(No Model.) 3 Sheets—Sheet 1.

E. E. RIES.

APPARATUS FOR HARDENING AND TEMPERING STEEL AND IRON.

No. 453,162. Patented May 26, 1891.

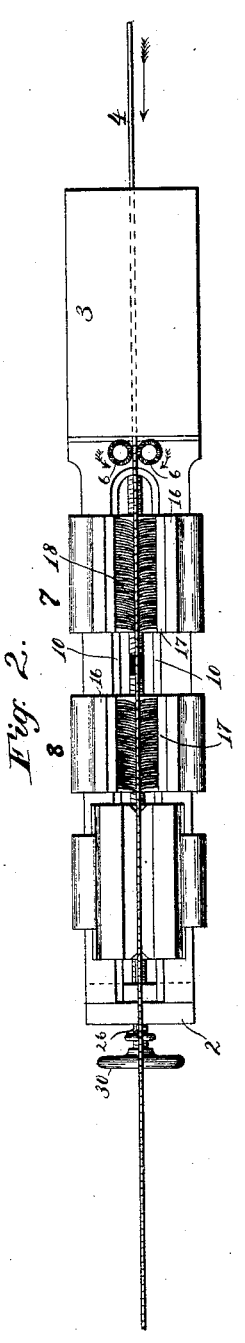


Fig. 2.

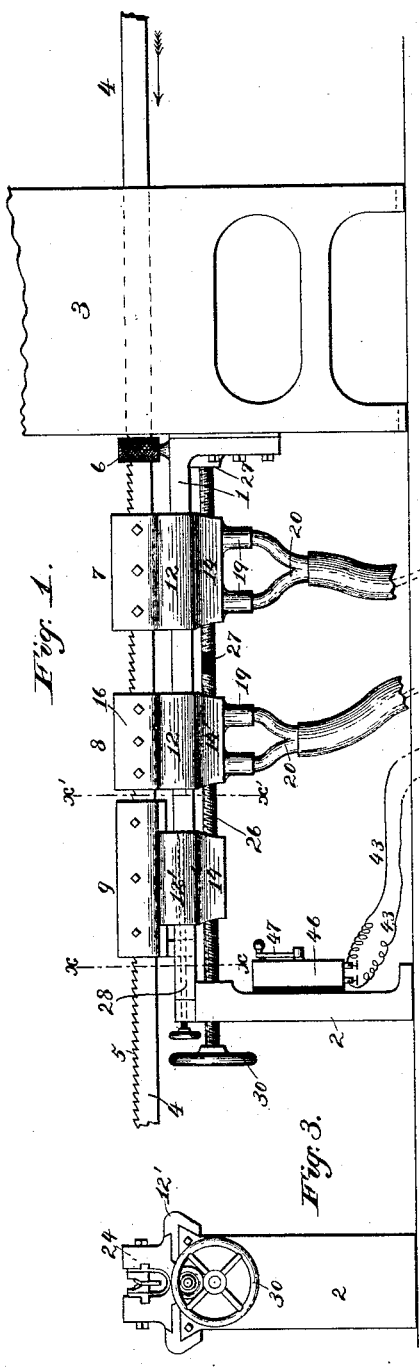
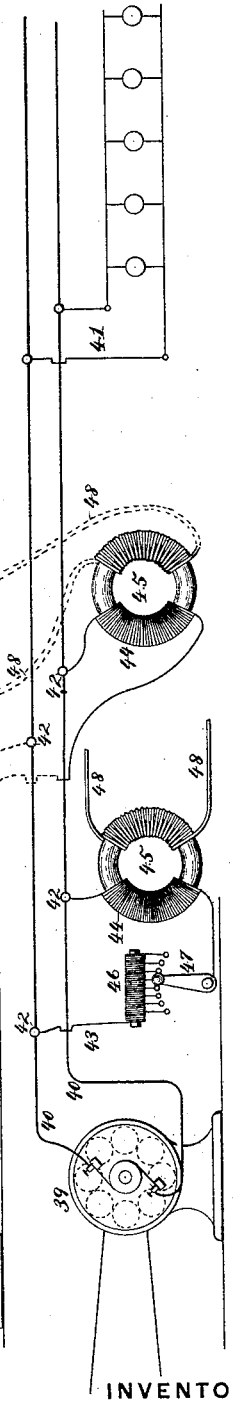


Fig. 1.

Fig. 3.



WITNESSES,

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(No Model.) 3 Sheets—Sheet 2.

E. E. RIES.

APPARATUS FOR HARDENING AND TEMPERING STEEL AND IRON.

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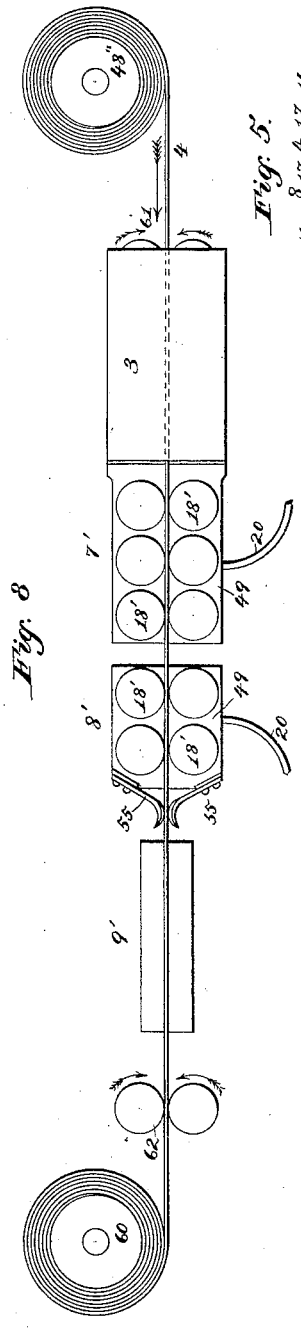

Fig. 8.

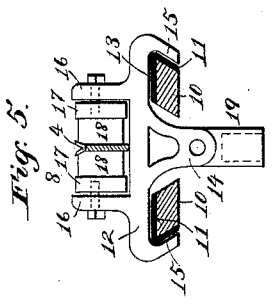

Fig. 5.

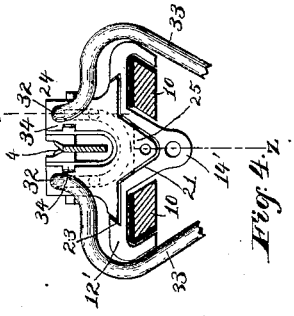

Fig. 4.

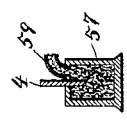

Fig. 12.

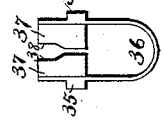

Fig. 7.

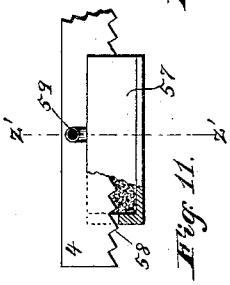

Fig. 11.

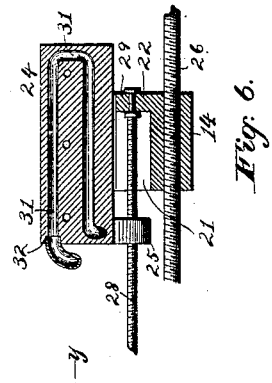

Fig. 6.

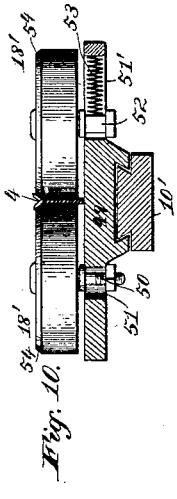

Fig. 10.

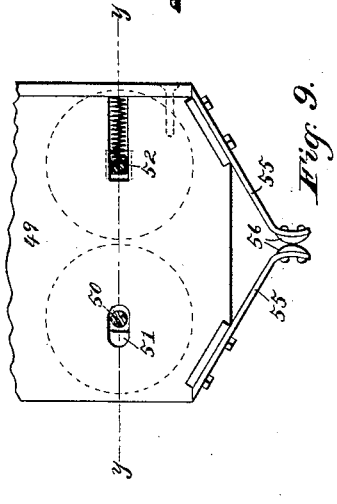

Fig. 9.

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Fig. 13.

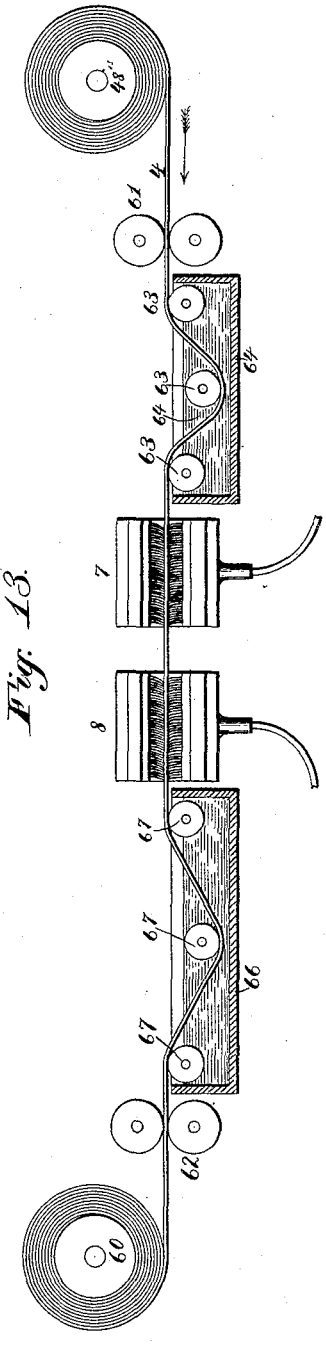
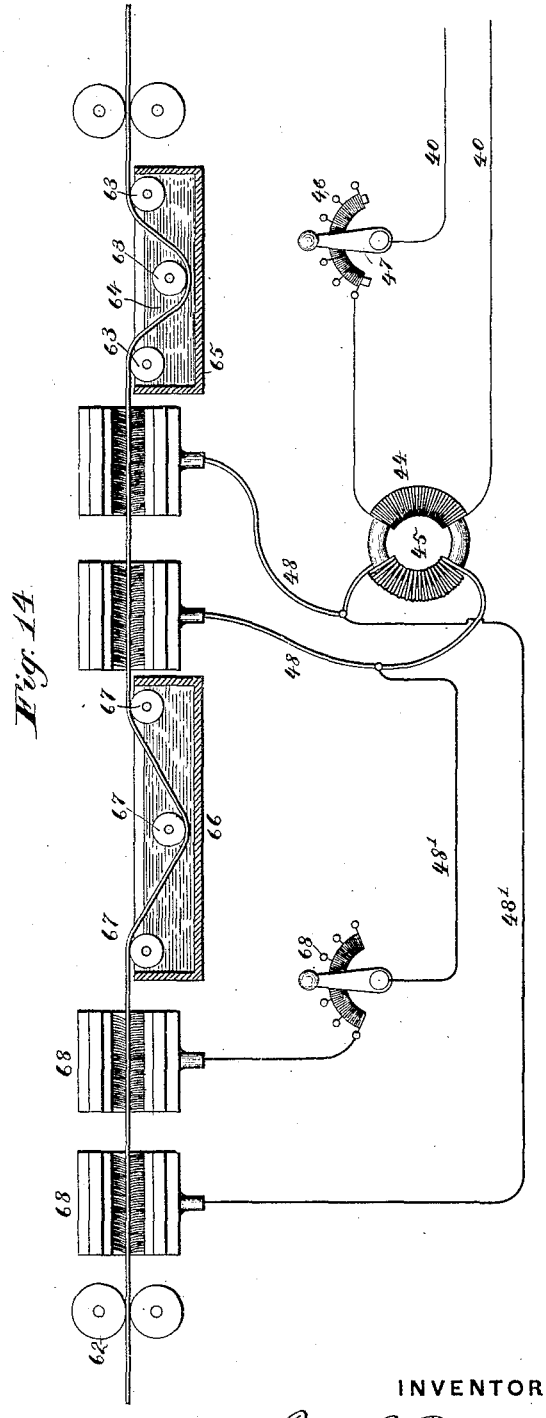


Fig. 14.



WITNESSES:

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Leopold Ries.

INVENTOR

Elias E. Ries,

By Joseph Lyons.

Attorney

UNITED STATES PATENT OFFICE.

ELIAS E. RIES, OF BALTIMORE, MARYLAND.

APPARATUS FOR HARDENING AND TEMPERING STEEL AND IRON.

SPECIFICATION forming part of Letters Patent No. 453,162, dated May 26, 1891.

Application filed October 31, 1888. Serial No. 289,609. (No model.)

To all whom it may concern:

Be it known that I, ELIAS E. RIES, a citizen of the United States, residing at Baltimore, in the State of Maryland, have invented certain new and useful Improvements in Apparatus for Hardening and Tempering Steel and Iron, of which the following is a specification.

My invention has reference to apparatus for hardening and tempering bands, webs, or rods of steel or iron by the aid of electricity, the main object being to render the process continuous in such manner that the repeated manual operations which heretofore had to be resorted to become unnecessary. The apparatus which I have devised for this purpose is so constructed that a web of steel or iron—which may be a saw-blade, a corset-spring, or other like lamina of steel or iron—is continuously fed between electrical contacts, which constitute the terminals of an electrical circuit, so that continuously-progressing sections of the web are heated to the desired degree by the passage of electrical currents through the same. Having thus attained the desired temperature, the continuously-progressing sections are passed, either in part or in whole, through a cooling medium, whereby the same are hardened to the desired degree, and the web is either delivered in this condition as a finished article of manufacture, or is before such delivery tempered by conduction of heat from the portions which did not pass through the cooling medium or by passing the same between the terminals of another charged electrical circuit. All this will more fully appear from the following detailed description, with reference to the accompanying drawings, in which several convenient forms of my apparatus are shown; but I desire it to be understood that I am not limited to the identical details of construction herein shown and described, since the same may be variously changed without departing from the fundamental features or from the *modus operandi* of my invention.

In the drawings I have shown in Figure 1 a front elevation of an apparatus embodying my invention for use in hardening and tempering saws, with the electrical generators and circuits conventionally indicated. Fig. 2 is a plan view of the apparatus, and Fig. 3 an end elevation of the same. Fig. 4 represents a section on line $x\,x$, Fig. 1; Fig. 5, a view of a section on line $x'\,x'$, Fig. 1; Fig. 6, a section on line $z\,z$ of Fig. 4; and Fig. 7, a detail view of the exchangeable cooling-jaws used in this form of my apparatus. Fig. 8 is a plan view of another form of my apparatus in which contact-rollers are used in place of brushes. Fig. 9 is a detail plan view of a portion of a set of contact-rollers; Fig. 10, a view, partly in elevation, of a section on line $y\,y$, Fig. 9; Fig. 11, an elevation, partly in section, of the cooling-trough employed in the apparatus shown in Fig. 8; and Fig. 12, a section on line $z'\,z'$, Fig. 11. Figs. 13 and 14 represent front elevations, partly in section but mainly in diagram, of two other forms of my apparatus, with the frames of the machines and the adjusting devices omitted.

Like numerals of reference indicate like parts in all the figures of the drawings.

Referring now more particularly to Figs. 1, 2, and 3, the main part of the apparatus is there shown mounted upon a bench 1, which at one end is supported by a standard 2 and at the other end by the frame-work 3 of a rolling-mill into which the raw material of the web of steel or iron passes, and is there formed to the required shape, or the machine supported by the frame 3 may be a tooth cutting and setting machine, into which a finished web of steel or iron is fed and is there operated upon to convert the same into a saw. The latter is supposed to be the case in the apparatus shown in Figs. 1, 2, and 3; but since the construction of such tooth-cutting and setting machines is well understood by those skilled in the art, and since for the purposes of my invention it is of no consequence what this construction may be, a description of the same is deemed unnecessary. It is sufficient to know that the steel or iron band or web 4 enters the machine at one end in the direction indicated by an arrow and issues at the other end with the saw-teeth cut and set, the arrangement being such that the teeth 5 are formed on the upper edge of the blade, as shown.

At the point where the saw-blade leaves the cutting and setting machine 3 there are mounted upon the bench 1 one or more sets

of rotary scouring and polishing brushes 6, which act to clean the two faces of the web from oxides, oil, and other insulating impurities, so as to produce clean metallic surfaces which furnish good electrical contacts.

The means for propelling the web 4 through the tooth cutting and setting machine and through the various devices mounted upon the bench are not shown in the drawings, Figs. 1, 2, and 3; but such means are well known and will ordinarily consist of feed-rollers suitably mounted and driven, as will hereinafter appear by reference to other figures of the drawings. Having passed between the scouring-brushes 6 6, the saw-web in its path over bench 1 passes successively and in the order named through two sets of electrical contact-brushes 7 and 8 and through a cooling apparatus 9. The two sets of contact-brushes are identical in construction, except that the set 7 is longer than the set 8, so that the description of one set 8 will answer for both.

By reference to Figs. 1, 4, and 5, it will be seen that the bench 1 is formed with two parallel ledges 10 10, with an open space between the same, like the bench of an ordinary lathe, and that the upper and outer faces of these ledges are covered each with a layer of insulating material 11, which may be hard rubber, vulcanized fiber, soapstone, or other like material which is not easily injured by heat. Soapstone, slate, and other refractory minerals are preferable; but other substances may be used with advantage, and if so desired the whole bench may be formed of marble or slate.

The brush-clamp 12 consists of a casting of good conducting metal, as copper or brass, and is formed with a flat bearing-surface 13 on either side of a central lug 14, which projects down into and through the open space between ledges 10 10, upon which latter the clamp 12 rests with its bearing-surfaces 13 13. The outer edges of the ledges are beveled off, as shown, and the sides of the clamp are turned down at 15 15 to conform to the shape of the ledges, so that it may move longitudinally upon the same, but cannot be displaced laterally. The clamp 12 has thus a miter bearing upon the bench; but it is evident that this construction may be varied in a great number of ways without departing from the fundamental idea of this part of my invention, which only requires that the brush-clamp be insulated from the frame-work of the apparatus and be guided longitudinally upon the bench.

From the upper face of the brush-clamp extend two brackets 16 16 at equal distances from the middle line, and to the inner side of each of these brackets is screwed or otherwise secured a brush-holder 17, in which the laminated electrical contact-brushes 18 are mounted in any ordinary or improved manner. The opposing brushes extend toward each other until they are very nearly in contact, and as the saw or other steel or iron web passes between the same they are bent backward in the direction of the travel of the web, as shown in Fig. 2, and thus make intimate contact with the faces of said web.

Each brush-clamp is provided with one or more, preferably two, sleeves or binding-posts 19 19, which project downwardly, as shown, from the lug 14, and in each sleeve is removably inserted the bared end of an otherwise insulated conductor 20, which constitutes a part of an electric circuit charged from a suitable source of electricity, as will appear further on, so that the two sets of brushes 7 and 8 constitute the terminals of such circuit, which terminals are bridged by continuously-progressing sections of the saw-web, which are heated by the passage of the current through the same.

Behind the shorter set 8 of contact-brushes is mounted upon the bench a casting 12′, which is similar to the castings of the brush-clamps 12, except that there are no brackets for securing brush-holders and no sleeves or binding-posts for electrical connections. Besides this, the casting 12′ has cut into its upper face a V-groove 21, which, however, is closed at one end by a wall 22, (shown in Fig. 6,) and above the V-groove there are dovetail guides 23, as shown in Fig. 4.

Seated in the dovetail guides is the base of the cooling-block 24, as shown, so that it may be moved longitudinally upon casting 12′, and a lug 25 at one end of the cooling-block will be received within the V-groove if the cooling-block is sufficiently moved in one direction with relation to casting 12′. An adjusting-screw 26, having right and left hand threads, passes longitudinally under the bench, and has at one end a smooth neck bearing in a journal-box 27, while it passes loosely through the standard or leg 2 of the bench. This screw 26 is separated into two parts by a piece of insulating material 27, and the forward part passes through a nut formed in lug 14 of the brush-clamp of set 7, while the rear part passes through similar nuts formed in lugs 14 and 14′ of brush-clamp of set 8 and casting 12′, respectively. Another adjusting-screw 28, which has a smooth neck-bearing 29 in the wall 22 of V-groove 21, works in a nut formed in lug 25 of cooling-block 24, but passes loosely through the end bar of the bench. It will now be understood that when the right and left hand screw 26 is turned by the hand-wheel 30 the distance of the two sets 7 8 of contact-brushes may be adjusted to suit the requirements of any particular work, while the cooling-block, mounted upon casting 12′, will move with the latter and with the set 8 of contact-brushes, so that the distance of the cooling-block from the set 8 of contact-brushes will not be disturbed. If, however, the adjusting-screw 28 is turned the cooling-block will be moved upon casting 12′, and its distance from the set 8 of contact-brushes may thus be adjusted.

The construction of the cooling-block and

its appurtenances will appear from Figs. 4, 6, and 7. The block 24 is U-shaped in general outline, and channels 31, formed in each branch of the U or fork, communicate with each other, as indicated in dotted lines in Fig. 4, and to the outlets 32 32 are connected the pipes or tubes 33 33, through which a cooling agent is passed into and through the channels 31. This cooling agent may be of any desired character, such as a liquid of a very low temperature or a compressed gas, which expands within the channels and thereby reduces the temperature of the cooling-block to any desired degree. Preferably ammonia-gas or anhydrate of ammonia will be used as the cooling agent; but the particular agent used forms no part of my present invention and is independent of the same. The opposing inner faces of the U or fork are formed each with a small recess 34, into which are sprung the lugs 35 35, formed on the outer faces of a U-spring 36, which has the general outline of the inner face of the cooling-block, so as to loosely fit against the same when the lugs 35 35 are sprung into the recesses 34 34, as shown in Fig. 4.

From the inner faces of the U-spring project inwardly the massive cooling-jaws 37 37, leaving a small space between the same, and when the article operated upon is a saw with its teeth set the cooling-jaws are cut away at the upper ends of their inner faces, as indicated at 38, to accommodate the teeth of the saw, while that portion of the blade which extends directly from the teeth is grasped between the jaws by the action of the spring, which thus exerts a yielding contact-pressure upon the saw-blade. If the teeth of the saw are not "set," as is sometimes the case, or if the object operated upon has no projecting portions, the cooling-jaws will have smooth inner faces. Generally speaking, the cooling jaws will be shaped to conform to the shape of the object to be hardened and tempered. So if that object be a steel wire each jaw will have a semicircular notch. If the object be a quadrangular rod, such as is used for umbrella-ribs, each jaw will have a notch to conform to one-half of the cross-section of such rib.

The operation of the apparatus so far described will now be easily understood. The object operated upon first passes through the machine 3, where it is formed to the required shape or is otherwise fitted to be subjected to the action of the devices mounted upon the bench 1. As has been stated above, 3 may be a rolling-mill by which ingots of steel or iron are shaped into a continuous web, wire, or thin rod, or it may be a machine by a which a lamina of steel or iron or a wire or rod previously prepared is passed to receive its final trim; or it may be a machine for cutting and setting the teeth of a saw. The latter is supposed to be the case in Figs. 1 and 2, and the steel blade is supposed to emerge from the machine with saw-teeth cut and set. Whatever the action of the machine 3 upon the web, wire, or other object 4 may be, the latter will be more or less spotted with oxides, oil, or other insulating impurities, and in order to remove the same before the article is passed between the contact-brushes it is first acted upon by the scouring-rollers 6 6, from which the article proceeds with clean metallic surfaces, as hereinbefore stated. In its further progress through the apparatus the web passes between the two sets of contact-brushes, the distance of which from each other is adjusted by the right and left hand adjusting-screw 26. This distance will depend upon the thickness of the article to be hardened and tempered, upon the quantity and tension of the current employed, upon the speed with which the article is fed through the apparatus, and upon the degree of hardness which it is intended to impart to the same. The blade or other object when made of high-grade steel should be heated to a cherry-redness when it issues from between the set 8 of contact-brushes. Lower grades of steel should be heated correspondingly higher, and a very few turns of the adjusting-screw 26 to the right and to the left will indicate to the attendant or operator the required relative positions of the two sets of brushes. The cooling apparatus 9 is adjusted by screw 28 as close as possible to the set 8 of contact-brushes, so that the heated article is transferred suddenly and without perceptible gradual transition from between the contact-brushes, where it is heated, into the chilling-bath, which the cooling apparatus in fact constitutes. By the arrangement hereinbefore described the cooling or chilling jaws are maintained under as low a temperature as may be desired, and the heated article which passes between these jaws, and with the latter gently pressing against the faces of the same, is suddenly chilled and hardened to the extent of contact, while the portions which do not make direct contact with the jaws 37 37 remain comparatively hot, and consequently soft. When the article operated upon is a saw-blade, as in the operation represented in Figs. 1 and 2, such saw-blade will issue from between the chilling-jaws with a narrow strip, including the saw-teeth, quite cold and exceedingly hard, while the remaining portion of the blade will be hot and soft, and as the saw recedes from the cooling apparatus the heat from this portion will slowly expand to the teeth and give to the same the required temper. To persons skilled in the art of hardening and tempering it will be clear that by means of the devices provided for adjusting the relative locations of the contact-brushes and cooling-jaws, by a proper selection of the latter, by a suitable adoption of temperature for the cooling apparatus, strength of electric current, and speed of feed of the article operated upon, it is easy to so arrange the parts that when the article is delivered beyond the cooling apparatus it will be hardened and

tempered to the degree suitable for its particular use. If for any particular article the apparatus is suitably adjusted, the heating, hardening, and tempering will be accomplished automatically and continuously and with great uniformity. The latter is a feature of very great importance, as is well known.

In the apparatus thus far described the contact-brushes must be made of a very good conducting metal and as massive as practicable, in order that they may not be perceptibly heated directly by the passage of the electric current and only very little by contact with the heated article operated upon. Any suitable source of electricity may be employed; but by preference I employ the currents of very low tension and great quantity furnished by the secondary coil of a transformer.

In Fig. 1 I have shown in diagram an alternating-current dynamo 39, from which a main circuit 40 extends, which circuit may be tapped, as shown at 41, for electric-lighting or other purposes. For use in hardening and tempering the main circuit is tapped at points 42 42, from which the branch circuits 43 extend, which include each the fine-wire primary 44 of an induction-transformer 45 and a suitable current-regulator 46. The latter is an ordinary rheostatic coil with a soft-iron core, whereby the resistance of the branch and the counter electro-motive force opposing the current in the main circuit is regulated by cutting more or less turns of the rheostatic coil in or out of circuit by means of a switch-arm 47. The terminals of the thick wire secondary coil of the transformer are connected with the wires 48 20, which are joined to sets 7 and 8 of contact-brushes, and it will now be understood how the quantity of current generated in the secondary coil of the transformer can be easily adjusted to suit any particular case. As stated above, any other suitable source of electricity may be employed. Instead of alternating currents a current of one direction may be employed, such as is furnished by an ordinary dynamo or by a secondary battery.

In the modified apparatus illustrated by Figs. 8, 9, 10, 11, and 12 a web 4, of iron or steel, which is taken from the roll 48″, is drawn in the direction indicated by an arrow into the machine 3, and is there operated upon to be fit to be subjected to the operations of the heating and chilling devices. The machine 3 may be of the character described with reference to Figs. 1 and 2, and the web is supposed to issue from that machine with clean metallic surfaces.

In place of the sets of brushes, sets 7′ and 8′ of the contact-rollers 18′ are employed, and the same are mounted in frames 49 49, which correspond to the brush-clamps 12 12 in Fig. 1, and to which the electrical connections 20 20 from the terminals of the source of electricity are attached. These frames are fitted to dovetail guides upon the bench, which in this instance has only a single ledge 10′. One of each pair of contact-rollers can be adjustably fixed in frame 49 by a screw and nut 50, the screw passing through a slot 51 in the frame, and the other contact-roller of each pair is mounted upon a square stud 52, guided in a suitable slot 51′ and forced forward by a spring 53, so that this roller will automatically accommodate itself to the particular article and will produce a yielding contact with the same. The surfaces of the contact-rollers will be shaped to conform to the cross-section of the article operated upon, as is indicated in Fig. 10, where the article is supposed to be a saw with the teeth set, and where, consequently, the contact rollers are beveled at one edge. This bevel 54 is shown in Fig. 10 on the upper edge of the contact-rollers; but when the saw is fed between the contacts with the teeth on the lower edge, as is supposed to be the case in the apparatus shown in Fig. 8, the bevels on the rollers will be formed on the lower edges of the same, as will be readily understood.

To the rear end of the frame of set 8′ are secured two heavy metal plates 55 55, which project beyond the frame and are inclined toward each other. The free edges of these plates are lined with exchangeable contact-jaws 56. These jaws are made of such metal as is best suited for the purpose. If the article operated upon is of considerable thickness, the contact-jaws are made of copper or other good conductor; but if the article is thin the contact-jaws may be made of platinum. As seen in the drawings, the jaws 56 are curved and they are gently pressed against each other, but will yield and separate to admit the web 4 by reason of the elasticity of the long plates 55 55. The purpose of the plates 55, with their contact-jaws, is to bring the last point of electrical contact of the web 4 with the heating devices as near as practicable to the chilling device 9′. This chilling device may be of the same character as that shown at 9 in Fig. 1, and in detail in Figs. 4, 6, and 7; but if the web 4 is of iron which is to be case-hardened the chilling device will take the form of a box 57, Figs. 11 and 12, which is provided with a central slot 58, and is filled with material, such as ferrocyanide of potassium, which will act upon the heated iron article to harden the same. A pipe 59, communicating with a supply of that material and emptying into the box 57, will keep the latter constantly filled. The chilling-box is made rather long, so that the hardened article when it issues from the same will be cold enough to be taken up by the roller 60 without requiring additional cooling. Feed-rollers 61 62, placed at each end of the bench, are timed to feed the web or other article continuously through the apparatus with uniform speed. It will be understood that the adjusting devices for the contact-brushes and for the cooling apparatus shown and described in connection with the apparatus represented in Fig. 1 will also be used in connection with

the modified form shown in Fig. 8, although for the sake of clearness and simplicity they have been omitted from the drawings.

In the modified form of apparatus shown in Fig. 13, a web 4 of steel or iron is taken from a roll 48″ by feed-rollers 61, and is passed over and under guide-rollers 63, through an alkaline or acid solution 64 in a trough 65 for cleaning the article from adhering spots of fat or rust. From this cleaning-trough 65 the web proceeds to and between the two sets 7 and 8 of contact-brushes, and from thence into the cooling-tank 66, over and under guide-rollers 67 67, and then between feed-rollers 62 to the receiving roll or drum 60. The cooling-tank in this instance is filled with a suitable liquid, such as oil, which while cooling the article will at the same time give to the same the required temper, as is well understood by those skilled in the art.

In Fig. 14 the same apparatus is shown, with the addition of subsidiary contact-brushes 68 68, which constitute the terminals of a branch 48′ 48′ from the main heating-circuit 48 48. The tank 66 in this instance contains, ordinarily, water of a low temperature, whereby to the web 4 is imparted a high degree of hardness, and the current from the branch circuit 48′ 48′ serves for reheating the web sufficiently to give the required temper to the same. By means of a rheostat 68 placed in the branch 48′ the amount of current diverted to the subsidiary contact-brushes is easily regulated.

The dip of the web 4 in the tanks 64 and 66 is greatly exaggerated in Figs. 13 and 14 for the sake of clearness of illustration. It will also be understood that the means for regulating the positions of the contact-brushes and chilling devices shown in Figs. 1 and 2 will also be used in connection with the modification represented in Figs. 13 and 14; but one of these sets 7′ may be fixed in position, in which case in place of the right and left hand adjusting-screw 26 a simple threaded screw will be used.

It will be understood that in place of the scouring-brushes 6 6 shown in Figs. 1 and 2, or in place of the tank with alkaline or acid solution shown in Figs. 13 and 14, any other effective cleanser may be employed.

I do not herein claim the method or process of hardening and tempering which is or may be practiced by the use of the various apparatus described, since the same forms the subject of another application, Serial No. 289,840, filed November 2, 1888.

Having now fully described my invention, I claim and desire to secure by Letters Patent—

1. In an apparatus for hardening and tempering bands, webs, or rods of steel or iron, the combination of two successive sets of electrical contacts, constituting the terminals of a charged circuit, and a chilling medium arranged behind the last set of contacts, with means for independently adjusting the relative distances of the contacts from each other and from the chilling medium, and feeding devices for passing the steel or iron article uniformly and continuously between the contacts and through the cooling medium in uninterrupted succession, substantially as described.

2. In an apparatus for hardening and tempering bands, webs, or rods of steel or iron, a chilling device consisting of a casting having a U-shaped recess and communicating channels formed in the body of the casting, with pipes or tubes for passing a cooling-fluid through the channels, and a U-spring removably mounted in the recess and provided with chilling-jaws adapted to receive the steel or iron article between them, substantially as described.

3. In an apparatus for hardening and tempering bands or webs of steel or iron, a chilling device consisting of a casting, a U-shaped recess, and communicating channels formed in the body of the casting, with pipes or tubes for passing a cooling-fluid through the channels, in combination with chilling-jaws mounted in the recess and shaped to receive and bear upon one portion of the band or web continuously passed between them, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ELIAS E. RIES.

Witnesses:
LEOPOLD RIES,
JNO. T. MADDOX.