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L. K. MARSHALL

2,294,413

METHOD OF LOCALLY HEAT-TREATING METAL BODIES

Filed April 25, 1939

FIG. 1.

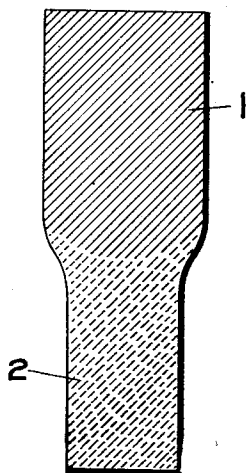


FIG. 2.

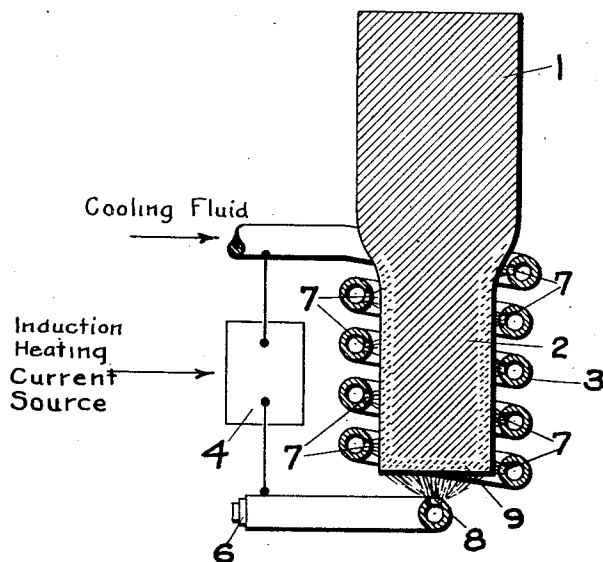


FIG. 3.

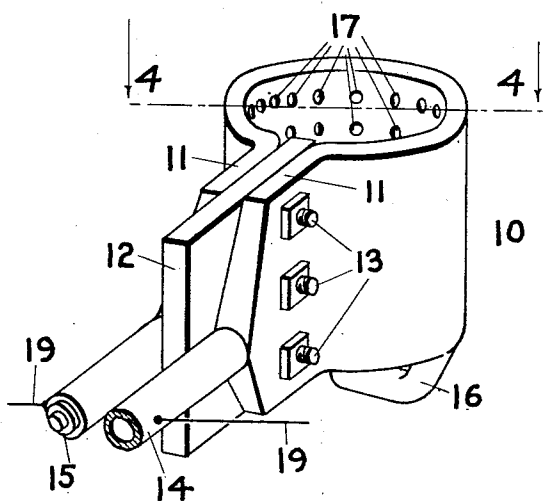
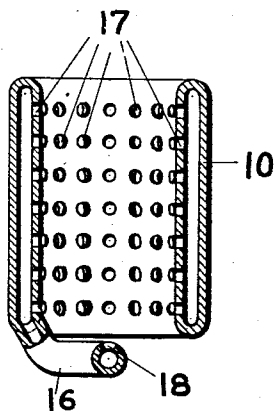


FIG. 4.



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UNITED STATES PATENT OFFICE

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METHOD OF LOCALLY HEAT-TREATING
METAL BODIES

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10 Claims. (Cl. 148—10)

This invention relates to a method of locally heat-treating metal bodies, and more particularly to a method of producing a metal body with a different temper on the inside than on the outside thereof. It is often desirable to produce a body having a hardened exterior and a relatively soft interior, for example in the case of punches. It is also desirable to be able to regulate accurately the thickness of the hardened exterior. Previous methods which have attempted to accomplish this end have required a high degree of skill in carrying them out, and have not produced uniformly satisfactory results.

An object of this invention is to devise a method for accomplishing the above purpose which is simple, and which requires only a low degree of skill in order to produce the desired results.

Another object of this invention is to devise such a method in which high frequency induction heating currents are utilized.

A further object of this invention is to secure a more accurate control over the varying degrees of temper as well as the relative depths of said tempers.

A still further object is to devise a method which utilizes the high frequency heating current in an efficient manner so as to produce a relatively inexpensive process.

The foregoing and other objects of this invention will be best understood from the following description of exemplifications thereof, reference being had to the accompanying drawing, in which:

Fig. 1 is a cross-section of a punch in an intermediate stage of treatment;

Fig. 2 is a cross-section of said punch inserted in a high frequency heating current coil illustrating a final stage of treatment;

Fig. 3 is a perspective view of a modified form of heating coil; and

Fig. 4 is a cross-section taken along line 4—4 of Fig. 3.

In Fig. 1 there is illustrated a punch 1 having a lower end 2 to which it is desired to give the proper temper relationships for best operating purposes. This lower end 2 is first hardened by the usual heating and quenching treatment, or by any other suitable method. For this purpose relatively inexpensive sources of heating may be utilized, and no attempt need be made to determine the depth to which the hardening takes place. It is merely necessary that the surface of the portion 2 be given the requisite final temper. This may readily be tested by hardness-testing machines inasmuch as in accordance with the

present invention this initial hardness which is given to the surface of the portion 2 is preserved in the final form of the punch. The dotted cross-section lines in the lower portion of Fig. 1 represent such a hardened state. As therein indicated, this hardness may extend throughout the entire diameter of the portion 2.

The punch, prepared as described above, is then inserted within the turns of an induction coil 3. This induction coil consists of a number of turns of a hollow electrical conducting tube. A source of high frequency current of the order of 1000 cycles, for example, is connected between the upper and lower ends of said induction coil 3. Upon energization of the coil by the source 4, heating currents are induced within the portion 2 of the punch 1, and thus this portion tends to be heated to a degree which would draw the temper previously produced therein and soften said portion. However, in order to preserve the exterior hardness, cooling fluid is passed into the upper or open end 5 of the induction coil, the lower end of which may be closed by a plug 6. The inner surfaces of the turns of the coil 3 are provided with a plurality of apertures 7, disposed around all sides of the portion 2. The coil 3 may also be shaped so as to provide one or more openings 8 which are directed to the bottom of the punch. Upon passing cooling fluid into the open end 5 of the coil 3, this cooling fluid is ejected through the openings 7 and 8, comes into contact with the surface of the portion 2, and thus maintains it at any desired temperature. The temperature and rate of flow of the cooling fluid is so determined that the surface temperature of the portion 2 stays below the point at which the temper thereof would be drawn. By regulating the power input to the coil 3, likewise the temperature of the interior of the portion 2 may be determined. Thus by maintaining these conditions for a predetermined length of time, the interior of the portion 2 will have its temper drawn, and will become soft, while the exterior surface thereof will remain in the hardened condition. By regulating the temperature and flow of cooling fluid and the power input to the coil 3, the depth of the resulting hardened shell on the outside of the portion 2 can be very accurately determined. Inasmuch as the temperature to which it is necessary to raise the interior of the portion 2 to draw the temper thereof is less than that which would initially be required to harden it by heating and quenching, the amount of high frequency power for this purpose can be made very much less than if the

entire punch were heated by high frequency current and then quenched in order to harden it. This step, therefore, of drawing the temper of the interior of the punch by high frequency currents represents a relatively inexpensive expenditure of high frequency power.

Instead of using a plurality of turns for the heating coil in some instances it may be desired to use but a single turn coil, such as is illustrated in Fig. 3. In this figure there is shown a single turn coil 10 having flattened end portions thereof clamped on opposite sides of an insulating plate 12 by means of bolts 13. The bolts 13 are insulated from the ends 11 by any well-known means as, for example, by having the bolts themselves formed of insulating materials. The coil 10 is provided with an open inlet tube 14, and may have the opposite tubular end thereof closed by means of a plug 15. The coil 10 may also have a bottom spray tube 16 connected to the lower end thereof. In order for cooling fluid which is passed into the inlet tube 14 to spray onto a body inserted within the coil 10, the interior surface of the coil is provided with a plurality of openings 17 which direct cooling fluid to the sides of such an inserted body, while the spray tube 16 may be provided with one or more openings 18 which spray cooling fluid upon the bottom of such an inserted body. As in the case of Fig. 2, high frequency heating current may be connected to the ends of the coil 10 by means of conductors 19 electrically connected to the ends 14 and 15 of said coil.

The cooling fluid which is used may be water, oils, solutions of various kinds, various mixtures of fluids, and the like. In some instances these fluids may be conducting or they may be non-conducting. Where the fluid has a tendency to short-circuit the turns of the heating coil, the single turn coil, such as that shown in Fig. 3, may be used, while in other instances the multiple turn coil, indicated in Fig. 2, may be used.

Of course it is to be understood that this invention is not limited to the particular details as described above inasmuch as many equivalents will suggest themselves to those skilled in the art. For example, the process may be applied to a wide variety of other devices than punches. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. The method of treating a metal body in which the hardness can be decreased by heat treatment which comprises hardening the surface and an interior portion of said body, said interior portion being enclosed and surrounded by said surface so as to be substantially inaccessible from the interior of said body, heating said interior portion by electrical induction to a temperature at which its hardness is decreased, and simultaneously cooling the surface surrounding said interior portion to maintain substantially its hardened condition.

2. The method of treating a metal body in which the hardness can be decreased by heat treatment which comprises hardening the surface and an interior portion of said body, said interior portion being enclosed and surrounded by said surface so as to be substantially inaccessible from the interior of said body, heating said interior portion by subjecting said body to a varying electromagnetic field to induce heating currents therein, and simultaneously cooling the

surface surrounding said interior portion to maintain substantially its hardened condition.

3. The method of treating a metal body in which the hardness can be decreased by heat treatment which comprises hardening the surface and an interior portion of said body, said interior portion being enclosed and surrounded by said surface so as to be substantially inaccessible from the interior of said body, heating said interior portion by surrounding said body by a coil carrying alternating electrical currents to induce heating currents in said body, and simultaneously cooling the surface surrounding said interior portion to maintain substantially its hardened condition.

4. The method of treating a metal body in which the hardness can be decreased by heat treatment which comprises hardening the surface and an interior portion of said body, said interior portion being enclosed and surrounded by said surface so as to be substantially inaccessible from the interior of said body, heating said interior portion by electrical induction to a temperature at which its hardness is decreased, and simultaneously cooling the surface surrounding said interior portion by a cooling fluid to maintain substantially its hardened condition.

5. The method of treating a metal body in which the hardness can be decreased by heat treatment which comprises hardening the surface and an interior portion of said body, said interior portion being enclosed and surrounded by said surface so as to be substantially inaccessible from the interior of said body, heating said interior portion by electrical induction to a temperature at which its hardness is decreased, simultaneously cooling the surface surrounding said interior portion to maintain substantially its hardened condition, and regulating the depth of said surface hardness by regulating the rate of cooling.

6. The method of treating a metal body, in which the hardness can be decreased by heat treatment which comprises hardening the surface and an interior portion of said body, said interior portion being enclosed and surrounded by said surface so as to be substantially inaccessible from the interior of said body, heating said interior portion by electrical induction to a temperature at which its hardness is decreased, simultaneously cooling the surface surrounding said interior portion to maintain substantially its hardened condition, and regulating the depth of said surface hardness by regulating the rate of heating.

7. The method of treating a metal body which comprises hardening the surface and an interior portion of said body, said interior portion being enclosed and surrounded by said surface so as to be substantially inaccessible from the interior of said body, heating said interior portion to a temperature at which its hardness is decreased by passing an electric current therethrough, and simultaneously cooling the surface surrounding said interior portion to maintain substantially its hardened condition.

8. The method of treating a metal body which comprises hardening the surface and an interior portion of said body, said interior portion being enclosed and surrounded by said surface so as to be substantially inaccessible from the interior of said body, heating said interior portion to a temperature at which its hardness is decreased by passing an electric current therethrough, and simultaneously cooling the surface surrounding

said interior portion by a cooling fluid to maintain substantially its hardened condition.

9. The method of treating a metal body which comprises hardening the surface and an interior portion of said body, said interior portion being enclosed and surrounded by said surface so as to be substantially inaccessible from the interior of said body, heating said interior portion to a temperature at which its hardness is decreased by passing an electric current therethrough, and simultaneously cooling the surface surrounding said interior portion to maintain substantially its hardened condition, and regulating the depth of said surface hardness by regulating the rate of cooling.

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10. The method of treating a metal body which comprises hardening the surface and an interior portion of said body, said interior portion being enclosed and surrounded by said surface so as to be substantially inaccessible from the interior of said body, heating said interior portion to a temperature at which its hardness is decreased by passing an electric current therethrough, and simultaneously cooling the surface surrounding said interior portion to maintain substantially its hardened condition, and regulating the depth of said surface hardness by regulating the rate of heating.

LAURENCE K. MARSHALL.

CERTIFICATE OF CORRECTION.

Patent No. 2,294,413.

September 1, 1942.

LAURENCE K. MARSHALL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, lines 59 and 71, and second column, lines 9, 22, 34, 48, 60, 71, page 3, first column, line 7, and second column, line 5, claims 1 to 10 inclusive, for "interior" read --exterior--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of October, A. D. 1942.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.

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