United States Patent [19]

Möbius et al.

[11] **3,865,640**

[45] **Feb. 11, 1975**

[54] **METHOD FOR THERMAL TREATMENT OF RINGS CONSISTING OF WIRE OR STRIP MATERIAL**

[76] Inventors: **Hans Eberhard Möbius,** Michael - Tritz- Str.4, 6622 Wadgassen; **Jakob Kubini,** Danziger Str. 66; **Sorayapour Soraya,** Nordring 75, both of 662 Volklingen, all of Germany

[22] Filed: **Nov. 27, 1972**

[21] Appl. No.: **309,748**

[30] **Foreign Application Priority Data**

Nov. 25, 1971 Germany 2158459

[52] **U.S. Cl.** **148/12.9,** 134/1, 148/157

[51] **Int. Cl.** **C21d 1/04**

[58] **Field of Search** 148/12.9, 12.4, 157; 134/1

[56] **References Cited**

UNITED STATES PATENTS

2,424,794	7/1947	Brown	148/157
2,798,832	7/1957	Harvey	148/157
2,848,775	8/1958	Ettenreich	148/12.9
3,276,918	10/1966	Langenecker	148/12.9
3,284,192	11/1966	Larson et al.	148/12.9
3,449,163	6/1969	Möbius et al.	134/1
3,622,404	11/1971	Thompson	148/12.9

Primary Examiner—W. Stallard

Attorney, Agent, or Firm—Otto John Munz

[57] **ABSTRACT**

The method provides for

austenitizing at about 850° to 900°C;

steelhardening in a fluid flow directed through the rings in radial direction at about 1.000 m^3 p.h. with a hardness scatter between 400 to 550 kp/mm^2 and with induced oscillations of 3 mm amplitude at 25 cycles frequency; and

tempering to a tensile strength of about 85 kp/mm^2

An apparatus for carrying out this method comprises a pivotable hook for receiving the rings;

at least one oscillating generator connected to the hooks;

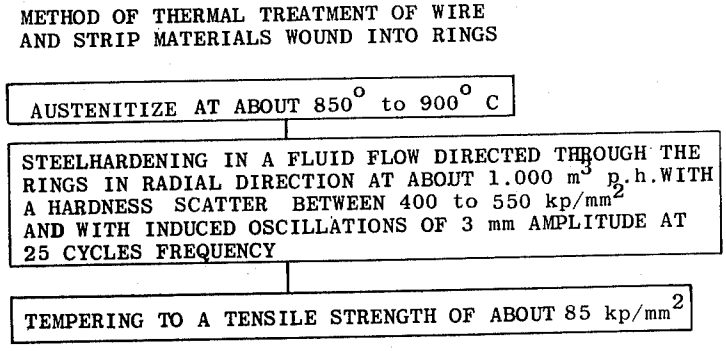
means to position the winding plane of the rings vertically when the hook is in operation;

means to subject the rings to a radial flow including a pipe system and a cover positioned on the side of the ring which faces away from the hook;

a horizontal support of the ring to be treated; and

supporting elements with rollers and oscillating generators connected with the supporting elements.

6 Claims, 3 Drawing Figures



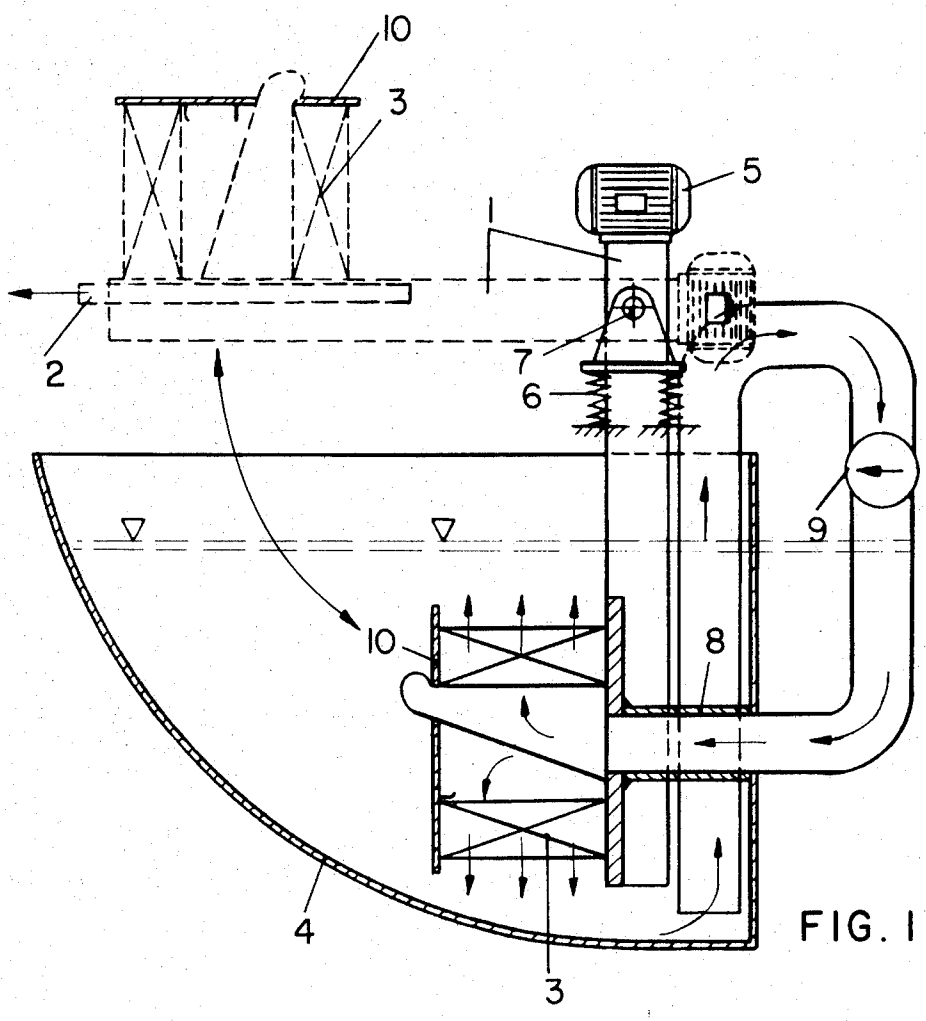


FIG. 1

METHOD OF THERMAL TREATMENT OF WIRE AND STRIP MATERIALS WOUND INTO RINGS

AUSTENITIZE AT ABOUT 850° to 900° C

STEELHARDENING IN A FLUID FLOW DIRECTED THROUGH THE RINGS IN RADIAL DIRECTION AT ABOUT 1.000 m^3 p.h. WITH A HARDNESS SCATTER BETWEEN 400 to 550 kp/mm^2 AND WITH INDUCED OSCILLATIONS OF 3 mm AMPLITUDE AT 25 CYCLES FREQUENCY

TEMPERING TO A TENSILE STRENGTH OF ABOUT 85 kp/mm^2

FIG. 3

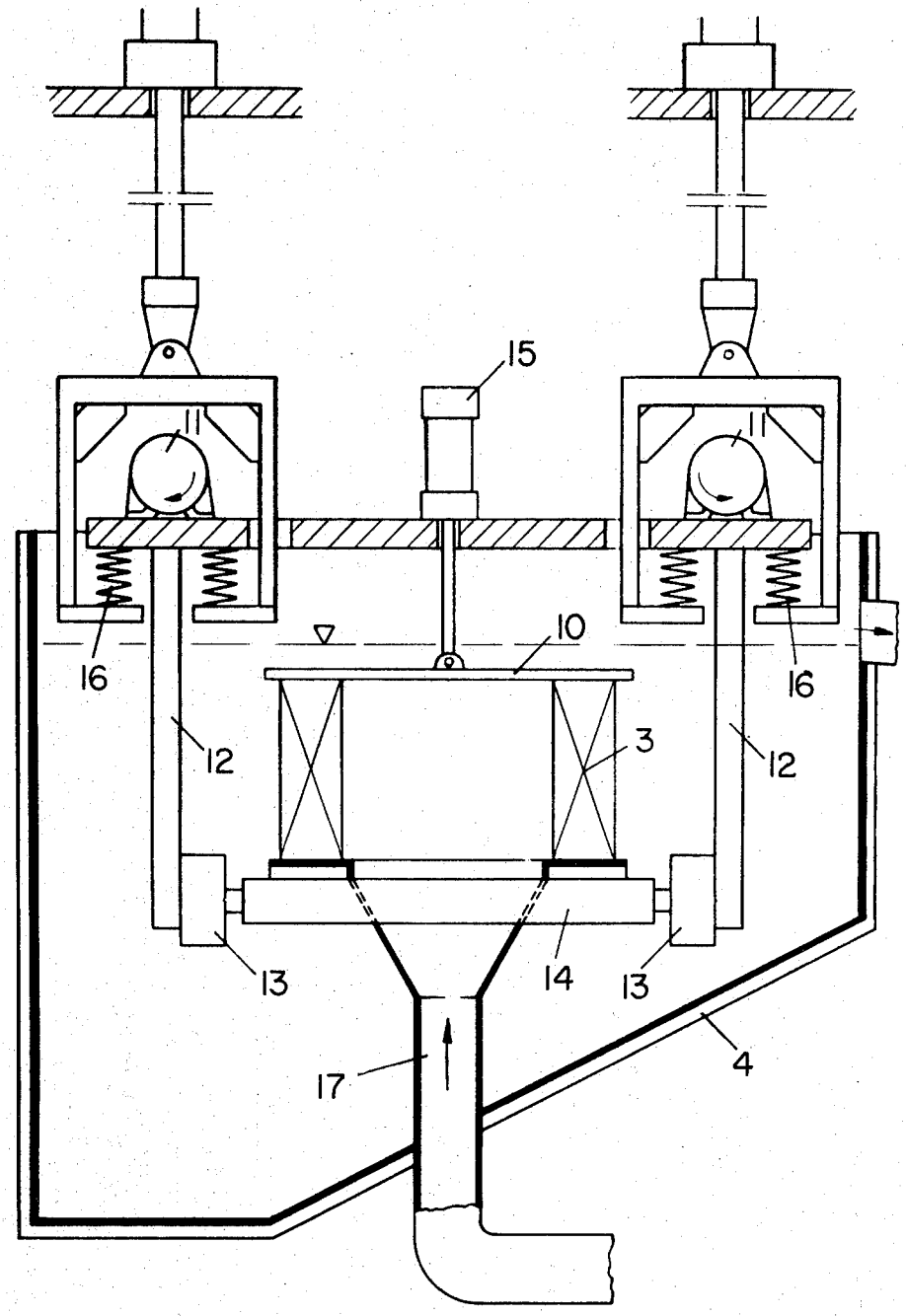


FIG. 2

METHOD FOR THERMAL TREATMENT OF RINGS CONSISTING OF WIRE OR STRIP MATERIAL

FIELD OF THE INVENTION

The invention relates to a method for thermal treatment of rings of wire or strip material, and to devices for carrying out such method.

THE PRIOR ART

Thermal treatment of wires or strips which have been wound up to form a ring or are combined to bunches has hitherto been employed rarely and, at any rate, only when the weight of the ring was light and the demands made on the quality of the thermally treated article were low. The reason for such limitation consists in the fact that, when the ring weight is heavier, a uniform cooling of all portions of the ring, may the latter be suspended and at rest, or moving in a closed state, is not assured. The result are differences in the mechanical properties at different spots of the ring after the thermal treatment.

The thermal treatment of wire is carried out in various ways. Thus, it is known to move wire in the form of strands through a furnace, harden it in a connected cooling path and temper it in a further furnace (German Pat. No. No. 951,725). Such a process of continuous movement is customary, e.g., for prestressed concrete wires and requires a high expenditure in capital and in continuous operating cost.

THE OBJECTS

An object of the invention is to provide a possibility of thermally treating wire or strips in the shape of rings, particularly rings of fairly high weight.

This problem is solved by the thermal treatment of rings of wire or strip material, and by subjecting the article to be treated to natural oscillations.

In a further development of the method of the invention, the medium surrounding the article to be treated is pressed radially through the ring. Thereby the heat transfer coefficient is raised.

In accordance with the invention there is a critical temperature for treating steel wire or steel strips thermally of approximately 900° C. Experiments have surprisingly shown that, notwithstanding the high temperature at which the wire or the strip material is of low stability and not itself rigid, the article to be treated can be induced to carry out natural oscillations.

Another object of the invention is to provide a thermal treatment of rings of wire or strip material of a fairly high weight, including heavy rings or rings combined to bunches weighing, e.g., 1,000 kg or more with great uniformity.

Yet another object of the invention is to provide by the method stated a simple and inexpensive production of the subject articles.

Still another object of the invention is to produce the articles, e.g., steel wire, of a lower temper brittleness than is achieved by conventional methods.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of the apparatus of the invention;

FIG. 2 is a diagram similar to that of FIG. 1 showing additional optional processing;

FIG. 3 is a flow diagram of the sequence of steps employed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The method of the invention is described in greater detail as follows:

In a ring or bunch of wire or strip material, which, e.g., is immersed in a tempering bath, numerous points of intersection between the individual wire windings exist. Furthermore, spaces almost closed by three or more parallel partial sections are disturbing if a temperature balance between the article to be treated and the surrounding medium is to be brought about within the shortest time possible. By the transmission of oscillations to the article to be treated, these critical spots within the ring of wire do no longer remain at their previous location. The points of intersection likewise change their position, just as the arch elements which extend in parallel direction along a partial section and are adjacent to each other, are separated. This dissolution of contact points and steady formation of differently located contact points leads to the result that in the heat exchange no element of volume of the wire to be treated is disadvantaged over a longer period of time with respect to other elements of volume.

The described type of intense heat exchange between the ring of wire or strip material and the surrounding medium is important, e.g., in the hardening in an oil or water bath. The method can also be used in a thermal treatment in the range of medium temperatures which require the employment of hot oil baths, salt baths, or of a fluidized bed. Examples thereof are the intermediate stage tempering of steels, the hot precipiation of non-ferrous metals, and the patenting of rope wire. Finally, the method can also be used when the surrounding medium is gaseous and when it is important that the thermal treatment be carried out with particular uniformity and speed.

EXAMPLE

A ring of steel wire of 38 Cr 1 quality, material No. 7001, with a wire of an ϕ (section diameter) of 6.5 mm and a weight of 500 kp was austenitized at 850°C and subsequently hardened in a commercial steel-hardening oil. In this process, the support of the ring of wire carried out oscillations of an amplitude of 3 mm and frequency of 25 cycles. 1000 cubic meter/per hour of oil were pumped through the ring of wire in one of the variants of the experiment. Then the hardness was measured at various cross sections of the ring.

At conventional hardening (without vibration), the hardness HV30 fluctuated between 280 and 550 kp/square mm. By means of vibration, the hardness fluctuated between 400 and 550 kp/square mm. In the case last-mentioned, the wire was subsequently tempered, so that a tensile strength of 85 kp/square mm resulted. The fluctuating range of the tensile strength after this tempering amounted to $\pm$ 1.5 kp/sqare mm.

These results show that the proposed method permits a thermal treatment of rings of wire, wherein all portions of the ring are very uniformly affected.

FIGS. 1 and 2 show devices for carrying out the method.

In FIG. 1, a hook 1 is provided which can be pivoted, e.g., between the rollers of a roller bed 2 (shown in dash lines). There, hook 1 receives the ring of wire or

strip material 3 to be treated, after a partial element of roller bed 2 has been moved laterally. Then hook 1 pivots downwards and the ring is submerged in a container 4 which is filled, e.g., with steel-hardening oil. By means of one or more imbalance motors 5, ring 3 is induced to natural oscillations. Springs 6 serve to absorb the oscillations in bearings 7. To induce ring 3 to natural oscillations, the frequency of the imbalance motors 5 must be chosen in such a way that it is within the range of natural frequency of the oscillatory article, i.e., of the windings, or portions of these windings, of ring 3. A ring 3 wound from wire or strip material is an oscillatory system which has no single natural frequency, but positively a natural frequency range. The frequency of the oscillation generators (imbalance motors 5) must therefore range within the wide resonance curve of ring 3, so that at least a portion of ring 3 oscillates in resonance.

The oscillation generators may also be, e.g., magnetic vibrators whose amplitude and possibly frequency can be adapted to the type and quality of the article. For instance, the natural frequency of rings of wire with a smaller wire diameter and larger winding diameter is lower. When the natural frequencies of the individual oscillatory elements differ very widely, it is advantageous to pass through an entire frequency range continuously and possibly repeatedly, in order to induce successively the various elements of the article to oscillate.

Ring 3 is subjected to radial flow by means of a pipe system 8 in which a pump 9 is provided. Hook 1, after immersion (position shown in the drawing) in container 4 abuts against an aperture of pipe system 8. By pump 9 an oil circulation in the manner indicated by arrows is forced when ring 3, on the side facing away from hook 1, is closed by a cover 10.

In processing stages which require a rather long period of treatment in the medium concerned, it may be advantageous to leave the ring plane of the rings of wire in horizontal position and thus to swing them, e.g., directly upon the roller bed. The oscillation is in this case, as shown in FIG. 2, transmitted through two imbalance motors 11 by way of support elements 12, resistant to bending, to vibration-proof bearings 13 by which the rollers 14 of the roller bed are supported. Ring of wire 3 is covered, if a radial flow is also required, by a cover 10 which, unless it is needed for the entire process, can be lifted by a hydraulic cyliner 15. The entire oscillating apparatus described is supported by springs 16.

Numeral 17 indicates the oil or water feeding pipe by which the oil or water necessary to be flown through the ring is supplied.

The arrangement shown in FIG. 2 can likewise be employed if the rings are to be processed further in a fluidized bed or furnace.

The fluid media to which the articles are exposed may be gaseous, liquid or solid, or combinations thereof and may be f.i. the same as described in the German Auslegeschrift No. 1,696,320.

The oscillations employed also may be the same, f.i. as those employed in treatment of rings, wire or strip material in chemically active media as described in the cited Auslegeschrift No. 1,696,320.

I claim:

1. Method of uniform thermal treatment of a plurality of rings of wire or strip material including heavy rings and in bunches weighing up to 1.000 kgs or more comprising the steps of exposing the rings to a fluid medium, and inducing in the article to be treated directional oscillations of natural frequencies of said rings to vary the locations of the adjacent rings and provide openings between them, while they are subjected to a heat-exchange fluid medium to circulate through the said openings.

2. Method for thermal treatment, as claimed in claim 1, further comprising the step of adjusting the frequency of the oscillations to correspond to the upper and lower limits of the natural frequency range of the article to be treated.

3. Method for thermal treatement as claimed in claim 1, further comprising the step of directing a flow of said medium in radial direction through the said rings.

4. Method for thermal treatment as claimed in claim 1, further comprising the

step of austempering said materials at about 850° to 900° C prior to said step of exposing;

steel-hardening said materials in said fluid flow by directing said flow through said rings in radial direction at about 1.000 m3 p.h. with a hardness scatter between 400 to 550 kp/mm^2 and inducing said oscillations at an amplitude of about 3 mm with a frequency of about 25 cycles.

5. Method for thermal treatment, as claimed in claim 4, further comprising the step of tempering said materials to a tensile strength of about 85 kp/mm^2.

6. Method for thermal treatment, as claimed in claim 4, further comprising the step of processing said materials in a fluidized bed.

* * * * *