(No Model.) 3 Sheets—Sheet 1.

H. LEMP.

METHOD OF PRODUCING LOCALLY ANNEALED STEEL PLATES.

No. 531,197. Patented Dec. 18, 1894.

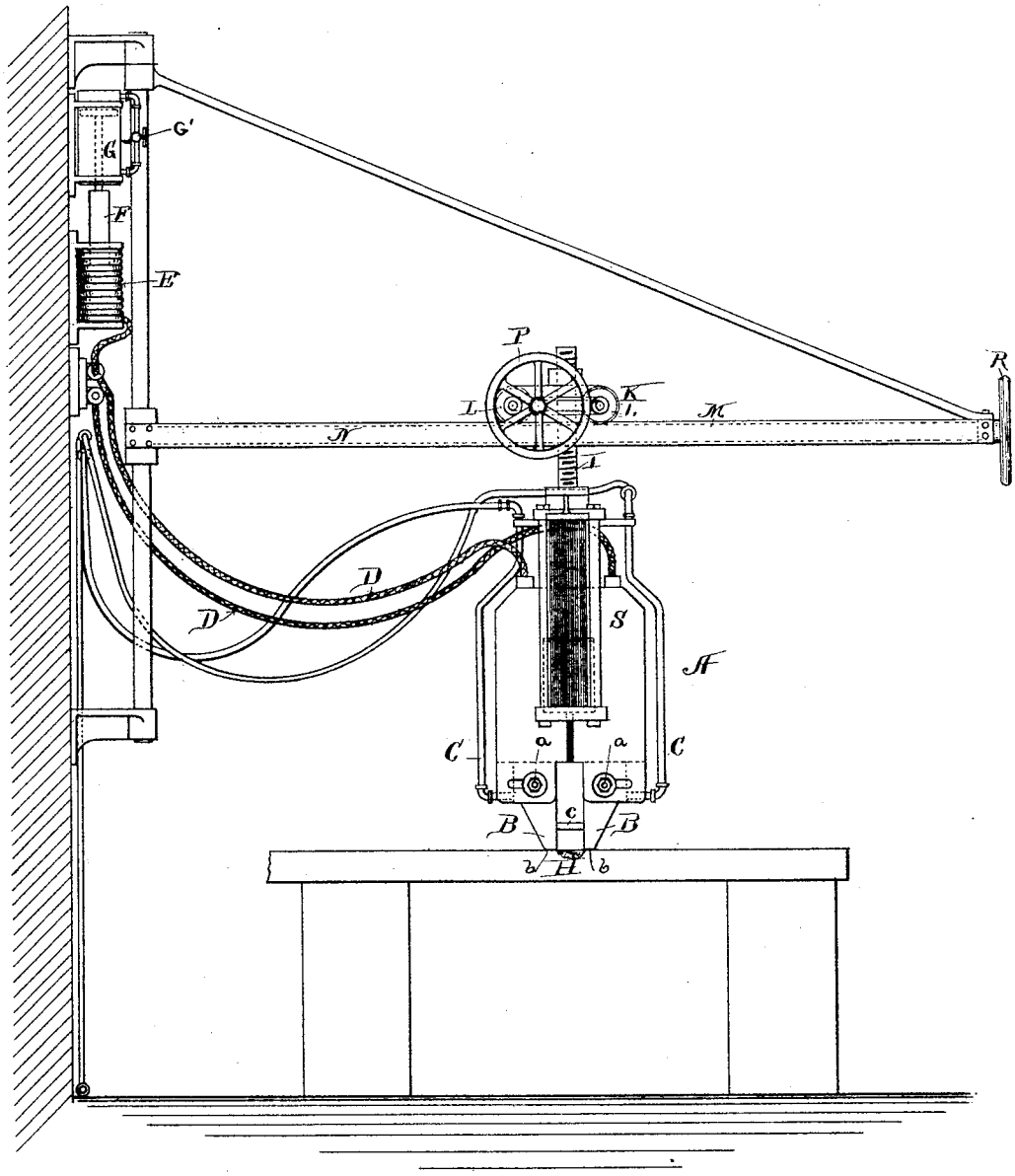

Fig. 1.

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Wm. A. Capel

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(No Model.) 3 Sheets—Sheet 2.

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Fig. 2.

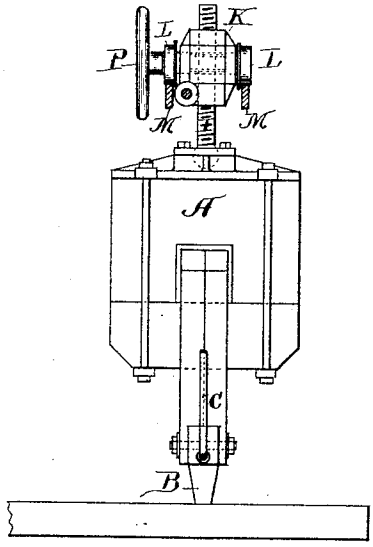


Fig. 4.

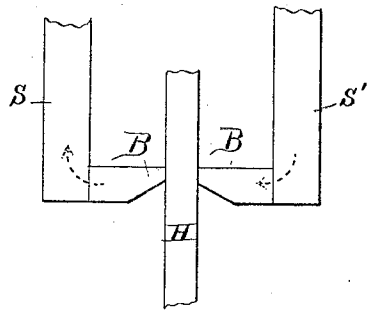
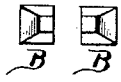


Fig. 3.



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(No Model.) 3 Sheets—Sheet 3.

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Fig. 5.

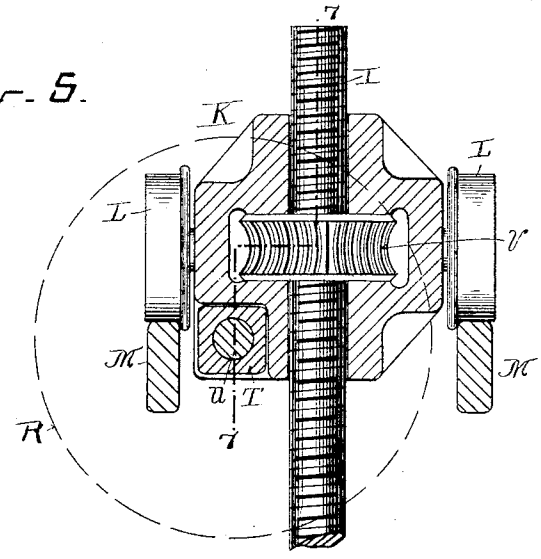


Fig. 6.

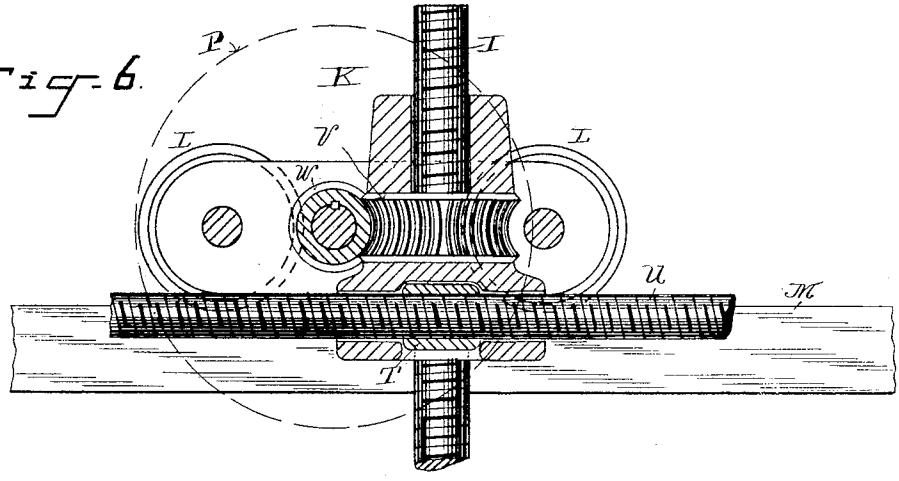
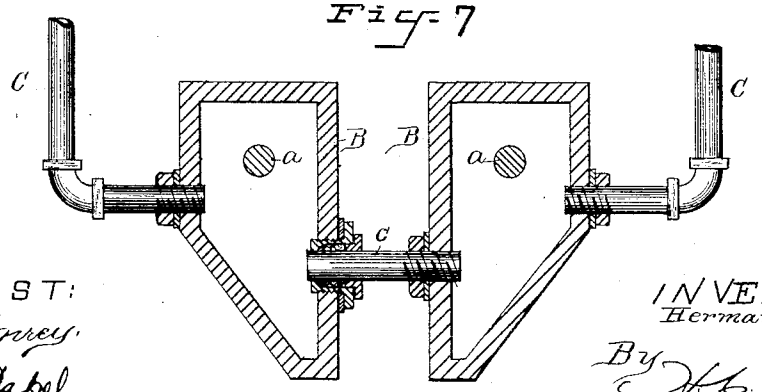


Fig. 7



ATTEST:
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Thos. T. Capel.

INVENTOR:
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UNITED STATES PATENT OFFICE.

HERMANN LEMP, OF LYNN, MASSACHUSETTS, ASSIGNOR TO THE THOMSON ELECTRIC WELDING COMPANY, OF MAINE.

METHOD OF PRODUCING LOCALLY-ANNEALED STEEL PLATES.

SPECIFICATION forming part of Letters Patent No. 531,197, dated December 18, 1894.

Application filed August 1, 1894. Serial No. 519,214. (No specimens.)

To all whom it may concern:

Be it known that I, HERMANN LEMP, a citizen of the United States, and a resident of Lynn, in the county of Essex and State of Massachusetts, have invented a certain new and useful Method of Producing Locally-Annealed Steel Plates, of which the following is a specification.

My invention relates to a novel method of obtaining hardened plates or other pieces of metal, such as steel, locally softened to admit of cutting, tapping or drilling, and is especially useful in the production of Harveyized armor plates which require to be provided with bolt holes, countersinks, embrasures or other holes or openings when in place upon the ship, though it is also applicable to other plates or pieces of metal and whether hardened all through, or merely at and near the surface.

My invention consists essentially in hardening the whole piece of steel or other metal, then locally heating the spot or portion in the body thereof to be softened, to the proper temperature, by an electric current passed through the metal itself, and then allowing the said portion to cool while keeping it supplied with a gradually diminishing amount of heat from such current, the rate of diminution being adjusted, as hereinafter described, to the capacity of the surrounding mass of metal to carry the heat away, so as to cause it to cool gradually and at a sufficiently slow or proper rate to become soft at such heated portion. By producing the local heating through generation of heat in the desired portion of metal itself by the passage of an electric current through such portion, the heating may be much more closely confined or localized and the rate of cooling better controlled.

My invention consists further in certain appliances designed to aid in the purpose of locally heating by the electric current and of confining the heating to the desired spot.

It is well known that an ordinary piece of steel such as tool steel, manganese steel, &c., which, through its peculiar chemical composition has been tempered or hardened by plunging it in water after heating or by otherwise cooling it off rapidly, may be softened again by bringing it to the right temperature and leaving it in the open air to cool off gradually. It may of course be made softer yet by decreasing the rate of cooling by surrounding the metal with some refractory or heat insulating substance such as ashes, magnesia, &c.; but for all practical purposes an ordinary piece of steel may be annealed or softened by allowing it to cool in the air. If, however, the attempt be made to soften or draw the temper at an individual spot in a large plate or piece of hardened metal by heating it to the right temperature and then removing the heating influence suddenly, the surrounding metal will carry the heat away so fast as to chill the heated portion and harden the same as if the heated spot alone had been plunged into water or other cooling medium. Moreover, no covering with any heat insulating material would prevent this inasmuch as a large percentage of the hot metal is in direct contact with cold metal from which it cannot be isolated by any known means. For this reason in the production of Harveyized plates for armor plates, for instance, it has not been found practical to first subject the whole plate to the hardening process and then locally heat the part which is to be cut, tapped or drilled; nor has it been found practical to first cut, tap or drill the metal plate and subsequently harden it, for in the hardening operation the plate is liable to become deformed or to crack around the openings or holes. It has, therefore, been found necessary either to tap, cut or drill the hardened metal at great difficulty and expense or else to locally apply some material to parts of the plate which will prevent it from becoming hardened during the hardening process.

My invention obviates the difficulties and objections heretofore met with in dealing with hardened armor plate having a skin or coating of hardened metal as well as in dealing with other large masses or pieces of hardened metal which require to be cut or formed at some part, and consists essentially in first producing a complete plate or piece of the hardened material including the portion to be cut

or formed, then by the passage of an electric current through the metal, heating the portion to be formed or cut to the proper temperature for drawing the temper and then allowing it to cool at such portion while supplying it with a gradually diminishing amount of heat from such current to prevent the fall of temperature in the heated portion due to the presence of the large masses of metal in direct contact with it from being a too rapid one.

By my invention the hard steel plate may be softened in isolated spots so that it may be readily drilled and tapped at such isolated spots alone, or continuous lines or extended surfaces may be softened for the purpose of allowing the material to be cut along the softened line.

In carrying out my process by the use of electric currents a transformer having a secondary adapted to supply current of large volume, such as is employed in electric metal working operations, may be used and the terminals thereof brought into contact with the previously hardened plate or mass of metal on either side of the spot to be annealed or softened. The current is made to enter the plate at one contact and leave it at the other bringing the intermediate portion to a dull red heat. If the process were stopped at this point and the current withdrawn, the metal would chill and be as hard in the spot as anywhere else but, if instead of withdrawing the current suddenly it be gradually diminished in amount in any well known manner as for instance by proper regulating devices, the temperature of the heated portion may be made to fall as gradually as it would if that portion were separate from the whole piece and left to cool on its own account. The depth to which this local softening process can be carried depends largely upon the arrangement of the contacts or manner of introducing the electric current by which the heat is generated in the body of the metal by the passage of the current through it. If the plate or piece of metal be hard through its whole thickness and not merely on its skin surface, the current may be made to enter at one side and leave at the other passing entirely through the mass of metal. On the other hand if only the skin is to be treated the contacts may be placed side by side upon the same surface.

The diminution in the rate of flow of the current after the metal has been brought to the proper heat may be produced by any desired form of current regulator as, for instance, by means of a reactive coil in series with the heating apparatus or by a resistance in series with the field of the generator furnishing the alternating currents for the heating transformer. Preferably, an automatically operating regulator actuated by gravity or other power is employed. The action of such regulator is adjusted to the desired rate by clockwork or any other time adjusting means which shall produce the required rate of decrease of such heating current in the metal.

The amount of heat furnished by the current might be gradually diminished or removed by moving the electrodes along the surface of the metal at the parts where it is to be locally heated and this may be a desirable way of producing a softened line of material in the hardened mass the rate of movement being, of course, adjusted to the particular circumstances of each case and being made slower where the mass of surrounding cold metal is larger or heavier. I have found, however, that good results may be obtained by adjusting the action of a current regulating resistance applied to any proper portion of the electric apparatus which furnishes the heating current in such manner as by its action to cause a diminution in the flow of said current.

In order to prevent the current from spreading too much and heating the metal beyond the desired zone of softening care should be taken not to use too heavy or powerful an electric current. This is particularly the case where the attempt is made to pass the current through the metal from one side of the plate to the opposite side.

I have obtained good results in the case of Harveyized plates by means of two copper contacts resting side by side upon the plate about one inch apart and each copper contact being about one inch square, then passing the current through the metal until the temperature between the contacts show a just visible red, and then reducing the heating current very gradually through a period of about ten minutes in which period the metal is allowed to cool gradually past the critical stage or temperature at which the material proceeds to set or become hard if the change of temperature is at such point rapid or sudden.

In the accompanying drawings I have shown some of the electrical apparatus that may be employed in practicing my invention.

Figure 1, is a general side elevation of an apparatus in which a transformer is used for heating one side of a piece of metal at an isolated spot. Fig. 2, is an edge elevation of the transformer. Fig. 3, shows in end elevation the transformer electrodes or contacts. Fig. 4, illustrates the manner of applying the electric contacts when the current is to be passed through from one side to the opposite side of the plate. Fig. 5, shows on a larger scale a vertical transverse section through the carriage K, taken in the plane of the axis of rod I. Fig. 6, is a vertical section taken longitudinally of the carriage in the planes indicated by the line 7, 7, of Fig. 5; and Fig. 7, is a vertical section through the electrodes B, B, taken in the plane of the axes of pipes C, C, and *c*.

Referring to Fig. 1, A, indicates the transformer which may be of any usual type suitable for generating heavy currents.

S, is the secondary and B, B, the contacts reduced toward their lower ends to produce the small contact surfaces *b*, *b*, and made, preferably, adjustable on the terminals of the secondary for the purpose of varying the extent, of heated metal between them. These contacts or electrodes are preferably hollow and a stream of cooling liquid is circulated through them by means of pipes C, C.

At *c*, is a pipe connecting the two hollow electrodes.

One way of mounting and constructing the electrodes B, B, is illustrated in Figs. 1, 2 and 7. Each electrode is seated in a slide formed between projections on the lower end of the secondary S, and has a bolt *a*, passing through it and through slots in said projections as shown. On the ends of these bolts are washers and nuts for clamping the electrodes at the desired distance apart. The pipe *c*, is preferably of insulating material and may be firmly attached at one end in the wall of one electrode while it slides through a gland in the wall of the other electrode, or it may be of metal and be insulated from the electrodes by suitable bushings of insulation. The water pipes C, may be rigidly secured in the electrodes and move bodily therewith or they may pass through glands in the walls of the electrodes as desired. I have shown them as rigidly attached to the electrodes and, on account of their considerable length, depend upon their resilience in the adjustment of the electrodes. By thus keeping the contacts artificially cool the heating in the mass of metal is better localized at the portions thereof between the electrodes themselves. In practice it will be found that when only slight contact pressure is used there is a tendency of the metal at the surface in contact with said electrodes to heat more than at the portion between them but by artificially cooling the electrodes the heating may be better confined as stated.

The flexible conductors which supply the primary of the transformer are indicated at D, D. In their circuit is shown a reactive coil E, of any suitable construction whose core F, is suspended from an adjustable dash-pot G, of any suitable character employed for the purpose of checking the descent of the core by gravity into the reactive coils. By this device a retarded rate of action of the regulator is obtained to produce the diminished rate of flow of the current. To suit different cases, an adjustment may be provided to regulate the rate of descent or movement of the movable portion of the regulator consisting, in this case, of the movable core F. When a dash-pot is employed the adjustment may be obtained by providing the dash-pot with a by-pass having a cock G′, which will regulate the rapidity of the flow of air or liquid in the dash-pot from one side of its piston to the other. By adjusting this cock the flow of current may be caused to diminish at the desired rate varying as will be understood under different circumstances.

H, indicates a Harveyized plate under treatment for local softening and the portion involved in the heating current is indicated by the shaded portion between the electrodes. To aid in moving the transformer over the surface of the metal plate H, it may be hung from a rod I, by a ball and socket joint or other flexible suspension. The rod I, is in turn mounted on a carriage K, which has wheels L, running on the rails M, of a swinging crane or bracket N. Wheels P and R, operate on suitable mechanism mounted on the carriage and connected with the rod I, and the wheels L, to lower the transformer or to move it along the rails. Various forms of mechanism may be devised for manipulating the transformer and its carriage. For the purpose of illustration I have shown the carriage provided with a recess for the reception of a steel nut T, through which and suitable ways in the carriage passes the screw U, which is rotated by wheel R, in moving the carriage and the suspended transformer over the plate. As a means for raising and lowering the transformer, I have shown a worm nut as V, located in the frame of the carriage and turned about the suspending rod I, by means of the worm W, which is rotated by the hand wheel P. By these means and by the swinging crane the transformer may be adjusted over any desired spot on the plate or mass of metal H.

As will be seen in Figs. 3 and 4, the electrodes or contacts where they engage with the mass of metal are made rather small, this being for the purpose of localizing the heating current so far as possible and the undue heating at such points is prevented by the artificial cooling.

What I claim as my invention is—

1. The herein described method of obtaining a hardened piece of metal with a portion only in the body thereof softened, consisting in hardening the whole piece, generating heat in the portion to be softened by an electric current passing through the metal itself at the portion whose temper is to be drawn, and then gradually diminishing the amount of heat supplied by the current to said heated portion at such a rate that, at any period of time, the amount of heat supplied is nearly but not quite equal to the amount of heat being absorbed by the surrounding metal, as and for the purpose set forth.

2. The herein described process of locally softening or drawing the temper from a Harveyized plate or similar plate having a skin of hardened metal, consisting in passing a heating electric current through the metal from one point on the surface thereof to another point by electric contacts engaged with said surface, heating the metal by the heat generated through the passage of the current in the metal, and to a dull red heat, and then

gradually removing or withdrawing the electric current, at such rate that the amount of heat supplied is nearly but not quite equal to the amount of heat being absorbed by the surrounding metal, as and for the purpose described.

3. In a heating device employing a transformer, the combination with the secondary, of hollow contacts or electrodes connected thereto, feeding and discharge pipes connected respectively to said electrodes, and a pipe of insulating material connecting said electrodes for the purpose set forth.

4. In a heating device employing a transformer, the combination with the secondary, of hollow electrodes seated in ways in the ends of the secondary and adjustably secured in place, feeding and discharge pipes connected respectively to said electrodes, and a connecting pipe between the electrodes properly insulated therefrom and having a sliding union with one of them.

5. In an apparatus for producing local annealing, the combination with the heating device, of a swinging bracket provided with a track, a carriage running on said track for carrying said heating device, a screw located in said bracket, a nut in the carriage fitted to said screw, a hand wheel for turning the screw to propel the carriage, and means for raising and lowering said device for the purpose set forth.

6. In an apparatus for producing local annealing, the combination with the heating device, of an overhead track, a carriage on said track, a screw-threaded rod connected to the heating device, a worm-nut located on said carriage to receive said rod, a worm for operating said nut to thereby raise and lower the heating device, and means for moving the carriage along its track for the purpose set forth.

7. The combination, substantially as described, with an electric heating apparatus, of an automatic current regulator for producing a diminished rate of flow of the heating current, and a retarding device connected with said current regulator whereby a slow diminution in the supply of heat may be produced.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 30th day of July, A. D. 1894.

HERMANN LEMP. [L. S.]

Witnesses:
W. A. M. TAGGART.
H. N. SWEET.