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G. W. WATSON

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HEAT TEMPERING AND HARDENING METHOD FOR METALS

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Fig. 1.

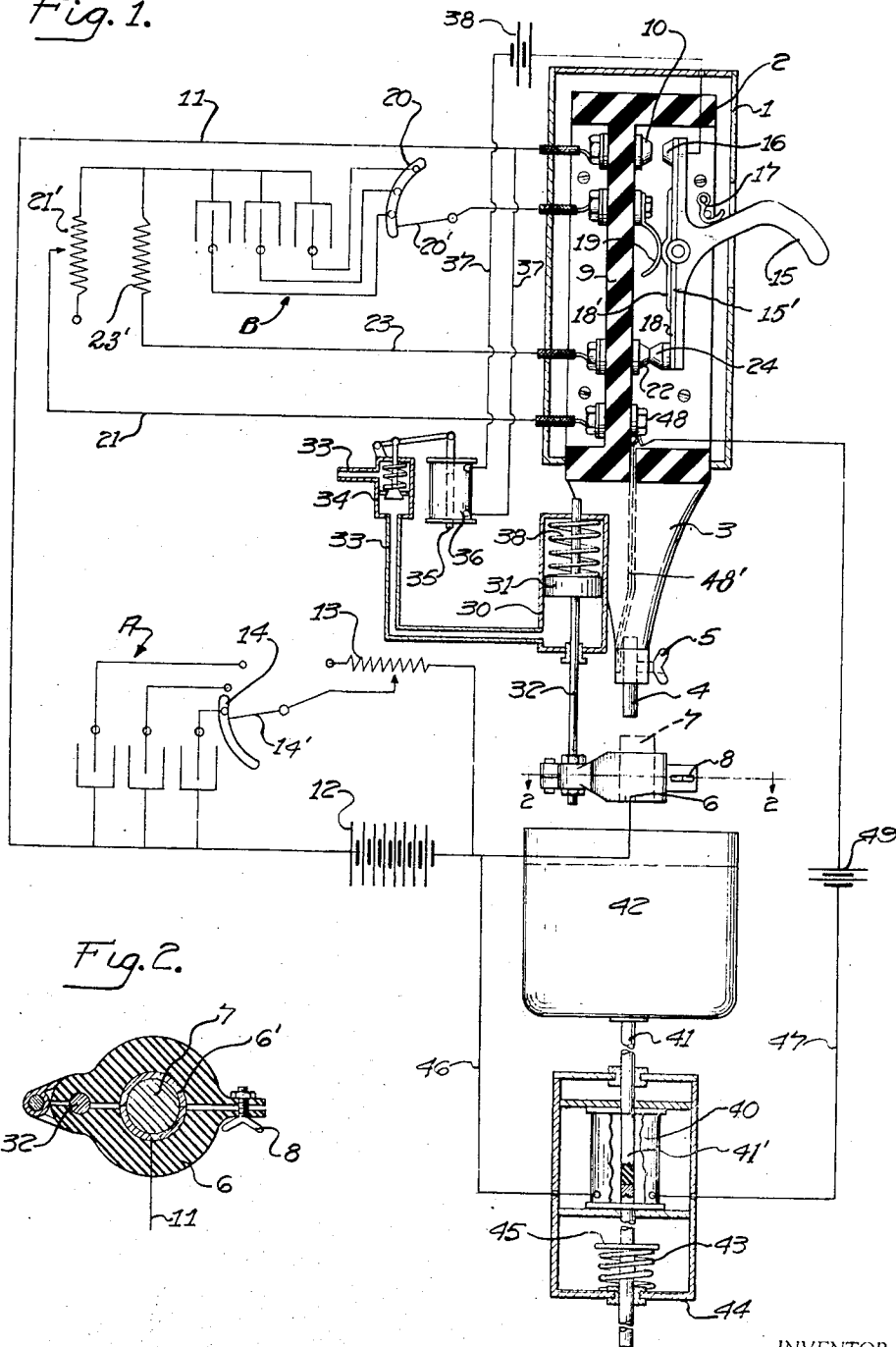
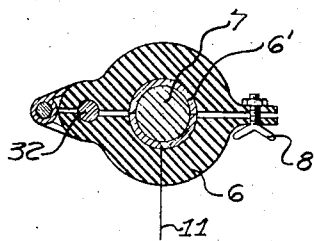


Fig. 2.



INVENTOR.
Glenn W. Watson.
BY Samuel Weisman
ATTORNEY.

UNITED STATES PATENT OFFICE

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HEAT TEMPERING AND HARDENING
METHOD FOR METALSGlenn W. Watson, Detroit, Mich., assignor to Pen-
weld Corporation, Detroit, Mich., a corporation
of Michigan

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4 Claims. (Cl. 148—10)

The present invention pertains to a novel method of heat tempering and hardening metals by means of an electrical treatment. The principal object of the invention is to provide a novel, rapid, effective and economical method for this purpose.

I have discovered that peculiar phenomena occur in the metal under treatment when the current in the circuit is controlled by two sets of condensers, one set limiting the amount of current flowing to the work under treatment and the other set simultaneously discharging into the work. In other words, one set of condensers becomes charged and the other set discharges during the treatment. The result is a striking change in the hardness of the metal, and the result may be controlled both as to hardness and brittleness by regulation of the capacities of the condenser sets and of the quenching operation, as described herein.

The work is mounted as a terminal in the circuit and is engageable by another terminal whereby a circuit through the work is completed. This circuit contains a primary source of current for charging the sets of condensers. The set previously described as discharging into the work becomes charged when the circuit is opened at the terminals, at which time the other set discharges at a remote point.

The theoretical basis of the electrical action on the metal has not as yet been determined, but it is evident that the work receives the current simultaneously from two sources, namely, the primary current source and the condenser set that discharges into the work. It has been found that these two currents are out of phase with each other and combine to prolong the application of the current to the work at the peak voltage, resulting in very rapid and effective treatment of the metal.

As already indicated, the amount of current taken by the work directly from the primary source is limited by the condenser set that becomes charged during the operation. The apparatus includes, in the circuit, a main switch with contacts adapted, in one position, to discharge the last named set externally of the work, and in another position, to permit the primary current source to charge said set through the work. The remaining condenser set is so mounted as to be normally charged by the primary current source and to discharge into the work while the main switch contacts are in the last described position.

The apparatus also includes means whereby the

last mentioned position of the main switch contacts causes the work to approach the adjacent terminal, or vice versa, through the action of an electrically controlled air cylinder or equivalent apparatus. Further included in the apparatus is an automatically movable quenching tank adapted to approach and immerse the work at the desired interval after current has started to flow into the work. The actuating apparatus for the immersing tank is preferably electrical and controlled by the closing of the circuit through the work. The duration of the time delay before immersion is regulated by adjusting the distance that the tank must travel to the work, or by some equivalent means.

The invention is fully disclosed by way of example in the following description and in the accompanying drawing, in which

Figure 1 is a sectional view of the mechanical parts of the apparatus, showing the wiring diagrammatically, and

Figure 2 is a section on the line 2—2 of Figure 1.

Reference to these views will now be made by use of like characters that are employed to designate corresponding parts throughout.

The main switch is contained in an enclosure 1 in which is suitably mounted an insulating body 2 for carrying the several contacts of the switch, as will presently be described. The lower end of the body is preferably tapered at 3 to carry an electrode or terminal 4 adjustably held by a set screw 5. Opposite the member 4 is a suitable work holder 6 in the form of a vise in which the work piece 7 is secured by turning a tightening screw 8 in the usual manner.

The insulating body 2 includes a wall or partition 9 on which the contacts are mounted. One of these contacts designated by the numeral 10 is connected through the wall 9 to a main conductor 11 leading to the work holder 6. The jaws of the holder are preferably insulated on the outside or may consist of insulating material with conductors 6' on the inner surface for engaging the work and to which the conductor 11 is connected, as illustrated in Figure 2. This conductor contains the primary current source 12 which is more commonly in the nature of an electric generator. Across the source 12 is connected a set of condensers A, and in series therewith is a variable resistance 13 for regulating the quantity of current taken by the group A. One side of each condenser is connected into the line, and the remaining sides are connected respectively to terminals of a multiple switch 14. The arm

14' of the switch is so mounted as to engage one or more of the terminals and thus bring a corresponding number of condensers into the circuit.

Adjacent to the wall 9 is pivotally mounted a switch operating handle 15 having a cross piece 15' lying parallel to the wall. One end of the piece 15' carries a contact 16 adapted to engage the contact 10 on pulling the trigger. These contacts, however, are normally separated by the action of a spring 17 bearing on the handle 15. A conductor 18 is mounted on the back of the piece 15' and is in permanent engagement with a spring contact 19 carried by the wall 9, through a wear piece 18'. The latter is connected through the wall to the movable member 20' of a multiple switch 20 similar to the switch 14. The terminals of the switch 20 are connected to the condensers of a group B, the remaining sides of the condensers being joined by a conductor 21 to the terminal 4 through the binding post 48 and conductor 48'. In the conductor 21 is mounted a variable resistance 21' for regulating the amount of current taken by the group B. By means of the switch 20, one or more of the condensers of group B may be thrown into the circuit.

In connection with the groups A and B, only one condenser may be provided rather than a set, and the regulation obtained by other means.

Another fixed contact 22 is mounted in the wall 9 and is joined by a conductor 23 and resistance 23' to the conductor 21 at a point between the variable resistance 21' and the set B. The contact 22 is normally engaged by another contact 24 mounted on the piece 15' and permanently engaged by the strip 18.

It is desirable to automatically bring the work 7 in engagement with terminal 4 on pulling the switch handle 15 to close the main circuit. Accordingly, there is provided an air cylinder 30 with a piston 31 slidable therein. The rod 32 of the piston is rigidly connected to the clamp 6 to move it with the piston. An air line 33 extends to the cylinder and is equipped with a valve 34. The valve in turn is rigidly connected to the moving plunger 35 of a solenoid 36, and the parts are so mounted that the valve is opened when the solenoid is energized. The ends of the solenoid are joined respectively to the contacts 10 and 16 by conductors 37. In one of these conductors is an independent current source 38 for energizing the solenoid 36.

The quenching mechanism comprises a solenoid 40 having a core or plunger 41 carrying a quenching tank 42 directly below the holder 6 and of sufficient size to contain it. A portion of the plunger 41 consists of insulating material 41' so that the plunger will be raised when the solenoid is energized. The drop of the tank is cushioned by a spring 43 resting on a support 44 and engageable by a disc 45 carried by the plunger. One terminal of the solenoid 40 is connected by a conductor 46 to the conductor 11 at a point between the source 12 and the work holder 6. The other terminal is connected by a conductor 47 to the conductor 21 by means of a binding post 48. An independent current source 49 is provided in one of the solenoid conductors, so that the supply of current to the solenoid 40 depends on the contacting of member 4 and work piece 7.

By this means of operation, the quenching tank is raised only after the work 7 begins to receive current. The interval between the commencement of current flow and the actual quenching may be regulated by adjusting the distance between the work 7 and the tank 42,

which may be done by an adjustment of the electrode 4 and work 7 at screws 8 and 5. This time interval is important in the results obtained and may be reduced practically to zero by bringing the tank 42 in its rest position very close to the work holder or may be prolonged by increasing the distance between the work holder and the tank in the rest position of the latter.

In the heat treating operation, the work 7 is placed in the holder 6 where it comes into electrical contact with conductor 11 and source 12 as previously described. The switch handle 15 is then pushed upward to close a circuit through the solenoid 36 and its independent source 38. At this time, the contacts 10 and 16 are also brought together, completing a circuit from the work 7, through the source 12, conductor 11, contacts 10 and 16, strip 18, contact 19, switch 20, 20', condenser group B, variable resistance 21', conductor 21 to the terminal 4. The source 12 delivers current to the terminals 4 and 6 but only to the extent permitted by the capacity of condenser group B which becomes charged and then obstructs further flow of current through the circuit. In this manner the set B limits the amount of current delivered from the source 12 to the work. At the same time, the group A which is normally charged by the source 12, also discharges into the work inasmuch as it is permanently connected in parallel with the closed circuit outlined above.

When the switch handle 15 is released, the spring 17 separates the contacts 10 and 16 to break the main circuit and also brings the contacts 22 and 24 together. The previously charged group B is thereupon discharged through a closed circuit comprising the switch 20, conductor 23, contacts 22 and 24, conducting strip 18 and conductor 19. The discharging of group B prepares it for its function in limiting or measuring the flow of current from the source 12 into the work by becoming charged when the main circuit is again closed by pushing the switch handle 15.

On separation of the contacts 10 and 16, the valve 34 in line 33 closes, and a spring 38 in cylinder 30 causes the piston 31 to withdraw the work 7. Separation of the terminals 4 and 7 obviously permit condenser group A to charge from source 12.

It has already been pointed out that the current flowing from source 12 into the work is limited by condenser group B. According to the present invention, this current is supplemented by the discharge of condenser group A into the work. The peculiar hardening of the metal under this treatment may be explained on the theory that transients or peak voltages of the concurring currents from source 12 and group A are combined in a peculiar manner. This phenomenon might be further explained by the following considerations. Both condensers are connected to and receive their charges from the one battery; but at any given time, one condenser set is in a charged state and the other in a discharged state. When the circuit is closed at the terminals 4 and 6, the charging of group B (by the source 12) and the discharge of group A occur simultaneously, thereby producing two currents entering the work, one from the source (charging group B) and the other from discharging group A.

A graph of the current which passes into and from either condenser shows a high initial voltage of very short duration. Inasmuch as the effect of the charging current and the discharging current of the condenser groups, respectively, is more than merely cumulative, it appears

that the charging current and the discharging current flow to the work out of phase with each other, thereby increasing the duration of maximum voltage and resulting in a high temperature in a comparatively short period of time.

In the event that the terminal 4 welds to the work 7, the terminal may readily be released at the set screw 5 and hammered or ground off the work, while another terminal is inserted in the tip 3.

As already indicated, the closing of the circuit at the terminals 4 and 6 starts the quenching tank 42 in motion. In this connection, it is to be noted that the quenching operation although automatic, is deferred until the current begins to flow into the work, while the actual time interval preceding the quenching is regulated in the manner described above. The nature of the heat treatment is controlled by the last named regulation and the adjustment of the switches 14 and 20.

Although a specific embodiment of the invention has been illustrated and described, it will be understood that various alterations in the details may be made without departing from the scope of the invention, as indicated by the appended claims.

What I claim is:

1. In a method of treating a metal body for tempering or hardening the same, the steps consisting of heating the metal by applying opposite terminals from a given current source respectively to spaced areas of the metal, simultaneously discharging into the metal in the same circuit with said source a condenser previously charged by said source, and limiting the quantity of current taken from the source by charging another condenser disposed in the same circuit with and between the source and the metal.

2. In a method of treating a metal body for tempering or hardening the same, the steps consisting of heating the metal by applying opposite terminals from a given current source respectively to spaced areas of the metal, simultaneously discharging into the metal in the same circuit with said source a condenser previously charged by said source, and at the same time charging another condenser in the same circuit in series with the source and the metal, whereby the last named condenser limits the quantity of current delivered from the source to the metal.

3. In a method of treating a metal body for tempering or hardening the same, the steps consisting of heating the metal by applying opposite terminals from a given current source respectively to spaced areas of the metal, simultaneously discharging a condenser into the metal out of phase with the source current and in the same circuit with said source, and limiting the quantity of current taken from the source by charging another condenser disposed in the same circuit with and between the source and the metal.

4. In a method of treating a metal body for tempering or hardening the same, the steps consisting of heating the metal by applying opposite terminals from a given current source respectively to spaced areas of the metal, simultaneously discharging a condenser into the metal out of phase with the source current and in the same circuit with said source, and at the same time charging another condenser in the same circuit in series with the source and the metal, whereby the last named condenser limits the quantity of current delivered from the source to the metal.

GLENN W. WATSON.