H. P. MACDONALD.

METHOD OF AND APPARATUS FOR HEAT TREATING METALLIC ARTICLES.

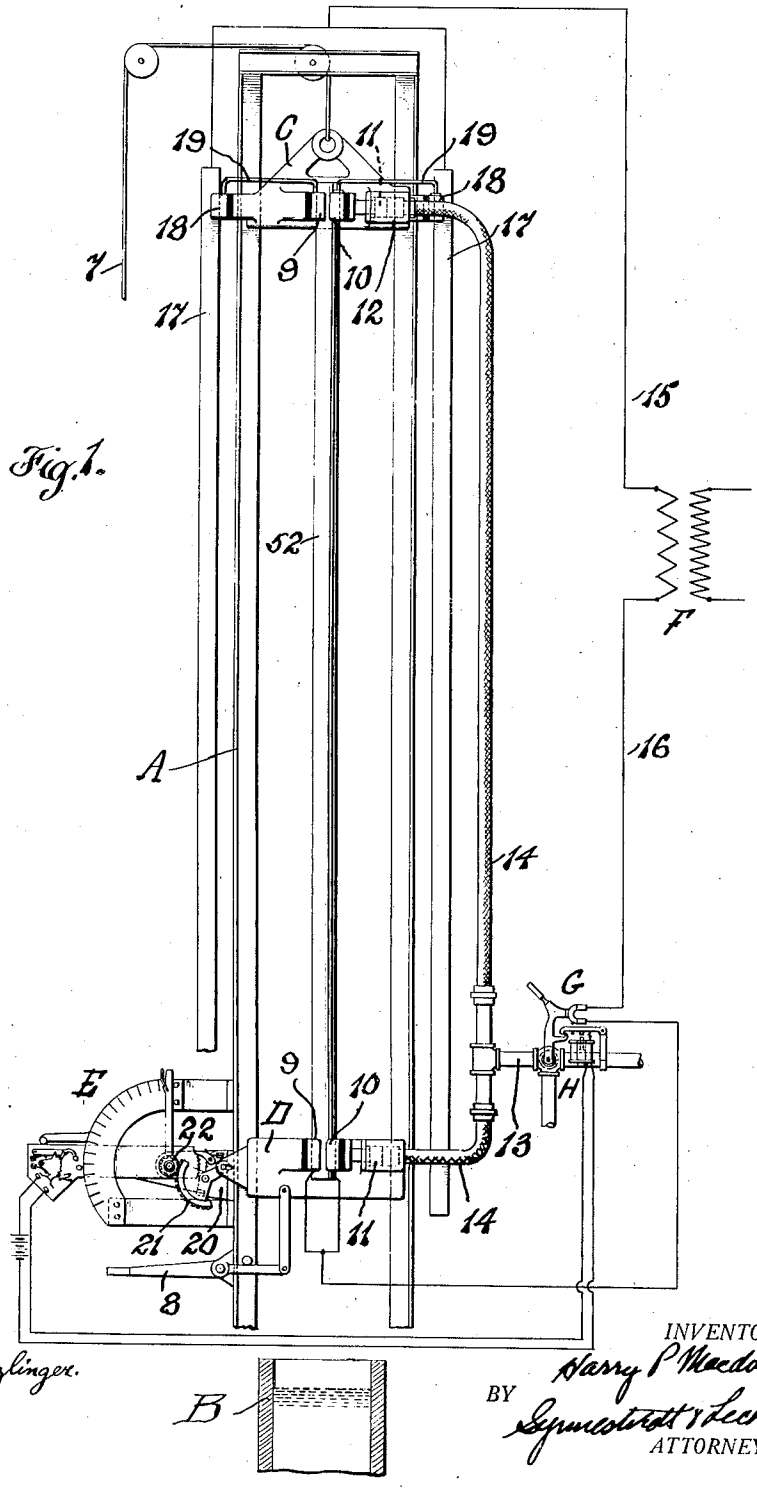
APPLICATION FILED JULY 15, 1920.

1,414,366.

Patented May 2, 1922.

3 SHEETS—SHEET 1.

Fig. 1.



WITNESS.

Gustav Genzlinger.

INVENTOR.

Harry P. Macdonald

BY

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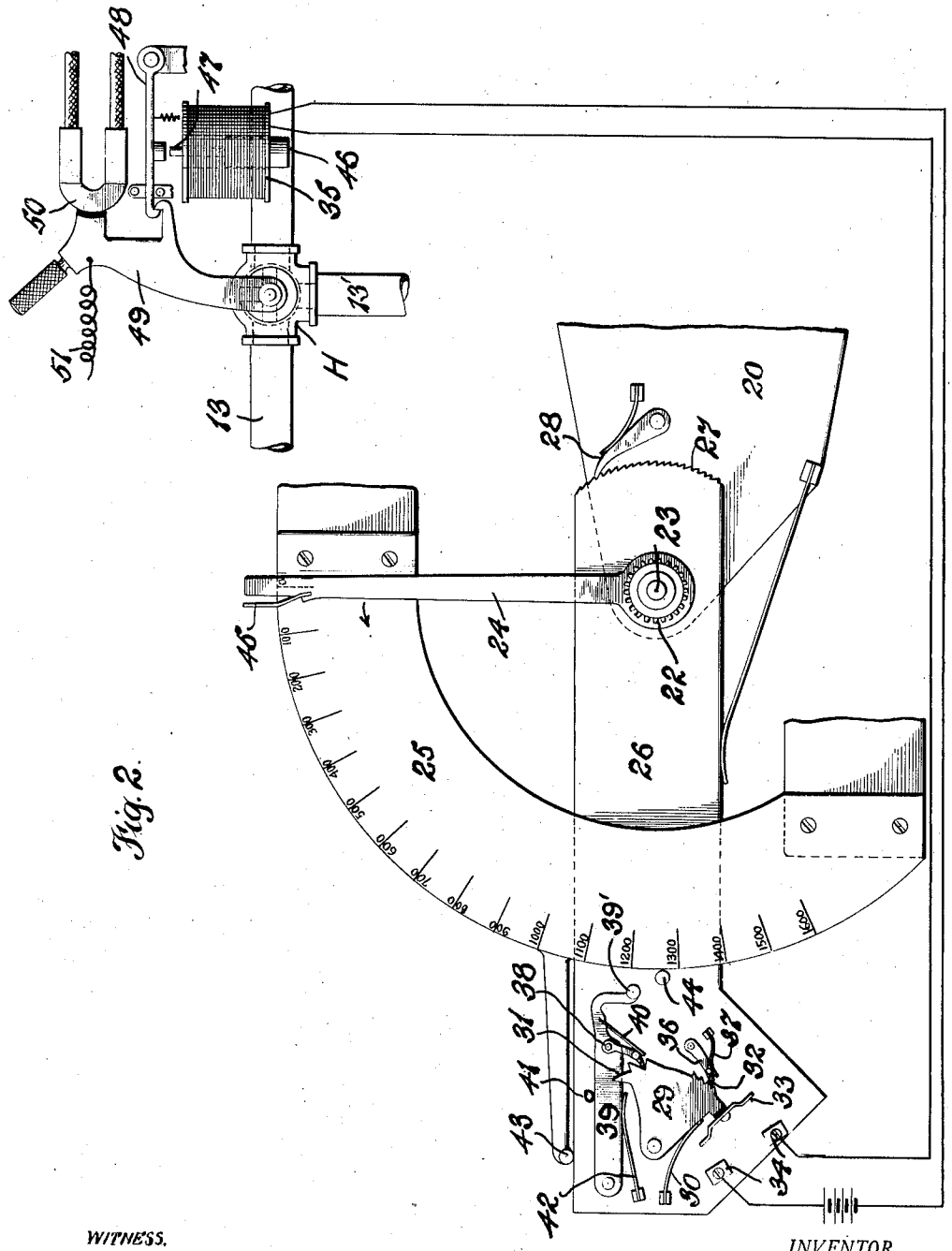


Fig. 2.

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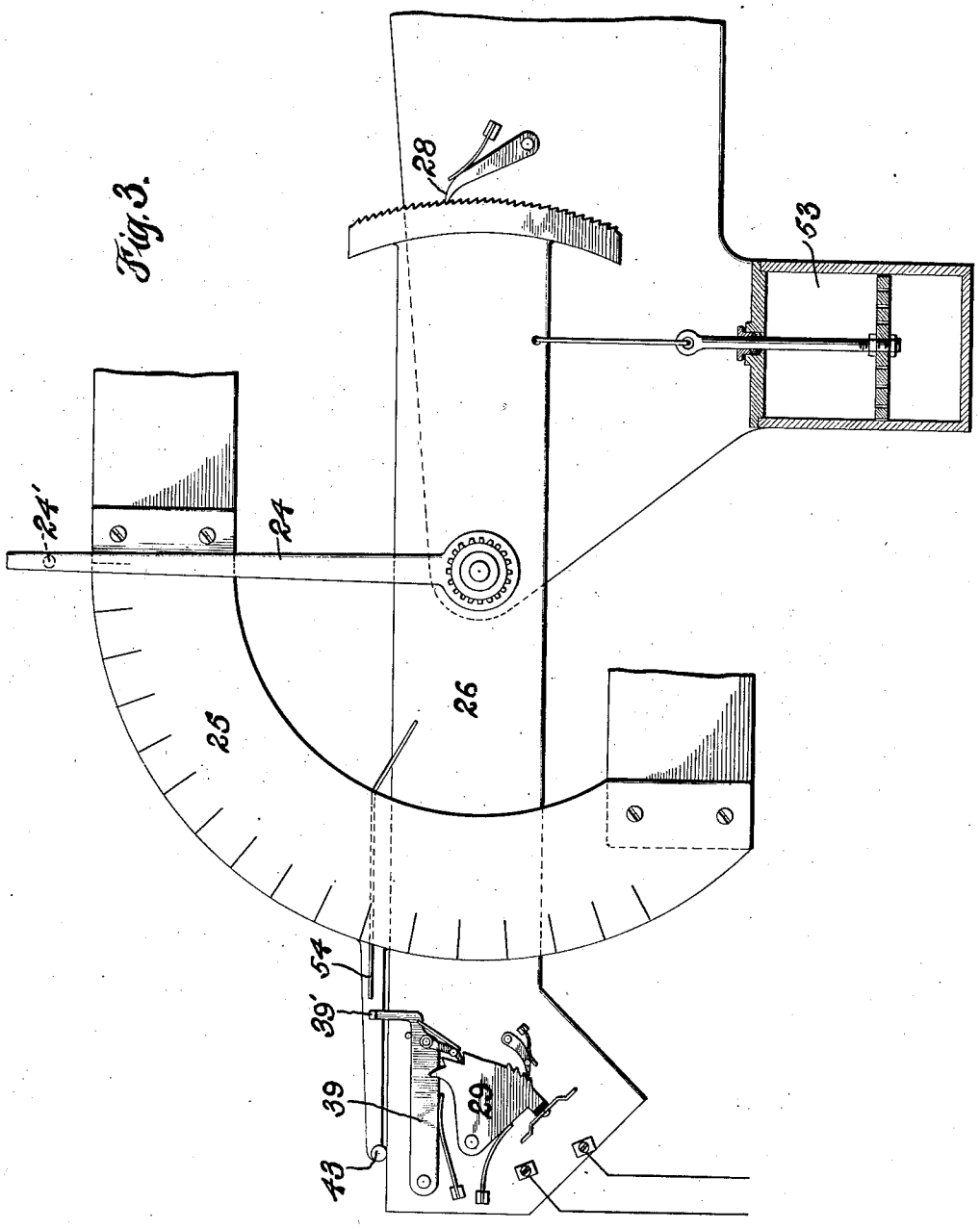
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3 SHEETS—SHEET 3.

Fig. 3.



WITNESS.

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UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR HEAT TREATING METALLIC ARTICLES.

1,414,366. Specification of Letters Patent. Patented May 2, 1922.

Application filed July 15, 1920. Serial No. 396,372.

To all whom it may concern:

Be it known that I, HARRY P. MACDONALD, a citizen of the United States, residing at Montclair, county of Essex, and State of New Jersey, have invented certain new and useful Improvements in Methods of and Apparatus for Heat Treating Metallic Articles, of which the following is a specification.

This invention relates to a method of and apparatus for heat treating metallic articles and it has for one of its primary objects the provision of an improved method whereby the best physical properties for any given steel may be obtained, or, stated in other words, my invention contemplates a method whereby, for any given steel, physical characteristics and properties may be obtained which are superior to those obtainable in standard practice.

Another object of the invention resides in the provision of improved means for automatically terminating the heating, either by discharging the article being treated from the machine or by cutting off the heat, at the time adapted to secure the best physical properties in the steel.

The foregoing, together with such other objects as may hereinafter appear, I obtain by means of improvements illustrated in preferred form in the accompanying drawings, wherein:

Fig. 1 is a side elevation of a heat treating machine embodying my improvements, in diagrammatic form; Fig. 2 is a fragmentary, side elevation of certain features of my invention drawn on an enlarged scale to more clearly illustrate the parts; and Fig. 3 is a view corresponding to Fig. 2 in which a modification of my invention is shown.

I have discovered in the heat treatment of steels, that the best physical properties are obtained if the steel is quenched at that portion of the critical period when the temperature is at a minimum, or stated in other words, at such time, during the critical period as the article has minimum length and is about to again expand. This may be stated, also, in this way; namely, that the critical period is of appreciable length and I have discovered that the physical properties are superior if the quenching is done approximately at the end of the critical period during which physical changes take place in the steel and just precedent to the period succeeding in which absorption of heat units again is represented in rise in temperature and increase in physical dimension. In so far as the method is concerned, therefore, the invention, in its broadest aspect, resides in quenching the steel as near this point as is practical.

One form of mechanism by means of which my invention may be carried out, is illustrated in Fig. 1 and Fig. 2, from inspection of which it will be seen that I have therein illustrated a vertical frame A located above a quenching bath B of oil or other suitable quenching agent, such frame being provided with contact blocks C and D which are slidable in the frame. The upper contact block C is adjustably suspended in the framework by means of a cable 7 and the lower contact block D, while slidable, is capable of being supported temporarily in a definite upper position by means of the treadle mechanism 8. The lower contact block is supported in this manner because of its operative relation with certain automatic actuating mechanism indicated as a whole by the reference letter E, which will be later described. The upper contact block C is adjustably suspended in order that the machine may be accommodated to receive articles of varying length.

Each of the contact blocks is provided with a fixed contact jaw 9 and a movable contact jaw 10, shaped to correspond with that of the article being treated, the movable contact jaws being operated by pistons 11, working in cylinders 12 to which fluid pressure, such as air, is supplied by means of piping 13, leading to a suitable source of supply. Flexible tubing 14 connects the pipe 13 with the cylinders 12. Current is supplied from a transformer F or other suitable source of supply, by means of the conductors 15 and 16, the former of which is connected to the bus bars 17, while the latter is connected to contact jaws 9 and 10 of the lower contact block D. Current from the bus bars is conducted to the contact blocks 9 and 10 of the upper contact block by means of the sliding contacts 18 and the cables 19.

The circuit is controlled by the circuit breaker mechanism G, and the air supply and exhaust is controlled by valve mecha-

nism H, preferably operatively associated with the breaker mechanism.

The automatic actuating mechanism E and the breaker and valve mechanism will now be described, attention being directed to Fig. 2 particularly. Secured to the frame at a point adjacent the lower contact block D is a bracket 20 on which is pivoted a gear segment 21, having a connection with the contact block D such that the gear segment is rotated on movement of the contact block down or up. The gear segment 21 meshes with a pinion 22 on the shaft 23 which is also mounted in the bracket 20 for rotation. Fast to the shaft 23 is an indicator arm 24 associated with a temperature or other dial 25, secured to the frame by the brackets shown. Mounted on the same shaft 23 but rotatable with respect thereto, is an arm 26, the inner end of which is provided with ratchet teeth 27 adapted to be engaged by a spring held pawl 28. The outer end of the arm 26 projects beyond the dial 25 and it is provided with a ratchet sector 29 yieldingly held in the position indicated in Fig. 2 by means of the spring 30, such ratchet sector being provided with one set of ratchet teeth 31 and with a contact blade 33 adapted to make contact with the contacts or terminals 34 of an electrical circuit controlling a solenoid 35. The ratchet teeth 32 are engaged by a pawl 36 held in engagement therewith by a spring 37 and the ratchet teeth 31 are adapted to be engaged by a pawl 38, pivoted on an arm or lever 39 and normally held in engagement by means of a spring 40. The lever 39 is normally held in upper position against the stop 41 by means of a spring 42, such lever being pivoted to the arm 26. The dial 25 is provided with a stop 43 which limits the upward movement of the arm 26. The arm 26 is provided with a stop 44, and the pointer 24 is provided with a spring 45 at its free end.

The armature 46 of the solenoid 35 is provided with a striker 47 adapted to release the spring held latch 48 which normally holds the circuit breaker arm 49 in a position in which the contact 50, carried by such arm, closes the main circuit.

The three-way valve H in one position connects the pipe 13 with the source of fluid pressure supply and in its second position, cuts off the supply and establishes communication between the pipe 13 and the pipe 13′, which latter is open to the atmosphere. The ports in the valve are so arranged as to supply air pressure to the cylinder 12 previous to the closing of the main circuit by the circuit breakers arm 49, it being understood that such circuit breaker arm is fast to the stem of the valve. The circuit breaker is normally held in open position by means of the spring 51.

The operation is as follows: Assuming that the article, such as a tube 52 is held in the machine, the operator moves the circuit breaker arm 49 toward circuit closing position, thus first opening the valve H to admit fluid pressure to the cylinders, after which, at the end of the movement of the circuit breaker arm, the main circuit is closed, so that the movable jaws 10 will be actuated to grip the article, before the current is turned on in order to prevent injury to the workman. The other portions of the automatic actuating mechanism are in the position indicated in Figs. 1 and 2. As the tube becomes heated by its internal resistance to the passage of the current therethrough, it begins to expand and the arm indicator 24 swings in the direction of the arrow by reason of the fact that as the article expands, the contact block D lowers and imparts movement to the segment 21 which in turn rotates the shaft 23 through the medium of the pinion 22. It will be understood that the mechanism for operating the indicator arm 24 is so arranged as to greatly amplify the expansion of the tube. The movement of the indicator 24 continues and the spring 45 comes into engagement with the abutment 39′ of the lever 39 and depresses such lever as the movement of the indicator continues, thereby shifting the ratchet sector 29 downwardly until such time as the indicator arm engages the stop 44 of the arm 26, at which time further rotative movement of the ratchet 29 ceases and the ratchet is held in its new position by means of the pawl 36. After the indicator arm 24 has come into engagement with the stop 44, the arms 24 and 26 move in unison until the critical or decalescent point is reached, that is to say, the point at which the tube will absorb heat units without a rise in temperature and without further expansion. During this critical period physical changes in the field take place and in most steels, during such period, not only does expansion cease but contraction takes place so that the arm 24 has a retrograde movement away from the stop 44 during such period. The arm 26, however, will remain stationary during the critical period because the pawl 28 will hold it in its new position.

During the retrograde movement of the indicator 24 the spring 42 will return the lever 39 to its upper position against the stop 41 whereby the pawl 38 will engage the upper tooth of the ratchet teeth 31. At the end of the critical period during which the physical changes above noted take place in the steel, the article again begins to expand and the indicator arm 24 again advances immediately reengaging the stop 39′ of the lever 39 and depressing such lever, whereby additional movement is imparted to the ratchet 29 and the contact strip or bar 33 is brought into engagement with the termi-

nals 34 closing the circuit of the solenoid 35, the armature of which advances to release the latch 48, whereupon the spring 51 shifts the breaker arm 49 to open the circuit and to serially close the valve H and establish communication between pipes 13 and 13′ whereby the air in the cylinders 12 is exhausted to the atmosphere, the jaws open, and the tube 52 is automatically discharged into the bath B.

It will be seen from the foregoing that the heat is cut off and the article quenched as nearly as it is possible to do so at the end of the critical period during which physical change takes place and approximately at the time when the tube is of minimum length and minimum temperature in such period. I thus obtain the quenching of the tube at the time at which the best physical properties of the steel are fully developed.

It will further be noted that the apparatus is such that regardless of the exact temperature at which the critical point of the particular steel being treated occurs, the work will be automatically discharged from the machine at the proper moment in the heating cycle. It is only necessary, in this regard, to so position the stop 43 and the arm 26 that the stop 44 will be engaged by the indicator arm 24 before the critical period is reached. Inasmuch as the critical period can be readily approximated for any given steel, it is a simple matter to position the arm 26 with sufficient leeway within which to accomplish the shifting of the parts carried thereby. As a matter of fact, the stop 43 could be entirely omitted, the purpose of its provision being to make the machine proof against careless operation.

Referring now to the construction shown in Fig. 3, this is devised to meet such steels which, because of their composition, or for other reasons, have but little or no contraction during the critical period, expansion merely practically pausing. With such a steel there will be little or no retrograde movement of the indicator 24, to meet which condition I have provided the following arrangement: The arm 26 is provided with a dash pot mechanism 53, preferably filled with oil or other heavy liquid and it is also provided with a spring 54, the remaining parts being substantially the same as those described.

The operation of this modification is as follows: A short interval before the critical period is reached, the stop 24′ on the arm 24 will engage spring 54 and depress the latter, allowing the indicator arm 24 to depress the lever 39 by engagement with the stop 39′ thereof, shifting the ratchet sector and associated parts as before described. When the spring 54 is practically flattened, arm 26 will move with arm 24 until the critical point is reached, and during the critical period arm 24 will substantially remain stationary, with the result that the spring will react from the arm 24 as a base and shift the arm 26 downwardly a short distance, thereby permitting the levers 39 to be again shifted to upper position, so that its stop 39′ will be reengaged by the stop 24′ of the indicator arm 24 when the movement of the latter again begins, which will effect the closing of the solenoid circuit, as previously described. This peculiar operation of the spring 54 results from the fact that the spring, while insufficient to impart movement of the arm 26 until the spring is practically flat, nevertheless, has sufficient strength to shift the arm 26 after the latter is once in motion and the resistance of the dash pot and the pawl 28 overcome.

It will be seen from the foregoing that I have described the apparatus as designed to operate during the decalescent period, which is the technical term defining the critical point or period on rising temperatures. This same point or period is called the recalescent period when the steel reaches the temperature at which this point occurs on cooling from higher temperatures. The behavior of the steel in cooling from higher temperatures through the recalescent point is approximately opposite to what takes place during the decalescent period and, therefore it will be seen that by reversing the arrangement of the parts, the device can be used with substantially the same effect, with little or no modification, to secure the same results during recalescence.

One important advantage incident to my invention is that uniformity in product is assured, and this irrespective of the length, composition or other varying factors of the articles being treated. The mechanism need not be set for any particular line of articles and does not require resetting for every departure.

I claim:

1. The herein described method of heat treating metallic articles which consists in cutting off the heat and in quenching at approximately the end of the critical period.

2. The herein described process of heat treating metallic articles which consists in quenching the article approximately at the end of the critical period.

3. The herein described method of heat treating metallic articles which consists in heating the article approximately through the critical period and in quenching the article approximately at the end of such period.

4. The herein described method of heat treating metallic articles which consists in quenching the article when it is at approximately its minimum length during the critical period.

5. The herein described process of heat

treating metallic articles which consists in terminating the heating at approximately the minimum temperature during the critical period and in quenching the article.

6. The herein described process of heat treating metallic articles which consists in supporting the article in a heating apparatus for automatic discharge therefrom and in effecting such discharge by mechanism actuated upon by the article itself at approximately the end of the critical period.

7. The herein described process of heat treating metallic articles which consists in supporting the article in a heating apparatus for automatic discharge therefrom and in effecting such discharge by mechanism actuated by the article itself through the phenomena occurring at the critical period.

8. The herein described process of heat treating metallic articles which consists in heating the article and in utilizing one or more of the phenomena occurring at the critical period to terminate the heating.

9. In heat treating apparatus the combination of means for heating the article and mechanism for automatically terminating the heating, said mechanism being associated with the article in such manner as to be responsive to the physical change or changes occurring in the article at the critical period.

10. In heat treating apparatus the combination of means for releasably supporting the article for the heating, means for heating the article, and mechanism for effecting the release of the article associated therewith so as to be responsive to the physical change or changes occurring in the article at the critical period.

11. In heat treating apparatus the combination of means for releasably supporting the article for the heating, means for heating the article, and mechanism for effecting the release of the article associated therewith so as to be responsive to the physical change or changes occurring in the article at the critical period, together with a quenching medium into which the article is released.

12. In heat treating apparatus the combination of a support for the article to be heated, and means effecting the release of the article including two members one of which is associated with the article to be moved as the article expands and the other of which is moved by the first member on movement of the latter in one direction.

13. In heat treating apparatus the combination of a support for the article to be heated, and means effecting the release of the article including two members, one of which is associated with the article to be moved as the article expands and the other of which is moved by the first member on movement of the latter in one direction together with means holding the second member in the position to which it has been shifted by the first menber.

14. In heat treating apparatus the combination of a support for the article to be heated, and means effecting the release of the article including two members, one of which is associated with the article to be moved as the article expands and the other of which is moved by the first member on movement of the latter in one direction together with mechanism adapted to be operated on by the second member in its movement.

15. In heat treating apparatus the combination of a support for the article to be heated, means for heating the article, and a means for effecting the release of the article and for terminating the heating, including two members, one of which is moved through the medium of the article itself as it undergoes the heating operation and the second of which is moved by the first member on movement of the latter in one direction, and mechanism actuated by the second member to terminate the heating and to release the article.

16. In heat treating apparatus, the combination of a releasable support for the article being heated, means for electrically heating the article, and a common means for operating the support and for cutting off the current serially.

17. In heat treating apparatus, the combination of a releasable pressure operated support for the article, means for supplying pressure to hold the support in article engaging position, and means actuated by the physical change in the article during heating to control the pressure supply.

18. In heat treating apparatus, the combination of a releasable pressure operated support for the article, means for supplying pressure to hold the support in article engaging position, and means actuated by the physical change in the article during heating to control the pressure supply and exhaust.

19. In heat treating apparatus, the combination of a releasable support for the article being heated, means for electrically heating the article, and a circuit breaker together with operating means therefor actuated by the physical change or changes occurring in the article during the critical period.

20. In heat treating apparatus, the combination of a support for the article, means for heating the article electrically, a circuit breaker releasably held in closing position, electro-magnetic means for releasing the breaker, a circuit therefor normally interrupted, and means for closing the circuit actuated through the physical change in the article undergoing heat treatment.

21. In heat treating apparatus means for heating the article and means for cutting off the heat, the latter means being actuated by

the variations in the physical dimensions of the article occurring during the critical period.

22. In heat treating apparatus means for heating the article and means for cutting off the heat, said means being actuated by the variations in rate of expansion of the article during the critical period.

23. In heat treating apparatus a combination of a releasable support for the article being heated, means for electrically heating the article and means for cutting off the heat and releasing the article from its supports, said means being actuated by the variations in expansion of the article during the critical period.

24. In heat treating apparatus a combination of a releasable support for the article being heated, means for electrically heating the article and means for cutting off the heat and releasing the article from its supports, said means being actuated by alternating contraction and expansion of the article during the critical period.

In testimony whereof, I have hereunto signed my name.

HARRY P. MACDONALD.