(No Model.)

E. E. RIES.

METHOD OF AND APPARATUS FOR HARDENING AND TEMPERING STEEL AND IRON.

No. 453,163. Patented May 26, 1891.

Fig. 1.

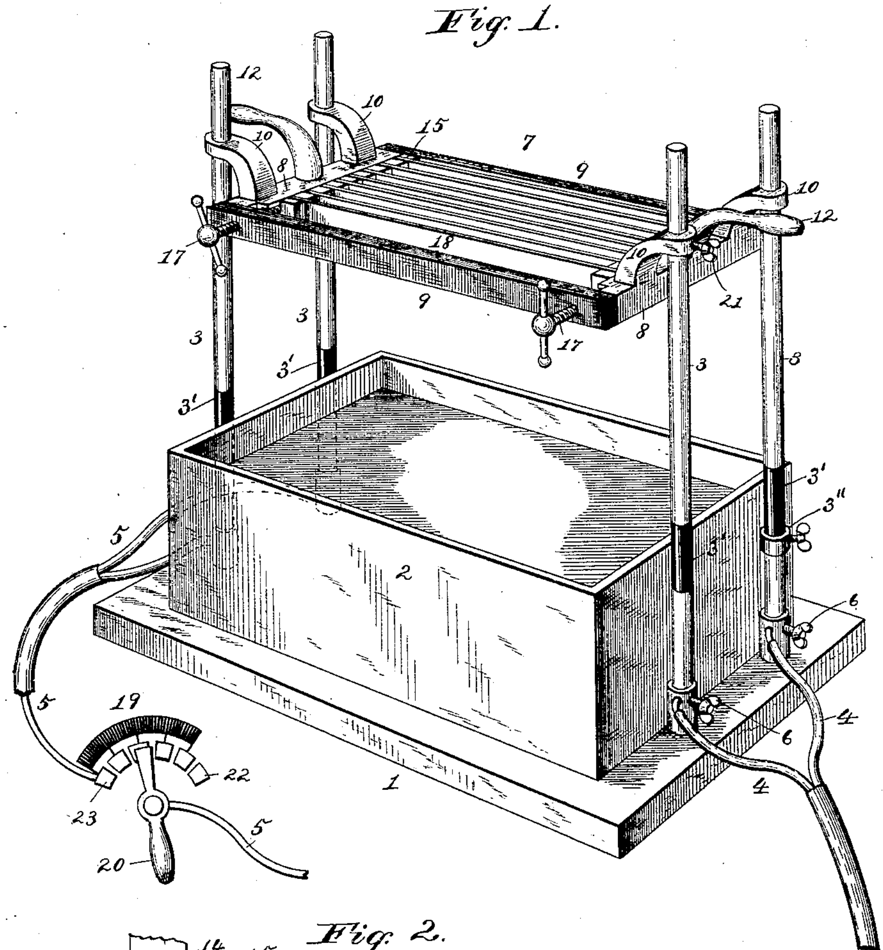


Fig. 2.

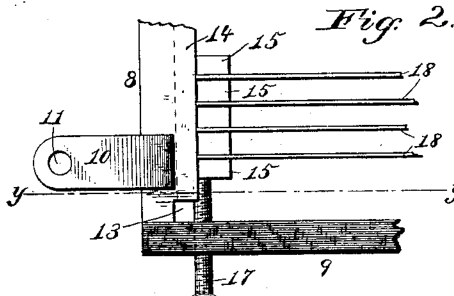
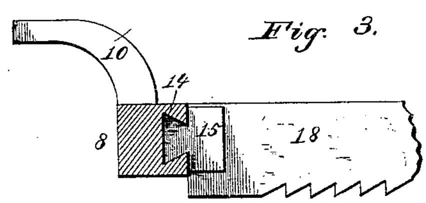


Fig. 3.



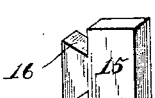


Fig. 4.

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METHOD OF AND APPARATUS FOR HARDENING AND TEMPERING STEEL AND IRON.

SPECIFICATION forming part of Letters Patent No. 453,163, dated May 26, 1891.

Application filed November 2, 1888. Serial No. 289,840. (No model.)

To all whom it may concern:

Be it known that I, ELIAS E. RIES, a citizen of the United States, residing at Baltimore, in the State of Maryland, have invented certain new and useful Improvements in Methods of Hardening and Tempering Steel and Iron, of which the following is a specification.

My invention has reference to improvements in the method of and apparatus for hardening and tempering articles of steel and iron by the aid of electricity, and its main object is to facilitate that process generally and to attain greater certainty and uniformity of result.

As heretofore practiced the steel or iron article to be hardened and tempered was generally heated to the desired degree in an open furnace with free admission of air. The article was then transferred as rapidly as possible from the furnace to the chilling-bath, and after removal from the latter was again heated in the furnace to give it the required temper. When this is obtained the reheated article is sometimes again plunged into a cooling-bath. This process is very inconvenient, and the results obtained are not uniform under apparently the same conditions. In the first place the heating in a furnace is a very slow process, and the long exposure of the steel or iron to the atmosphere while being heated produces a remarkably thick layer of oxide upon the surface, which layer, when the article is chilled, peels off in scales, whereby the surface becomes rough and requires additional dressing. The heavier the article operated upon the more this defect becomes apparent, and this is especially true in low grades of steel and in iron, which must be heated to a higher temperature to give them the desired degree of hardness. In the second place, other things being equal, the hardness of the article depends largely, if not entirely, upon the degree of incandescence which it has at the instant it is received in the chilling-bath, and the operator must judge of that in every instance separately, and he must take into account the loss of incandescence which takes place during the transfer from the furnace to the chilling-bath. Where the steel or iron is thin, as in knife or saw blades, the loss of incandescence during the transfer is considerable, and in order that the article may be in proper condition when immersed into the bath it must be heated in the furnace to a higher degree than is actually necessary, which is very objectionable, more especially when high-grade steel is operated upon. Thus it happens that when a great number of like articles are hardened and tempered in succession no two of them will have the same hardness or temper. All these imperfections are obviated by my improved process, wherein the article to be hardened is heated very rapidly by the passage through the same of a suitable current of electricity, which will raise the same to a certain accurately adjustable degree of incandescence, and will maintain it in that condition until the instant of immersion into the chilling-bath. Having determined the conditions under which a certain article is raised to the required temperature, any desired number of like articles may successively be operated upon with exactly the same result, and thus the uniformity of hardness of discrete; but like objects, which in the manufacture upon a large scale is very desirable, may be secured. All this will more fully appear from the following detailed description, in which reference is made to the accompanying drawings, illustrating an improved apparatus for practicing my improved process. It will, however, be understood that I am not limited to the precise details herein shown and described, since the same may be varied without departing from my invention.

In the drawings I have shown, in Figure 1, a perspective view of an apparatus embodying my invention for hardening and tempering a number of discrete but like articles; in Fig. 2, a plan view of a portion of the clamp-frame shown in Fig. 1. Fig. 3 is a view of a section on line y y, Fig. 2; and Fig. 4 is a perspective view of a spacing-block employed in this apparatus.

Like numerals of reference refer to the same or like parts throughout the drawings.

Upon a suitable base 1, of insulating material, is mounted a rectangular tank 2, which contains the chilling fluid, such as water or oil, and four vertical guide-posts 3 3 3 3, of metal, rising from the base 1, two on each end of the tank, are connected with a suitable source of electricity (not shown) by wires 4 5, which are clamped to the guide-posts by binding-screws 6 6. A rectangular frame 7, composed of two metallic end bars 8 8 and two side bars 9 9 of insulating material, is guided between the posts 3 by metal brackets 10 10 10 10, of which two extend from each end bar of the frame. These brackets rise from the upper surfaces of the end bars and curve outwardly. They are perforated vertically at 11 near their free ends, as shown, and the guide-posts are received in these perforations, so that the whole frame may be moved up and down upon the guide-posts by means of suitably-shaped handles 12 12, fixed to the side bars of the frame. The handles 12 12 may be of metal, and will then be insulated from the frame, or they may be made of insulating material. Each end bar 8 has formed therein a short recess 13 at one end of the inner side, and has in the remaining projecting portion a dovetail groove 14. A number of metallic spacing-blocks 15 are provided for use with this frame, and these blocks are each formed with a dovetail tongue 16, which fits into the groove 14. Each block is of such width that it may be inserted into the recess 13, after which its tongue will engage the groove in the end bar, and the block may then be moved along the end bar to any position upon the same.

Near each end of one of the side bars 9 is fitted a clamp-screw 17, which passes through the side bar and bears against the spacing-blocks inserted into the adjacent end bar. In this manner any number of articles to be hardened and tempered may be clamped within the frame 7, with spacing-blocks between the same, as will be readily understood.

In the drawings I have shown a number of steel or iron laminæ 18 18 with spacing-blocks between the same. These laminæ may be knife or cutter blades, springs, or any other suitable article of manufacture, and in Fig. 3 such lamina is shown as a saw-blade. The leading-wires 4 5 are supposed to be connected with the poles of a suitable source of electricity, which furnishes a current of low tension and great quantity. Such currents are technically known as "heating-currents," and may be derived either directly from a dynamo-generator or from the secondary coil of an induction transformer or from a secondary battery. My invention, however, is not limited to the use of either of these sources of electricity, since the heating-current may also be obtained from a primary battery or from any other generator of low-tension currents. A rheostat 19, of any ordinary or improved construction, included in one of the leading-wires 5, is used for both closing and opening the circuit and for regulating the current. This is done by proper manipulation of the switch-lever 20, as is well understood by those skilled in the art.

With this apparatus articles of steel or iron of a certain definite length are hardened and tempered in the following manner: The clamp-frame 7 is raised to the position shown in Fig. 1 by means of the handles 12 12, and is fixed in that position by the binding-screw 21. Then one spacing-block 15 is inserted at each end of the frame in the manner hereinbefore described, and is moved within the dovetail groove 14 until it abuts against the side bar 9 at the rear of the frame. The bar, rod, blade, or other article 18 to be hardened and tempered is then placed in the frame against the pair of spacing-blocks just inserted, and another pair of such blocks followed by another specimen of a like article 18 is then placed in position, and so forth, until the frame is filled, a pair of spacing-blocks being placed against the last article 18 of the series. The clamp-screws 17 17 are then operated to force the spacing-blocks and the blades or other articles between the same together; and it will now be understood that the blades 18 are in multiple-arc branches of the circuit, of which the leading-wires 4 5 and the compound switch and rheostat form a part.

The charging of the frame 7 is done while the circuit is open at the rheostat, the switch-lever 20 being for this purpose turned upon the idle contact-plate 22 at the right-hand end of the rheostat. For greater convenience the frame 7 may be entirely removed from the posts 3 3 for the insertion of the articles to be operated upon. The frame being properly charged, the switch-arm 20 is slowly moved toward the terminal contact-plate 23 to close the circuit and to cut out resistances until the blades 18 have attained the desired degree of incandescence. Supposing now it is found that this incandescence is attained when the switch-arm is in the position shown in Fig. 1, the operator will know that the same degree of incandescence will be produced in all subsequent charges of the frame with like blades or articles 18. Consequently in hardening and tempering a large number of like objects consecutively the switch need only be moved to the same position to insure the same degree of incandescence, and therefore, other things being equal, the same hardness and temper in all blades or other objects by the subsequent chilling. While the current is thus maintaining the steel or iron articles at the proper degree of incandescence the binding-screw 21 is loosened and the frame is allowed to descend into the chilling-fluid in the tank 2, and at the instant when the lower edges of the blades 18 come into contact with the chilling-fluid the circuit is suddenly opened by turning the switch-lever upon the idle contact-plate 22. In this manner the cooling of the heated articles by radiation before the instant of immersion into the chilling-fluid is avoided. This can be still better avoided by breaking the heating-circuit automatically at the instant of immersion in any desired manner. For this purpose I have shown in the drawings, Fig. 1, an insulating-sleeve 3′ upon each guide-post 3, but flush with the surfaces of the same. These insulating-sleeves are so located that when the frame 7 descends and at the instant when the lower edge of the blades or other articles 18 touch the chilling-fluid the brackets 10 10 will just have passed beyond metallic contact with the guide-posts, and thus the circuit will be automatically broken, after which the switch-lever 20 will be turned upon the idle contact-plate 22. To insure the immersion at the moment of the breaking of the circuit the level of the chilling-fluid is adjusted by pouring more or less of it into the tank. An adjustable stop-sleeve 3″ upon one or more of the guide-posts is used for controlling the depth of immersion.

Other means for breaking the circuit automatically at the instant of immersion may be used; but the arrangement shown is quite effective and insures uniformity of result in successive operations. It will be observed that in this process the whole length of the article or of a number of discrete but like articles is heated at the same time and that the chilling takes place at the same instant in every part of the length of the article, and not progressively from point to point, as has heretofore been suggested. The warping of the articles is thus in a great measure avoided and the degree of hardness imparted to every portion of the length is the same. In this process any of the well-known chilling-fluids may be employed. If oil be used, the articles operated upon will have received both their proper hardness and temper after immersion; but if water be employed the articles will ordinarily be too hard and too brittle, and they must be again slightly heated to receive the required temper. This is done electrically by raising the frame out of the tank and closing the circuit again for a short time with a much greater resistance included than before; but this resistance once ascertained for a given article will be the same in all subsequent operations upon like articles, whereby great uniformity of results is obtained. When only the edge of the article subjected to the process is chilled, as is sometimes the case with saw-blades, the subsequent tempering is effected in the ordinary manner—viz., by allowing the chilled portion to become gradually heated by the unchilled portions, which are ordinarily hot enough for this purpose—and when the proper temper is reached, as is indicated by the color assumed by the chilled portion, the whole article is immersed in the chilling-fluid, whereby the tempering is arrested at any desired stage.

It will be clear that in practicing my process I am not absolutely confined to the use of the identical apparatus described, since other devices, and notably those in common use in electrical manipulations, may be used with advantage.

As hereinbefore stated, the current employed should be of a constant but low potential and of a correspondingly large volume. The generator of such current will necessarily have a very low internal resistance, and for the purposes of my invention this internal resistance must be very low.

The leading-in wires are made very heavy, so that the internal resistance of the generator, together with the resistance of the leading-wires, will be only a very small fraction of the total resistance of the circuit, by far the greater portion of which is represented by the articles clamped in the frame 7. With this construction I secure an automatic regulation of the current passed through the articles operated upon irrespective of their number and also irrespective of the slight and unavoidable differences of resistance between the several articles—that is to say, with this construction it is of very little consequence whether each saw-blade or other article 18 has exactly the same resistance, for it will always receive a current inversely proportionate to that resistance, and all these blades will be heated to the same degree of incandescence at the same time by current from the same source. I am for this reason not obliged to charge the frames 7 completely in each instance, since if the proper relation of resistance is provided a single saw-blade clamped in the frame 7 will be raised to the same degree of incandescence as a dozen or more. This automatic regulation of the current and uniformity of heating of several articles at the same time is the more perfect the greater the resistance of the articles is as compared with the resistance of the remainder of the circuit, and more especially as compared with the internal resistance of the generator, as is well understood by those skilled in the art.

Having now fully described my invention, I claim and desire to secure by Letters Patent—

1. The method or process of hardening and tempering steel or iron articles, which consists in passing a current of the proper heating effect through the whole length of such article until the same has attained a predetermined degree of incandescence, then interrupting the flow of current, and simultaneously therewith immersing the article throughout its whole length in a chilling medium, substantially as described.

2. The method or process of hardening and tempering steel or iron articles, which consists in passing a current of the proper heating effect through the whole length of such article until the same has attained a predetermined degree of incandescence, then interrupting the flow of current and simultaneously therewith immersing the article throughout its whole length in a chilling medium, and then reheating the chilled portions to the required temper, substantially as described.

3. The method or process of hardening and tempering steel or iron articles, which consists in passing a current of the proper heating effect through the whole length of such article until the same has attained a prede-

termined degree of incandescence, then interrupting the flow of current and simultaneously therewith immersing the article throughout its whole length in a chilling medium, and then reheating the chilled article electrically to the required temper, substantially as described.

4. The method or process of hardening and tempering a number of steel or iron articles simultaneously, which consists in passing a current of low potential in multiple - arc branches through the whole length of said articles until they have each attained a predetermined degree of incandescence, then interrupting the flow of current, and simultaneously therewith immersing the heated articles throughout their whole length in a chilling medium, substantially as described.

5. An apparatus for hardening and tempering steel or iron articles electrically, consisting of a frame having means for spacing and clamping said articles therein, a chilling-bath adapted to receive the frame, and an electric circuit including the frame and the articles clamped therein, substantially as described.

6. In an apparatus for hardening and tempering steel and iron articles electrically, the combination of a rectangular frame having two metallic end bars insulated from each other and provided with means for spacing and clamping steel or iron articles therein, between the end bars, a chilling-bath adapted to receive the frame, and an electric circuit having its terminals at the end bars of the frame, substantially as described.

7. In an apparatus for hardening and tempering steel and iron articles, the combination of a frame for clamping the articles, with vertical guides permitting the frame to be raised and lowered, a chilling-bath arranged below the frame for receiving the latter when lowered, and an electric circuit including the guides and the frame, substantially as described.

8. In an apparatus for hardening and tempering steel or iron articles, a rectangular frame having metallic end bars insulated from each other and grooved for the reception of metallic spacing-blocks, in combination with such spacing-blocks and clamping devices therefor and for the articles held thereby, a chilling-bath disposed below the frame, and an electric circuit including the frame, substantially as described.

9. In an apparatus for hardening and tempering steel and iron articles electrically, the combination of a frame for spacing and clamping the articles, with metallic guide-posts for raising and lowering the frame thereon and in electrical contact therewith, a chilling-bath disposed to receive the frame then lowered, an electric circuit including the guide-posts and frame, and insulating-sleeves on the guide-posts for interrupting the circuit when the frame is in its lowest position, substantially as described.

10. In an apparatus for hardening and tempering steel and iron articles, the combination of an electric circuit and a frame having means for including a number of such articles in multiple-arc branches in said circuit, and a chilling-bath disposed to receive the frame, substantially as described.

11. In an apparatus for hardening and tempering steel and iron articles, the combination of a holder for the articles, an electric circuit including the articles in the holder, a chilling-bath disposed to receive the holder, and a cut-out arranged to automatically interrupt the circuit simultaneously with the immersion of the said articles in the bath, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ELIAS E. RIES.

Witnesses:
A. H. HENDERSON,
JOSEPH LYONS.