E. C. CARTER.

METHOD OF TREATING METAL.

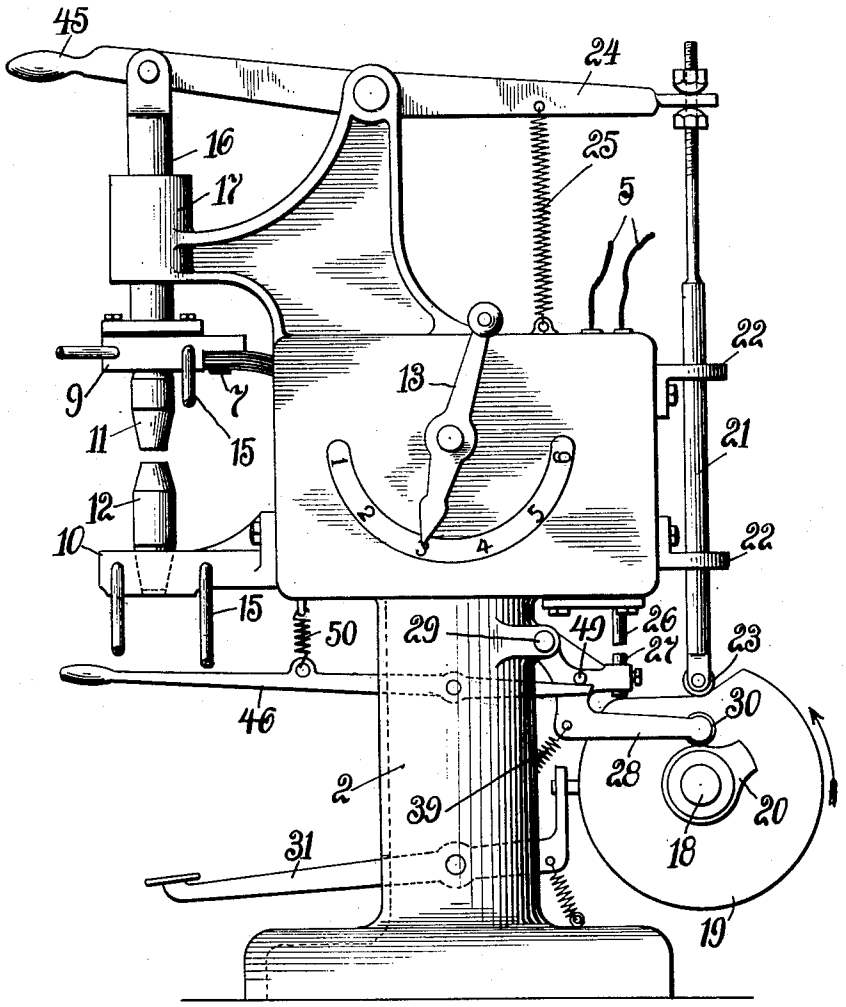
APPLICATION FILED NOV. 13, 1913.

1,147,783.

Patented July 27, 1915.

2 SHEETS—SHEET 1.

Fig. 1.



Witnesses

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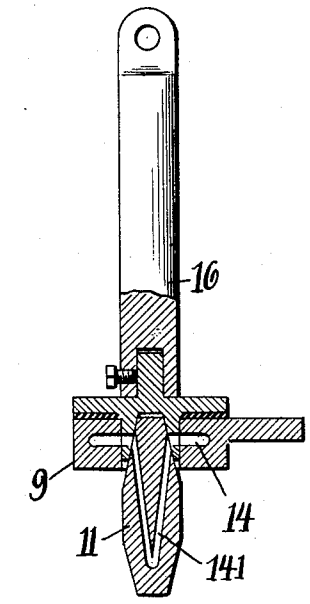
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2 SHEETS—SHEET 2.

Fig. 2.



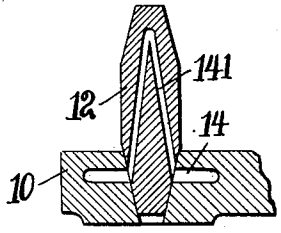
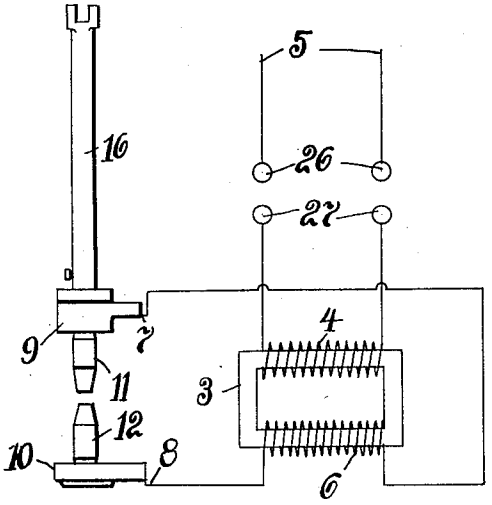


Fig. 3.



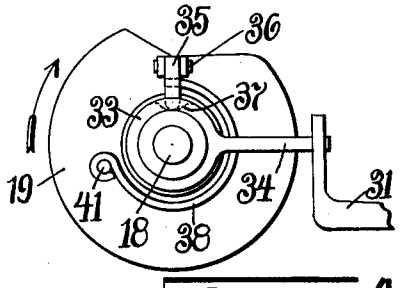
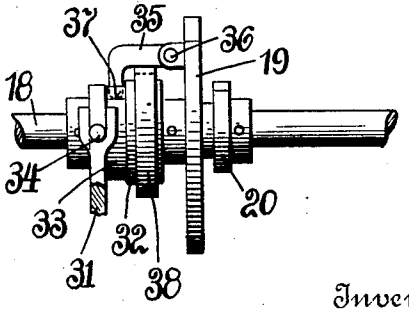


Fig. 4.

Fig. 5.



Witnesses

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UNITED STATES PATENT OFFICE.

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METHOD OF TREATING METAL.

1,147,783. Specification of Letters Patent. **Patented July 27, 1915.**

Application filed November 13, 1913. Serial No. 800,892.

To all whom it may concern:

Be it known that I, ELMER CLIFFORD CARTER, a citizen of the United States, residing at Dayton, in the county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Methods of Treating Metal, of which I declare the following to be a full, clear, and exact description.

This invention relates to processes for treating metals to give them different degrees of hardness, and has particular reference to the use of electric appliances in such processes.

While the inventive idea disclosed herein is capable of application generally to the treatment of metals by first heating and then rapidly cooling them, and it is the intention to cover all such applications broadly, the process is adapted particularly to hardening only certain portions of pieces of steel of the proper chemical composition to respond readily to the heating and cooling operations. As will be better understood later, these portions of the metal can be of any desired shape or area. Such hardening as previously done was inconvenient and expensive, owing to the difficulty experienced in confining the heating and cooling to a limited section of the metal being treated and the necessity of handling the metal several times to put it through the necessary preliminary treatment and the several successive operations of the hardening process proper. By the present method, but one handling of the metal is necessary and no preliminary treatment of the part to confine the heating and cooling to the desired section is required. The operations are also carried on with no discomfort to the workers, owing to the fact that all heating furnaces are done away with and the operators are not obliged to handle the metal while it is hot.

To carry out the improved process some form of electrical device is used which permits passing an electric current through the section of the metal which is to be hardened by means of electrodes composed of a good heat conducting material such as copper, and so arranged that water or some other cooling medium can be circulated through them. The current is first regulated to adapt it to the work to be done, after which the electrodes are brought into contact with the metal, and the current then passed through the electrodes and the metal immediately between them until the metal is brought to the proper temperature because of the resistance afforded by the metal to the passage of the current from one electrode to the other. The current is then shut off, and the electrodes retained in contact with the previously heated portion. The cooling medium circulating through the electrodes maintains the electrodes at a relatively lower temperature while the metal between them is being heated and as soon as the current is off the electrodes and cooling medium quickly carry the heat away from the metal so that the metal is chilled and hardened just as would be the case if the metal was first heated and then dipped in water as is done in carrying out the process in the old way. It is apparent, however, that the new process is much quicker and more convenient than the old, and that the hardening should be better, as between the heating and cooling, the hot metal is not exposed to the air and there is no opportunity for oxidation to occur, with the resulting scale or roughened surface requring a machining operation to remove it.

It will readily be seen that this process has many useful applications, not only in hardening portions of steel material, but in annealing and otherwise applying heat treatment to metals. In hardening, the process is adaptable to many classes of work, for example, hardening the working points of pawls and leaving the rest of the metal soft and tough, hardening the working surface of cams without changing the condition of the rest of the metal composing the cams, or spot hardening sheet steel to protect certain parts of it from the wear naturally resulting from the use to which the sheet is to be put. By providing electrodes of different forms, any desired shape or extent of surface can be hardened, or, in the case of small parts, the entire part may be held bodily between the faces of the electrodes and the entire part hardened.

Briefly stated then, the object of the invention is to provide a simple, inexpensive and efficient process for applying heat treatment such as a hardening process to metals by means of an electrical device by which a heating electric current can be passed through the metal, said electric device com-

prising artificially cooled electrodes which can be held in contact with the previously heated metal after the current is shut off, thereby quickly cooling the metal and giving it the desired degree of hardness.

It is understood that any suitable apparatus may be employed in practising or carrying out this process. In the accompanying drawings there is shown one form of such apparatus but it is not desired to be limited to same, as it is illustrative only and is employed because it seems peculiarly adapted to use in explaining the process to the best advantage.

In the accompanying drawings, Figure 1, is a right side elevation of the illustrative machine. Fig. 2, is a detail showing the water cooled electrodes. Fig. 3, is a diagram illustrating the connections of the electrical features of the machine. Fig. 4, is a detail showing the driving clutch mechanism. Fig. 5, is a detail showing the drive shaft and the elements carried by the shaft.

As a whole, the machine comprises the usual transformer with a primary circuit to carry an alternating current of any desired voltage, and a secondary circuit carrying a current of low electro motive force but of great volume. The electrodes are in the secondary circuit and are made of any material of high conductivity, preferably copper, and are arranged so that water or some other cooling medium may be circulated through them. The machine may be operated from a power driven rotary shaft carrying devices to both close the primary circuit and impart relative movement to the electrodes, so that they, in connection with the metal held between the electrodes, will close the secondary circuit. The devices just mentioned are normally disconnected from the power shaft but a foot operated controlling device is provided whereby the aforesaid devices, which are rigid together, may be clutched to the driving shaft and caused to rotate with it. The device which moves the electrodes is arranged so that the electrodes are in contact with the work during practically the entire rotation of the driving shaft, while the device which closes the primary circuit is usually effective for but a very small part of the rotation of the shaft. A rheostat is provided for regulating the current while independent hand operated means are provided for either holding the electrodes in contact with the work, or holding the current no longer than is provided for by the arrangement of the devices carried by the driving shaft. By changing the size or shape of the devices carried by the rotary shaft, or regulating the speed of the shaft, and also by means of the control given by the rheostat over the voltage of the current, an almost endless number of variations in the voltage and duration of the current or the length of the contact of the electrodes is possible.

Described in detail, and with reference to the drawings 2 indicates a hollow standard supporting the machine proper. At the top of this standard is a compartment containing a transformer of the usual type consisting of a core 3 a primary winding 4 adapted to be connected to the current leads 5 and a secondary winding 6 which consists of a few turns of heavy bars or sheets of copper or other suitable conducting material, the ends of which are connected at 7 and 8 respectively to plates 9 and 10 in which the electrodes 11 and 12 are removably mounted. Contained in the interior of the machine is also a rheostat with a handle 13 by means of which the strength of the current can be regulated according to the indices on the index plate. The plates 9 and 10 carrying the electrodes are properly insulated from the rest of the machine, and have passages 14 registering with passages 141 extending through the electrodes so that water or any other satisfactory cooling medium can be circulated through these passages by means of the tubes 15 running to a source of supply. The plate 10 carrying the lower electrode is attached to a fixed extension of the machine frame while the plate 9 holding the upper electrode is carried by a rod 16 sliding through a sleeve 17 integral with the frame of the machine. In order to permit free movement of the rod 16, the end of the secondary winding which is attached at 7 to the plate 9 consists of a number of thin flexible sheets of copper.

In ordinary operations, the machine is driven from the rotary shaft 18 carrying cams 19 and 20, loosely mounted on the shaft but rigid together. A cam 19 is designed to operate the upper electrode 11. The rod 21 slidably mounted in brackets 22 attached to the machine frame carries at its lower end an anti-friction roll 23 resting in the cut of the cam 19. A beam 24 pivoted to an extension of the machine frame is connected at one end to the rod 21 and at the other end to the rod 16. In order to accommodate work of different thicknesses between the electrodes, the connection between the rod 21 and the beam 24 is adjustable as shown. From the construction just mentioned it necessarily follows, that when the cam 19 is rotated and the part of the cam having the greater radius is brought under the roll 23, the upper electrode is forced down against the tension of a spring 25, and held down until the cutaway portion of the cam is again brought under the roll 23, when the spring 25 returns the parts to their normal position. The two sets of contacts by which the primary circuit is closed are shown at 26 and 27. The two

lower contacts 27 are carried by an arm 28 pivoted at 29 to the machine standard and having an extension carrying an anti-friction roll 30 resting against the edge of the cam 20. But one set of these contacts appears in Fig. 1 as the other is directly behind and in line with the set shown. The shape and arrangement of the parts is such that the rotation of the cam 20 will raise the lower contacts against the upper contacts, thereby closing the circuit and holding it closed until the part of the cam having the greater radius passes out of contact with the roller 30, after which a spring 39 draws the arm 28 back to its original position and breaks the contact.

The cams 19 and 20 are, as stated above, rigid together so that they always perform their work one in a certain relation to the other, but both are loosely mounted on the shaft 18. A clutch is provided, operated by the foot lever 31 to establish a driving connection between the shaft and the cams. The construction of this clutch mechanism is best shown in Figs. 4 and 5. Fixed to the shaft 18 is a disk 32. Beside it is a disk 33 loosely mounted on the shaft, and having an arm 34 resting in a forked upper extension of the foot operated lever 31. A dog 35 is pivoted at 36 to a bracket secured to the side of the cam 19 with the free end resting in a cut 37 in the circumference of the disk 33. Attached to the dog 35 is one end of a flexible metal strap 38, the other end of which is held by a stud 41 projecting from the side of the cam 19. It is apparent that when the operator presses down on the foot pedal 31, the opposite end will be raised, lifting the arm 34 and turning the disk 33 partially so that its cutaway portion is carried from under the end of the dog, camming the end of the dog upward. This draws the flexible strap 38 into contact with the driving disk 32, and the resulting frictional connection results in the disk 32 and the cams 19 and 20 rotating as a unit until the dog 35 again comes above the cut 37 which has, in the meantime, been allowed to return to normal position by the operator releasing the pressure on the foot pedal 31, when the dog 35 drops into said cut and allows the flexible strap to spring away from the driving disk and thereby destroy the aforesaid frictional connection. During the rotation just described of the cams, the upper electrode 11 was moved into contact with the work and held in contact during practically the entire rotation of the cam. Almost immediately after the electrode was moved to contacting position, the cam 20 closed the primary circuit, and held it closed an instant just after the cams began to rotate. However, during the time that the current was on, the metal between the electrodes was heated to the proper temperature, and as soon as the current was shut off by breaking the contact, the artificially cooled electrodes immediately began conducting the heat away from the metal, thereby chilling it, and giving it the desired hardness.

The beam 24 is provided with a handle 45 by means of which the upper electrode 11 can be held in contact with the work independent of the operation of the driving devices above described. There is also provided a corresponding manually operable lever 46 pivoted to the machine base and engaging a stud 49 in the pivoted arm 28. A spring 50 supports the lever in normal position. Downward pressure on the handle of this lever 46 will raise the lower contacts against the upper contacts, thereby closing the primary circuit. The contacts may of course, be held together as long as the operator desires. These independent levers are provided for use in treating metals having a thickness or other peculiarity that the machine is not prepared to accommodate, or they may be used to maintain the current or contact of the electrodes longer than is possible with any driving devices that could be readily attached to the shaft 18.

A brief description of the way in which the illustrative device is used to spot harden a piece of sheet steel will give a clear idea of the process. The metal is placed with the spot to be hardened resting on the lower electrode 12. The foot pedal 31 is then depressed, operating the clutch which establishes driving connection between the rotary power shaft and the machine driving devices mounted on the shaft. At the beginning of the rotation of the driving devices the upper electrode is forced against the work and held there during practically the rest of the rotation. Immediately after the electrode is in contact with the work, the circuit is closed and the electric current is passed through the electrodes and the metal for a short part of the rotation of the shaft. The current is then shut off, but the electrodes remain in contact with the work for a considerable length of time after the circuit is broken or until near the end of the rotation of operating devices. As the electrodes are artificially cooled by circulating water or some other cooling medium through them, they are kept at a relatively low temperature while the current is on and after the current is turned off the heat is rapidly carried away from the material by the electrodes and said cooling medium and the degree of hardness desired thereby secured.

Having described the novel process and a method of carrying it out, as well as various useful applications of same, it is not the desire to be limited to any particular application but to obtain protection covering all applications of the process that come within the scope of the following claims.

What is claimed is:—

1. The process of treating metal which consists in heating the metal to the required temperature by pressing electrodes against the metal and passing an electric current through said electrodes, then shutting off the current and quickly reducing the temperature by retaining the electrodes in contact with the metal while a cooling medium is circulated through said electrodes.

2. The process of treating steel which consists of heating the steel to any desired temperature by pressing electrodes against it, and passing an electric current through the electrodes and the steel, then shutting off the current, and reducing the temperature by retaining the electrodes in contact with the previously heated metal while a cooling medium is circulated through the electrodes.

3. The process of hardening metal which consists of first heating the metal to the desired temperature by pressing electrodes against it and passing an electric current through the electrodes and the metal, then shutting off the current and quickly conducting the heat away from the metal by retaining the electrodes in contact with the metal while a cooling medium is circulated through the electrodes.

4. The process of treating any desired portion of a piece of metal which consists of heating said portion to the proper temperature by pressing electrodes against it and then passing an electric current through the electrodes and the metal, then shutting off the current, and then quickly conducting the heat away by allowing the electrodes to remain in contact with the previously heated metal, while a cooling medium is circulated through the electrodes.

5. The process of hardening any desired area of a piece of steel which consists of first heating said area to the proper temperature by pressing the electrodes against it and passing an electric current through the electrodes and the area to be hardened, then shutting off the current and quickly conducting the heat away from the previously heated area by holding the electrodes in contact with said area while a cooling medium is circulated through the electrodes.

6. The process of spot hardening steel which consists of heating the spot to the desired temperature by pressing electrodes against it and passing an electric current through same, then shutting off the current and conducting the heat away from the metal by holding the electrodes in contact with the previously heated metal while a cooling medium is circulated through the electrodes.

7. The process of spot hardening steel which consists of heating the spot to the desired temperature by pressing electrodes against it, and passing an electric current through the electrodes and metal, then shutting off the current, and chilling the metal by holding artificially cooled electrodes in contact with the previously heated metal.

8. The process of spot hardening steel by holding against the spot to be hardened electrodes through which a cooling medium is constantly circulated and passing a heating electric current through the electrodes and the portion of metal between the electrodes to raise said portion to the proper temperature, then shutting off the current and retaining the artificially cooled electrodes in contact with the heated metal whereby to quickly cool the metal and thereby complete the hardening process.

In testimony whereof I affix my signature in the presence of two witnesses.

ELMER CLIFFORD CARTER.

Witnesses:
R. C. GLASS,
CARL BEUST.