thereby to produce definite grain structures in the material. Further, the lead bath cooling method results in less scale being produced on the wire. Under certain circumstances the lead bath cooling method may not be desired.

Conventional patenting methods are generally continuous only during the heating and cooling steps, whereas any subsequent treatment of the wire such as cleaning, coating and coiling may be separately conducted thus breaking up the continuity of the whole wire treating operation. Further, in conventional patenting the wire is fed at a relatively low lineal speed (e.g., about 40 feet per minute) which fails to keep up with other processing at high speeds (e.g., about 600 feet or more per minute). This necessitates either a plurality of patenting equipment or use of numerous supply coils, spoolers, etc., resulting in poor uniformity of the wire.

It is an object of this invention to provide an apparatus and method for the continuous patenting and treatment of steel wire at high speeds.

Another object is to provide such an apparatus and method wherein the entire operation may be conducted in a minimum amount of space, materially reducing the amount of equipment required.

A further object is to provide such an apparatus and method wherein the patenting of the wire is conducted in combination with the subsequent steps of cleaning, coating, drying and coiling all as part of one continuous high-speed operation.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawings:

FIG. 1 is an elevation view of the apparatus of this invention;

FIG. 2 is an enlarged elevation view, partly in section, of a part of the apparatus of this invention in FIG. 1;

FIG. 3 is a plan view of the lead bath of the apparatus of FIG. 1;

FIG. 4 is an elevation view, partly in section, of another embodiment of this invention; and

FIG. 5 is an elevation view, partly in section, of yet another embodiment of this invention.

This invention constitutes an improvement over that described in the U.S. application of Nye et al., Serial No. 111,244, filed May 19, 1961.

In reference to FIGS. 1, 2 and 3, the wire W to be treated is removed from coils 1 which are shown mounted on racks 2. To facilitate wire removal these racks 2 preferably have a tilted base and a bar 3 in the position shown to effect removal of the wire one convolution at a time. The wire is only taken from one coil, but to aid in continuity of operation another stand-by coil may be mounted on an identical rack next to rack 2 and the leading end of the stand-by coil connected as by welding to the trailing end of the wire from coil 1. The wire W is then tensioned by running it through a series of pinch rolls 4. If the wire has any undesirable scale thereon, this may be removed by scale romoval means (not shown) comprising, as well known in the art, a series of small diameter rolls over which the wire is sharply curved to break the scale. If desired, a die block may be disposed adjacent to the scale removal means.

After the wire W is run through the series of pinch rolls 4 to provide tensioning (or through the aforesaid scale removal means and/or die block) it may then be wound on a rotary storage block 5 which has a push-up flange 6 and is rotated by suitable drive means in the base 7. The wire is introduced tangentially along the flange 6 and is wound on the block 5 and may be continuously removed therefrom over the sheave 8 which is mounted on overhead arm 9.

The wire W is then guided over sheave 10 and wound on rotating take-up block 11 along a push-up flange 12 located at the base of the block which has suitable drive means to effect rotation thereof. The action of the push-up flange 12 is to continuously, helically advance a coil of wire upward along the block 11 and into a non-rotating furnace 13 which is a dome-shaped structure surrounding the upper end of the block. The interior of the furnace 13 is equipped with suitable heating means, e.g., burners, electrical heating coils, or any other suitable heating device known to those skilled in the art. A block and furnace assembly suitable for use herein is disclosed in the U.S. application of Nye et al., Serial No. 55,651, filed September 13, 1960. As the wire helically advances along the block 11 into the furnace 13, heat is continuously and uniformly applied to the wire at a temperature substantially above its critical point, e.g., about 1750° F. This structure permits a high lineal speed of the wire (about 1000 feet per minute) while enabling accurate and adequate heat treatment of the wire in a relatively small volume of space.

The furnace 13 is provided with an opening 14 in its side through which the wire is removed tangentially from the block 11. The wire is then guided around sheaves 15 and 16 and introduced tangentially onto the downward push flange 17 of rotating block 18 which is immersed in a molten lead cooling bath 19. The wire continuously, helically advances down along block 18 through the molten lead cooling medium which reduces the temperature of the wire to, for example, about 1000° F. The rotating block 18 has a rotary drive means within the housing 19A. The housing is supported outside the bath 19 by hydraulic cylinder 19B which is capable of raising the block out of the bath. Thus, rotation of the block (and resulting cooling of the wire) in ambient air is possible if desired. The arrangement shown permits lead bath cooling without any sheaves being immersed in the lead. The wire is tangentially removed from the bottom of block 18 and directed around sheaves 20 and 21 and

introduced through water cooling bath **22** where the wire temperature is further reduced. The water cooling bath may be suitably mounted and a replenishing water supply may be supplied by any suitable means known in the art.

The wire is withdrawn continuously from the water bath **22** and run through ambient air for some distance; at the wire temperature existing at this location, any water remaining on the wire will evaporate. The wire is then run around sheave **23** and introduced into a wire cleaning chamber **24**. The chamber **24** contains means for directing abrasive particles at high velocity at the wire **1** as it is passed between sheaves **25** within the chamber **24**. In the drawing, this is exemplified by centrifugal wheel **26** which has a feeding means **27** located thereon to introduce a supply of abrasive particles to the center of the wheel. The particles are thrown down by the centrifugal force of the vanes situated radially along the wheel **26**. A particularly suitable device for accomplishing this result is a "Wheelabrator," manufactured by the American Wheelabrator and Equipment Corporation, Mishawaka, Indiana. A detailed description of such devices is contained in the book "Shot Peening," 4th edition, published in 1951 by the aforenamed company. The wire may be passed between the sheaves **25** as often as necessary to accomplish a thorough cleaning thereof. This cleaning chamber **24** eliminates the need for chemical or solvent cleaning tanks with subsequent neutralization, drying, etc., while providing for thorough cleaning of wire moving at high speeds, e.g., 1000 feet per minute, in a relatively small volume of space. More than one such cleaning chamber may be used if necesary.

The cleaned wire leaving chamber **24** is then run around sheave **28** mounted on top of the furnace **13** and introduced down through an opening **29** therein. The wire then runs down through the hollow center of block **11**. The block **11** has a hollow drive shaft **30** which extends axially downwardly from the block **11**. The shaft **30** has keyed thereon an arm **31** extending outwardly therefrom having a sheave **32** at its extremity and a sheave **33** set in a radial slot in the shaft **30**. The end of shaft **30** is journaled in the end of a stationary block **34** having a push-flange **35** thereon. The wire W is guided through the interior of shaft **30**, out and over sheaves **33** and **32** and as the arm **31** rotates, it acts to wind the wire W on block **34** along the push-flange **35**. This continuously produces an advancing helical coil of wire **36**. A suitable winding device and assembly showing the appropriate engagement between the shaft **30** and the stationary block **34** is shown in the U.S. applications of Nye, Serial No. 67,350, filed November 4, 1960, now Patent No. 3,049,315, and Nye et al., Serial No. 75,965, filed December 15, 1960, now Patent No. 3,097,812. The block **34** has coil guide members **37** which curve downwardly, then horizontally, and downwardly over which the successive coils **36** are advanced.

Along the horizontal portion, a coating means **38** is situated to effect a continuous protective and lubricating coating of the coil **36** with borax, lime, or the like. This may be done by spray nozzles **39** or other suitable means known to those skilled in the art. After the coating means **38**, a dryer **40** is provided to dry the coating applied. This may be any suitable known type of dryer, e.g., hot air, electrical coils, etc. The coils then move downwardly where they are collected on a suitable receptacle **41**. If desired, a conveyor **42** may be located along the top of the horizontal portion of the guide members **37** to effect a slight separation of the convolutions to provide better coating and drying. This may be in the form of an endless belt or chain as shown engaging the coils from the inside.

The operation in FIG. 4 is similar to that in FIGS. 1, 2 and 3 and similar reference numerals have been used wherever possible; only the distinctions between the two will be discussed. In FIG. 4, the wire W is supplied and tensioned as in FIG. 1 (reference numerals 1–9) and is supplied over sheave **10** to the rotating take-up block **11** which is mounted horizontally. The furnace **13** is also mounted horizontally around the extremity of block **11** and is not dome-shaped. The lead and water bath assemblies are the same as is the cleaning chamber **24**. As the wire emerges from the chamber **24**, it is introduced through the hollow end of block **11**, to the coil winding assembly which is the same as in FIG. 1 except that it is mounted horizontally. The coating means, drying means and receptacle are the same.

FIG. 5 depicts an embodiment of the invention wherein the tensioning means **4** and storage block **5** have been omitted. The lead bath **19** and water bath **22** have been replaced by an air cooling operation composed of a pair of sheaves **50** around which long loops of wire W are festooned in ambient air to effect cooling. The air cooled wire is then wound into coils **36** as in FIG. 1 except that no cleaning, coating or drying is conducted. Movable collector arms may be provided at the base of stationary block **34** on which the coils **36** may be collected while receptacle **41** is changed. FIG. 5 depicts another optional modification in the arrangement of the coils **1** which are the source of wire for the patenting operation. In this modification the coil **1** from which wire is removed for patenting is mounted vertically and the wire is drawn off upwardly and over sheave **52**. The coils **1** are mounted on stands **53** which have hydraulic cylinders **54** to raise and lower the stands for the purpose of placing new coils thereon. A suitable arrangement is disclosed in the U.S. application of Bittman, Serial No. 111,375, filed May 19, 1961, now Patent No. 3,082,973.

One of the advantages of this invention is that the same drive shaft **30** is used both for the rotating block within the furnace as well as the rotary winding mechanism. Further, since these two operations are conducted on adjacently connected devices a great saving of space is realized which is highly important in factories where work space is at a premium. It is most advantageous that these meritorious features are realized in a novel operation which provides for uniform and continuous treatment of steel wire.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

We therefore, particularly point out and distinctly claim as our invention:

1. An apparatus for the continuous patenting of steel wire which comprises in combination a furnace, a rotary take-up block in said furnace adapted to continuously, helically advance a coil of wire through said furnace for heating thereof, continuous cooling means adjacent said furnace adapted to decrease the temperature of the wire after emergence from said furnace, said rotary take-up block having coaxially attached thereto a tubular drive shaft therefor for continuous passage of the cooled wire therethrough, said shaft having winding means thereon, a stationary take-up block secured to said shaft for wrapping of wire thereabout by said winding means, and receiving means adjacent said stationary take-up block adapted to receive coils of wire from said stationary block.

2. An apparatus according to claim 1, wherein said cooling means comprises a pair of widely spaced sheaves between which a plurality of convolutions of said wire are run at high speed in contact with ambient air.

3. An apparatus according to claim 1, wherein said cooling means comprises a rotary drum around which the wire passes as it emerges from said furnace, and a molten bath in which said drum is immersed.

4. An apparatus according to claim 1, wherein said winding means comprises an arm extending outwardly from said shaft, said arm having a sheave at its outer end around which the wire passes as it is wound onto said stationary block.

5. An apparatus according to claim 1, wherein said cooling means comprises a rotary drum around which the wire passes as it emerges from said furnace, and a molten bath in which said drum is immersed, said drum having support means mounted on a pivot outside said bath and means for swinging said support means about said pivot to raise said drum out of said bath.

6. An apparatus for the continuous patenting and treatment of steel wire which comprises in combination a furnace, a rotary take-up block in said furnace and a tubular drive shaft therefor adapted to continuously, helically advance a coil of wire through said furnace for heating thereof, continuous cooling means adjacent said furnace adapted to decrease the temperature of the wire after emergence from said furnace, cleaning means adjacent said cooling means, said cooling means being disposed between said furnace and said cleaning means, said cleaning means comprising enclosures wherein abrasive material is directed at the wire as it is continuously moved therethrough, said shaft having winding means thereon, a stationary take-up block secured to said shaft for wrapping of the cleaned wire passing through said shaft and over said winding means around said stationary block, coating means adjacent said stationary block adapted to continuously provide the coils of wire from said stationary block with a protective coating, drying means adjacent said coating means, said coating means being disposed between said stationary block and said drying means, said drying means being effective to continuously dry said coating, and receiving means adjacent said drying means adapted to receive the coated coils of wire as they continuously emerge from said drying means.

7. An apparatus according to claim 6, wherein said winding means comprises an arm extending outwardly from said shaft, said arm having a sheave at its outer end around which the wire is run for winding onto said stationary block.

8. A process for the continuous patenting and treatment of steel wire which comprises the following steps in sequence: continuously rotating and advancing said wire helically forming coils thereof while applying a source of heat thereto, cooling said wire by continuously immersing the wire into a molten bath, continuously cleaning said wire by directing free abrasive particles at the surface of said wire, conducting the cleaned wire through the rotating coils, winding said wire into successive non-rotating convolutions, continuously coating the convolutions of wire as they are advanced axially, and continuously drying the convolutions of coated wire.

9. A process for the continuous patenting and treatment of steel wire which comprises the following steps in sequence: continuously rotating and advancing said wire to form coils thereof while applying a source of heat thereto, continuously cooling said wire, conducting the cooled wire through the rotating coils, and winding the wire into successive non-rotating convolutions, and collecting the wire convolutions in the form of an upwardly growing package.

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