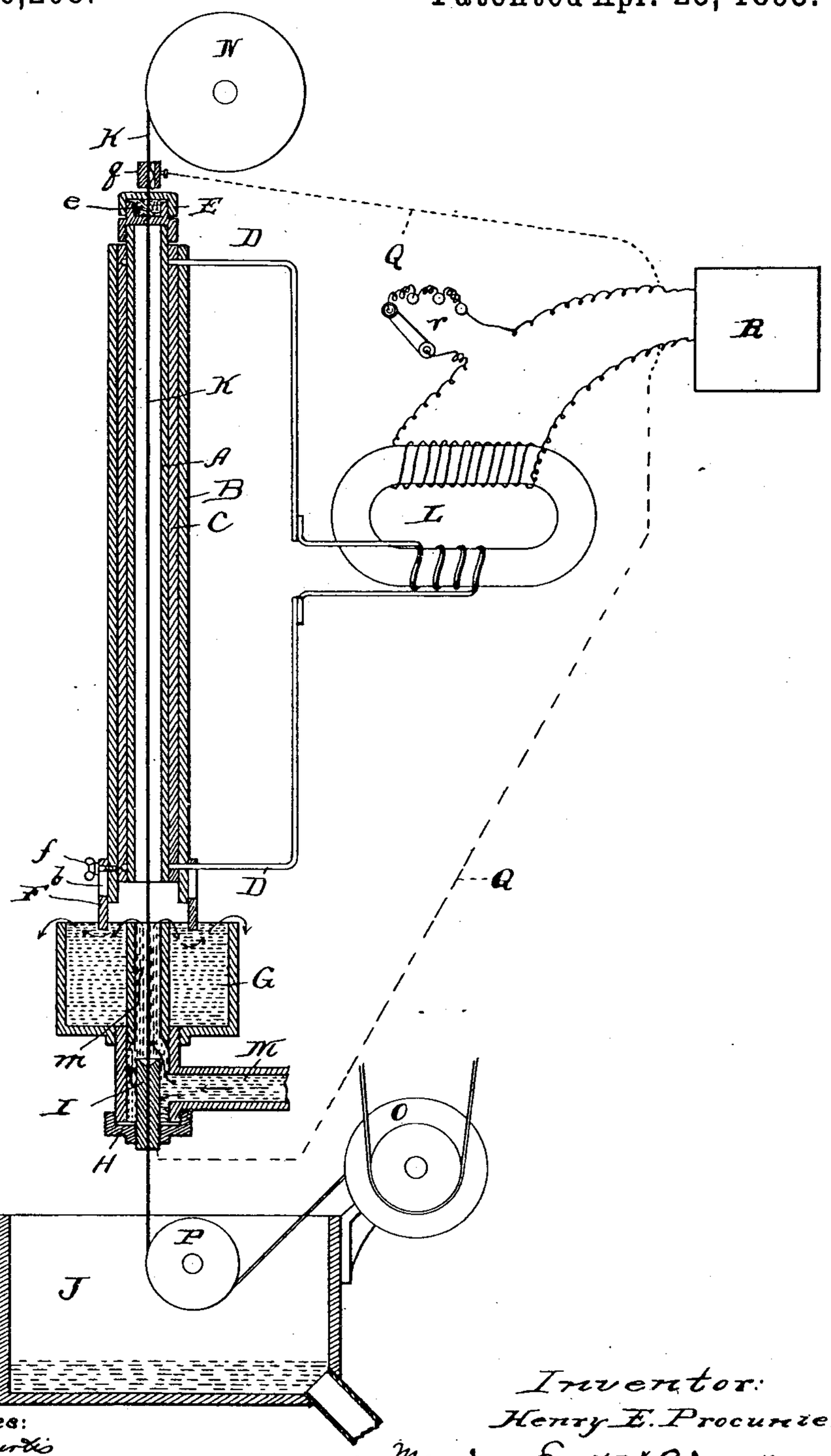
(No Model.)

H. E. PROCUNIER.

PROCESS OF AND APPARATUS FOR TEMPERING OR HARDENING STEEL WIRE.

No. 496,208. Patented Apr. 25, 1893.



Witnesses:
Law. E. Curtis
A. D. Munday.

Inventor:
Henry E. Procunier
By Munday Evarts & Adcock
His Attorneys.

UNITED STATES PATENT OFFICE.

HENRY E. PROCUNIER, OF OAK PARK, ASSIGNOR TO THE AMERICAN SPRING COMPANY, OF CHICAGO, ILLINOIS.

PROCESS OF AND APPARATUS FOR TEMPERING OR HARDENING STEEL WIRE.

SPECIFICATION forming part of Letters Patent No. 496,208, dated April 25, 1893.

Application filed May 4, 1891. Serial No. 391,622. (No model.)

To all whom it may concern:

Be it known that I, HENRY E. PROCUNIER, a citizen of the Dominion of Canada, residing at Oak Park, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Processes of and Apparatus for Tempering or Hardening Steel Wire, of which the following is a specification.

I have been engaged for some time in endeavoring to temper steel wire by means of electric heat, using for that purpose the methods and apparatus described in several Letters Patent of the United States. I have been unable however to obtain good results by the use of the patented agencies because of the loss in the hardening of certain qualities of the steel necessary to impart proper spring life to it. To avoid this difficulty I have devised my present invention and my use of it, extending over a considerable period of time, satisfies me that I have overcome the objections pertaining to the previous methods, and I have reached results which I find unequaled by any other process or apparatus.

I have shown in the accompanying drawing a vertical section of that portion of the apparatus to which my invention in part relates.

In the drawing A represents a tube, preferably of metal, to which are connected copper arms D D, which are joined to an electrical converter or transformer L. This converter is properly connected with an electrical dynamo generating an alternating current, and is provided with means such as a rheostat *r* whereby the strength of the current carried to the tube A may be regulated at the will of the operator. By means of the current received through the converter, the tube A is heated.

To protect the tube from changes in temperature and from the oxidizing influence of the air, an outer B tube is placed around tube A; and between tubes A and B a packing C is placed, preferably of asbestus, cement or plaster of paris or some other non-conducting material. This packing together with the outer tube prevents unequal expansion or warping of tube A while it is heating or cooling. The arms D D are also arranged to allow expansion of the tube A under heat. The tube A is arranged vertically as shown. At the top it is closed by a stuffing box E packed with asbestus *e* and having an orifice just sufficient to admit the ribbon or wire K which is to be treated.

At the lower end of the heating tube is located the chilling bath G which is constructed and arranged as follows:—The oil or chilling fluid is supplied to bath G through the tube M and is conducted by such tube into a contracted vertical passage way *m* surrounding the wire K. Its flow in the horizontal direction is prevented from striking the wire by the plug I which surrounds the latter opposite the mouth of the tube M and by which the flow in that direction is broken. It is now however free to rise in the passage *m* with a steady even flow, and in so doing it comes in contact with the wire moving in a parallel but reversed direction, and it continues this upward movement until it reaches the top of the bath and passes off at the outer sides of the latter. In this manner an ascending current of oil is created and maintained through the passage *m* and along the wire which bears against the latter equally at all points, rises to the same level at all sides and also maintains an even temperature all around the wire because the oil enters the bath at a uniform temperature and no part of it feeds faster than any other part. I thus subject every part of the wire to a very uniform chilling action. As the oil overflows the bath G it falls into and is caught by a tank J, and being then filtered it may be returned to service again. By reason of the small area of the passage *m*, no part of the oil in it can stagnate, but every part thereof must move and continue in motion so long as it remains in the passage by reason of the propelling power of the incoming fresh oil. The wire passes direct from the heating tube into the chilling bath and preferably without exposure to the air. To secure this result the tube or its cover may be extended so as to enter the chilling fluid, but I prefer to cover the intervening space between the tube and the chilling medium by a tube F which makes a practically air tight connection between the two, and forms in conjunction with the tube

what may be termed a muffle. The tube F is secured upon tube B by one or more set screws *f*, and it may be made adjustable by providing elongated slots *b* for such screws. Its lower edge extends down into the cooling fluid as shown by the drawing so as to shut out the outside air. The plug I is perforated for the passage of the wire, and this opening should be of such size as will substantially prevent loss of the chilling medium through the plug. It is sustained by a cap H secured to the walls of the passage *m*, and it may be made removable and to conform to the wire being treated, so that it may be replaced by another where the dimension or kind of wire is changed. The ribbon or wire is passed by a steady even motion from spool N through the heating tube and hardening bath and under the idler P and is then wound on to spool O. The tube F is made movable so that the operator may observe the heat being communicated to the wire when necessary, and it also is convenient when the wire needs adjustment or a new spool of wire is being started through the apparatus.

By the use of this apparatus I obtain important advantages:—I avoid any variation in the temperature imparted to the wire at different points in its length. This result is due to the fact that the entire operation is performed in a closed passage or muffle wherefrom the external air is excluded. The wire enters the chilling bath as soon as it has received its proper heat and is not allowed to remain heated an unnecessary or injurious length of time before it is chilled. It enters the fluid in a vertical direction so that the fluid bears against all sides of it alike and rises to the same height all around it. All lateral current or currents in the fluid are broken up before they come in contact with the wire, so that no one side or part of the wire is chilled any more quickly or to any greater extent than any other side. Whatever movement there is to the chilling fluid is in a direction parallel with the length of the wire, so that while fresh oil is being continuously supplied, there is no unequal action upon any part of the wire caused by the inflowing of the oil, and a steady and even temperature results. By reason of the contracted nature of the passage through which the oil rises and in which it comes in contact with the wire, no portion of it can remain stationary, but all of it is kept in constant motion by the continual incoming of fresh oil, thus maintaining an even temperature in all parts of the oil. The action in this respect is very different from what it would be if the passage had sufficient area to hold a large body of oil, inasmuch as in that case the outside portions would remain unaffected by the heat taken from the wire, and would stagnate to some extent in the passage instead of moving steadily through it. The gas generated in the muffle by the contact of the wire with the oil or chilling medium is allowed to escape under the tube F and through the oil without destroying the substantially air tight qualities of the muffle and the presence of any excess of gas is thus prevented.

I prefer to heat the wire simply by radiation from the tube, but if this should be insufficient an electric current may be directed through the wire itself by means of the wires Q Q, one connected to a contact *q* located at the initial end of the heating tube, and the other to the plug I, said wires being connected to the dynamo R. Or some features of the invention may be used where the wire is heated wholly by a current through the wires Q Q, the tube remaining cold. Or the tube A may be heated by means other than electricity. I deem the electric heating of the tube or some other manner of heating wherein the tube is not exposed to the exterior air as more desirable than those methods in which it is exposed.

I claim—

1. A vertical muffle through which the wire is drawn, means for heating and means for moving the wire, in combination with a chilling bath and a supply pipe delivering the chilling fluid to the bottom of said bath, substantially as set forth.

2. A vertical muffle through which the wire is passed, means for heating, and means for moving the wire, in combination with a chilling bath connected to the muffle so as to prevent access of the air to the wire as it passes from one to the other, and a supply pipe delivering the chilling fluid to the bottom of said bath, substantially as set forth.

3. A vertical muffle and means for heating the same, in combination with a chilling bath a supply pipe delivering the chilling fluid to the bottom of said bath, and means for feeding the wire vertically through both the muffle and the bath, substantially as specified.

4. The combination of means for heating the wire, with a chilling bath having a contracted vertical passage, means for feeding the wire in one direction through said passage, and means for feeding the oil in the other direction through the same, substantially as set forth.

5. The combination of a vertical heating tube and means for heating the same with a chilling bath having a contracted vertical passage, means for feeding the wire through the tube and passage in one direction, and means for feeding the oil through the passage in the other direction, substantially as set forth.

6. A chilling bath having a vertical passage *m* through which the wire travels, and means for moving and means for heating the wire, in combination with a supply pipe conducting the incoming fluid to the lower end of said passage, substantially as specified.

7. A chilling bath having a vertical passage *m* through which the wire travels, and means for moving and means for heating the wire, in combination with a supply pipe conducting

the incoming fluid to the lower end of said passage, and a device, for breaking up the lateral current in the fluid before it reaches the wire, substantially as specified.

8. The combination with a vertical tube or device in which the wire is heated, means for heating, and means for moving the wire downwardly, of a bath placed immediately below the tube and a fluid supply arranged to deliver the chilling fluid at the bottom of the bath so that it rises along the wire, substantially as specified.

9. A vertical heated tube through which the wire passes and in which it is heated, said tube being closed to the air at its upper end and being also provided with a non-heat-conducting covering, means for heating the tube, means for moving the wire, means for protecting the wire from the air as it travels from the tube to the bath, a chilling bath located at the lower end of the tube and a fluid supply arranged to deliver the chilling fluid at the bottom of the bath so that it may move upward along the wire, all combined substantially as specified.

10. The combination of the vertical tube A in which the wire is heated as it moves, said tube being closed at the top except for the passage of the wire, means for heating, means for moving the wire, a chilling bath below said tube, and a tube F inclosing the wire between the tube A and the bath and extending into the chilling fluid, substantially as set forth.

11. The combination of means for moving and heating the wire, with the bath, the supply pipe opening into the bottom of the bath, and the plug I having a passage for the wire, substantially as specified.

12. The combination of means for moving the wire, with the heating tube, the chilling bath, and the inclosing tube F adjustably supported upon the lower end of the heating tube, substantially as specified.

13. The combination of means for moving the wire, with the tube A, means for heating said tube, the covering B, an inclosing tube F supported from said covering, and a chilling bath immediately below tube F, substantially as specified.

14. The combination with means for moving the wire downward, of means for heating the wire, and a chilling bath adapted to allow the downward passage of the wire and having a supply arranged to deliver the chilling fluid at its bottom, and also having means so located as to break up the lateral current in said fluid before its contact with the wire, substantially as set forth.

15. In an apparatus for hardening wire the combination of a vertical muffle having at its upper end a stuffing box or opening adapted to be closed by the wire, means for heating the muffle, a wire feeding apparatus adapted to conduct a wire or ribbon through said muffle, a chilling bath situated at the lower end of said muffle and an air excluding conduit or extension of said muffle surrounding the wire and extending from the muffle to the bath, substantially as set forth.

16. In an apparatus for hardening wire the combination of a vertical muffle having at its upper end a stuffing box or opening adapted to be closed by the wire, a non-conducting covering for said muffle, means for heating the muffle by an electrical current, a wire feeding apparatus adapted to conduct a wire or ribbon through said muffle, a chilling bath situated at the lower end of said muffle and an air excluding conduit or extension of said muffle surrounding the wire and extending from the muffle to the bath, substantially as set forth.

17. The hereindescribed improved method of hardening wire which consists in heating the wire by radiant heat while air is excluded from contact therewith, and then passing the heated wire vertically downward directly and without contact with any substance and without exposure to the air in a chilling bath, substantially as set forth.

18. The hereindescribed improved method of hardening wire which consists in heating the wire while air is excluded therefrom and while in a confined body of carbon vapor, and then passing the wire without exposure to the air, vertically downward directly into a chilling bath, substantially as set forth.

19. The hereindescribed improved method of hardening wire which consists in heating the wire while air is excluded therefrom, then passing the wire vertically downward directly into a chilling bath without exposure to the air, and feeding the fluid of said bath to the wire evenly on all sides thereof and in a direction opposite to that of the movement of the wire, substantially as set forth.

20. The improvement in the mode of hardening wire consisting in first heating the wire, and then passing it vertically through a rising body of oil or other chilling fluid, substantially as set forth.

21. The improvement in the mode of hardening wire consisting in heating the wire and passing it while still hot vertically through a rising body of oil or other chilling fluid, the latter being deprived of all current approaching the wire laterally, substantially as set forth.

HENRY E. PROCUNIER.

Witnesses:
EMMA HACK,
H. M. MUNDAY.