

Nov. 5, 1935.

W. H. WOOD ET AL

2,019,555

ELECTRIC HEATING AND CONDITIONING APPARATUS AND METHOD

Filed Nov. 25, 1933

2 Sheets-Sheet 1

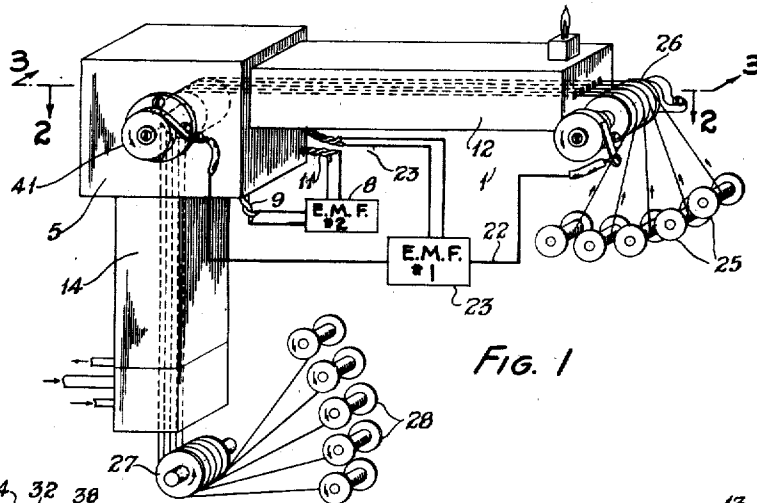


FIG. 1

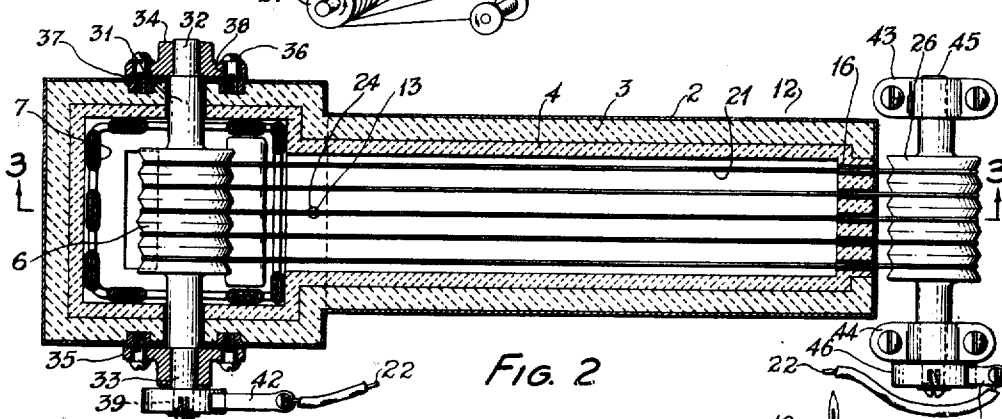


FIG. 2

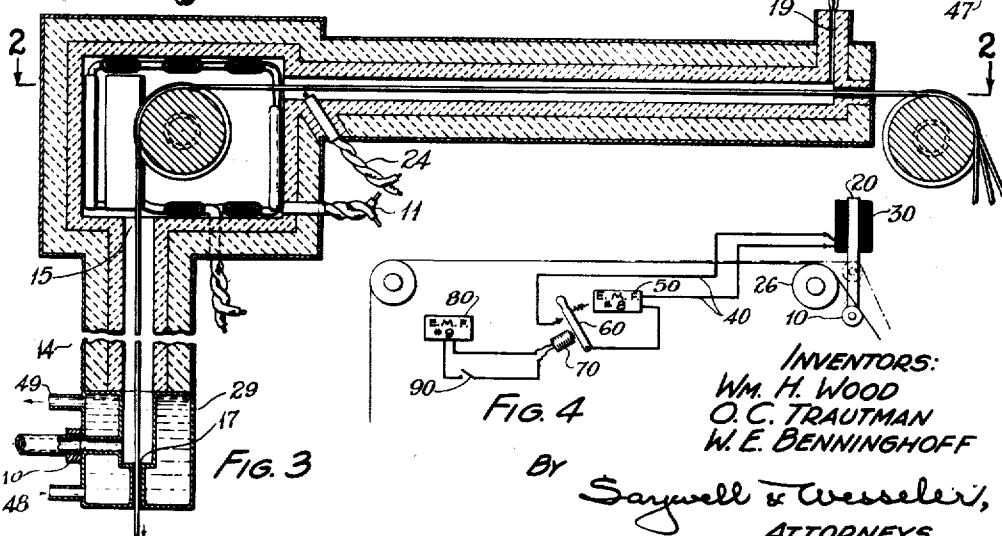


FIG. 3

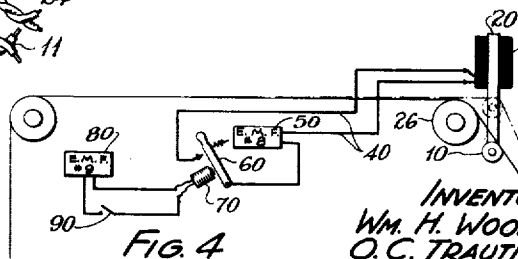


FIG. 4

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2 Sheets-Sheet 2

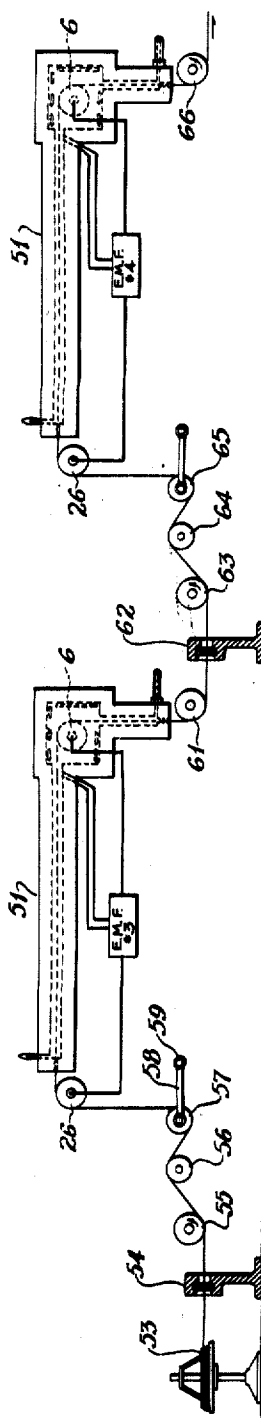


FIG. 5

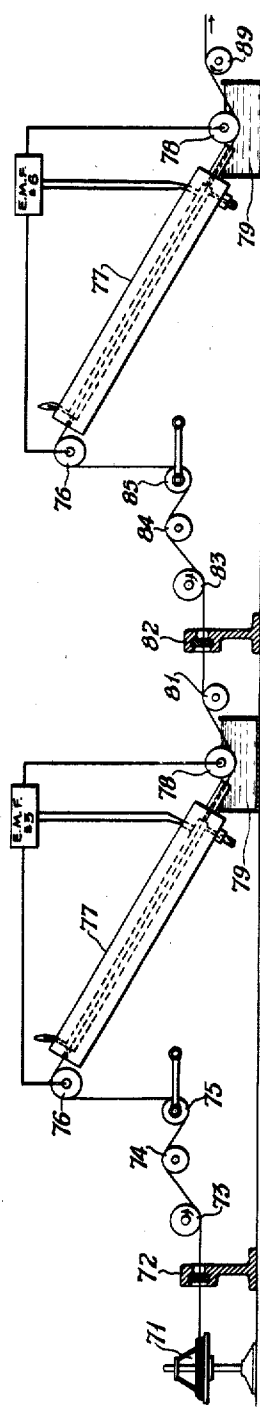


FIG. 6

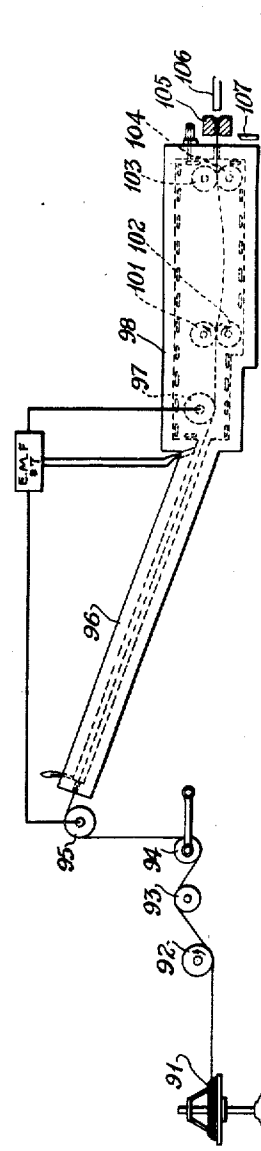


FIG. 7

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2,019,555

ELECTRIC HEATING AND CONDITIONING
APPARATUS AND METHOD

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Application November 25, 1933, Serial No. 699,694

24 Claims. (Cl. 219—11)

This invention, as indicated, relates to a method of and apparatus for heating and conditioning metal wire, strips, bars, and like continuous elongated metal structures or other suitable shapes and forms of such metal structures. This application constitutes, in part, a continuation of our application Serial No. 606,494, filed April 20, 1932, on Apparatus for heat treating wire.

In the previous application there was in contemplation the heat treating of wire through the inclusion of the wire to be treated in an electric heating circuit and the present invention has the same method of heating in view. It is desirable, however, where certain physical characteristics of the product are in view, to accurately control the temperature of the material undergoing treatment throughout its course of heating and cooling, and the present method and apparatus provide for such complete and accurate control.

The invention is especially adapted for use with material such as wire and the like, wherein no hardening effects are desired and wherein the sudden abstraction of heat from the wire, after being brought up to the desired temperature, is avoided, and whereby the material is brought back gradually to normal temperature. This is true with reference to conditioning steel wire and the like, but when copper or brass wire or the like is to be softened after working, a quenching bath is used immediately after the heating step. Thus, the present apparatus is adapted either to change the condition of metal influenced by a heating, coupled with either a gradual cooling effect or a sudden cooling in order to produce desired characteristics in the product. The drawing of copper or brass wire or the like results in hardening the same, and thereafter the wire must be heated and softened. These steps may be carried out as a continuous process, as will be hereinafter explained. The present invention is primarily intended for producing heated wire as part of a continuous process and thereafter annealing, fabricating, or physically conditioning such wire, but no limitation whatsoever as to the use of the apparatus for any other purposes for which it is adapted is to be implied from the description of the same for the use stated. The use of the term "wire" herein is expressly defined as covering any elongated metal stock adapted to be made part of an electrical heating circuit operating progressively over successive portions thereof, whether such stock is in the form of wire, strips, bars, or the like, or has been partially fabricated or shaped preliminary to entering the heating circuit.

The principal object of the present invention is to produce an apparatus having means conveying electric current to a wire to be treated as a part of the heating circuit and to provide a roller or other contact or supporting element past which such wire passes, which will not abstract heat therefrom or act as a chilling or tempering element, except between predetermined and defined limits which will vary in accordance with the results to be attained.

Another object of the invention is to provide a method of heating and conditioning one or more strands of wire as part of a continuous process and to provide a temperature control for the supporting contact elements for the strands of wire which will be independent of the heating circuit for such wire and will operate between predetermined and defined limits in accordance with the final physical characteristics which it is desired to impart to the product.

Another object of the invention is to provide heating means independent of the wire heating circuit for heating the supporting and contact elements of the apparatus in the direction of motion of the material under treatment, which contact elements may be maintained at the desired temperature without extended heating of a large part of the apparatus accompanied by the thermal losses and expense consequent thereon, which would otherwise be entailed.

Another object of the invention is to provide independent heating means for the supporting or guiding means for the heated wire, which may be in the form of a separate electric heating circuit independently controlled by a thermostatic device and forming no part of the heating circuit of the apparatus for producing the required temperature in the material undergoing treatment.

Another object of the invention is to provide a chamber of small capacity within which the supporting, guiding and contact elements, in the direction of motion of the heated wire, are positioned, which will be suitably insulated against thermal losses and provided with means for maintaining a predetermined temperature in the supporting elements.

Another object of the invention is to provide a roller for supporting contact with one or more wires to be heat treated or conditioned, such roller, by reason of its small mass and the accurate control of the temperature of the insulated housing within which it is supported, may be quickly brought to substantially the temperature of the wire undergoing treatment, and may be

maintained at such temperature at a minimum expense.

Another object of the invention is to provide an apparatus having a plurality of wire supporting elements so interrelated to each other as to automatically correct temperature variations caused in any one of such wires through irregularities of metal structure or composition, or other causes, and to protect such wire strands in the course of their treatment from variations of temperature through contact with the supporting members, which would have an undesired effect upon the hardness or other physical qualities of the wire undergoing treatment.

Other and further objects of the invention will appear in the course of the following description.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means and method hereinafter fully described and particularly pointed out in the claims, the annexed drawings and the following description setting forth in detail certain means and modes embodying the invention, such disclosed means and modes constituting, however, but several of various forms in which the principle of the invention may be used.

In said annexed drawings:

Figure 1 is a perspective view showing one form of electric heating and conditioning apparatus embodying the principles of the invention;

Figure 2 is a central horizontal sectional view, taken along the line 2—2, shown in Figures 1 and 3, looking in the direction of the arrows;

Figure 3 is a central vertical sectional view, taken along the line 3—3, shown in Figures 1 and 2, looking in the direction of the arrows;

Figure 4 is a diagrammatic view of a portion of the apparatus shown in Figure 1 with control device combined therewith;

Figure 5 is a diagrammatic view in side elevation, with parts thereof shown in section, of a combined wire drawing and annealing apparatus embodying the principles of the invention;

Figure 6 is a diagrammatic view in side elevation, showing a combined wire drawing and conditioning apparatus, with parts thereof shown in section; and

Figure 7 is a diagrammatic view in side elevation of an electric heating and conditioning apparatus combined with a fabricating apparatus embodying the principles of the invention.

As has heretofore been indicated, the present invention is a continuation in part of the invention set forth in application Serial No. 606,494, filed April 20, 1932, by applicants.

The apparatus used may embody features similar to those heretofore shown and described, but having variations to permit the same to be utilized in conjunction with metal modifying or conditioning means, or as part of a series of mutually interdependent units, whereby a saving in time and expense of metal treatment and conditioning may be brought about and a satisfactory product obtained more efficiently.

For convenience of illustration and description, the material undergoing treatment has been shown in the form of wires, but it is not desired to limit the application of the invention to wires, but to have the same include also various suitable types of elongated metallic material, such as strips and light bars and the like, and when the terms wire or wires are used hereinafter in the specification or claims, it is to be understood, unless specifically excepted, to include any such elongated metallic material adapted for electric

heating as part of a heating circuit wherein the material progresses between the contact points as explained herein.

The apparatus shown in Figures 1 to 4 inclusive comprises a casing 1 through which wire or elongated strip material is adapted to be drawn and subjected to electrical heating between spaced contact members, making a portion of such material undergoing treatment a part of the electric heating circuit and protecting the area undergoing heat treatment from oxidation or like changes and from temperature changes adversely affecting the condition of the stock.

The casing may be variously constructed, but, as shown, has an outer wall 2 of metal within which is disposed a wall of insulating material 3 over the greater portion of its extent, within which material an inner refractory lining or surface 4 is provided preferably for the entire apparatus.

The casing as shown comprises a roller housing or chamber 5 within which is supported a roller 6 adapted to contact with the stock undergoing treatment and serve as an electrical contact element to convey current thereto. The roller 6 is the contact member toward which the heated stock moves while a part of the heating circuit, and it is intended to maintain said roller at a temperature between predetermined and defined limits suited to bring about certain desired results. The roller 6 may be variously heated, but in the construction illustrated in Figures 1 and 2, is confined within the interior of the chamber 5 which is of small cubic content and provided within the same with a series of heating elements 7 which may be formed of any suitable resistance material disposed preferably upon the various walls of the chamber and with a minimum of openings from the chamber so as to conserve the heat within the same.

A certain degree of heat may be imparted to the roller by the heated stock passing over the same and with the use of external heating means to replace radiation losses, but improved performance can be obtained by utilizing special heating elements in the chamber as substantially the entire source of heat, especially during the initial stage of the operation. The heating elements are preferably connected with a separate source of electromotive force 8 by means of suitable conductors 9, and a thermo-couple 11 and temperature control apparatus of conventional type is associated with said source of current 8 to control the current in the heating coils and regulate the temperature of the chamber 5.

The casing in the form illustrated comprises the chamber 5 and a horizontal chamber 12 communicating therewith through a narrow opening 13 in the wall of the housing and a vertical chamber 14 communicating with the housing 5 beneath the same through a narrow opening 15.

The chamber 14 may be of any desired length and is intended to serve as a means for gradually reducing the temperature of the wire or like material which is undergoing heat treatment or conditioning. The chamber 14 may be provided with specific areas of different temperature range or constructed so that the wire passing there-through will have different heat radiation losses. The chamber, as shown more particularly in Figure 3, is provided at its extreme lower end with a water jacket 20 which serves to regulate the temperature adjacent the wire immediately prior to its leaving the casing, as well as at the time 75

of its emergence from the casing. The water jacket is provided with an inlet passageway 48 and outlet passageway 49 through which water or other fluid of any desired temperature exchanging characteristic may be supplied at any desired rate of flow through such water jacket. Thus, in the event it is sought to gradually cool the wire after it leaves the heated roller 6, its passage down the vertical chamber 14 will result in gradual cooling in the refractory lined section of the chamber with the insulation thereabout, and as it approaches the lower end, if cool water is circulated through the water jacket, the cooling will be accelerated and increased still further as the wire emerges through the narrow passageway 17 at the extreme end of the chamber.

The insulation and lining of the housing 5 and chambers 12 and 14 is made substantially continuous, as shown in Figures 2 and 3, the refractory inner walls may be carried through to the outer metal shell of the casing 12 at points where openings are provided in the casing, but the extent of the same should be limited to reduce heat losses. These openings comprise passageways 16 through the end of the horizontal chamber 12 for the individual wires or strips undergoing treatment. Openings 17 through the water jacket 29 are provided at the free end of the vertical chamber 14 for the individual wires or strips undergoing treatment. If the water jacket is omitted, as may be desirable for certain operations, the opening 17 may correspond with those shown in Figure 2. Adjacent each of said respective openings, passageways 18 and 19 are provided for the entrance and discharge, respectively, of a gaseous medium which preferably is an inert or non-oxidizing gas which may be nitrogen or hydrogen or illuminating gas or natural gas, intended to prevent the glowing surface of the stock undergoing treatment from becoming coated with a scale or other superficial coating harmful or disadvantageous from the standpoint of utility or appearance to the metal undergoing treatment. The colors of brass and copper wires are very delicate and are changed by even slight heating in air or by any moisture content, for which case the gas used must be very dry. In some cases, however, where special treatments are desired, we provide other compositions of gas. For example, by the use of a determined mixture of air and steam it is possible to produce a coating on ferrous metal wire which is black and highly resistant to atmospheric oxidation, wherefore we control the gas composition according to the end in view. This gaseous medium may also serve the function of a temperature modifying element and may be introduced into the passageways within the casing at a predetermined degree of temperature in accordance with the effect desired.

The apparatus illustrated is preferably adapted to receive simultaneously a plurality of strands of wires 21 or strips of metallic material to be treated and forming over a portion of their course of travel through the casing, part of a heating circuit 22 connected with a suitable source of electro-motive force 23 and controlled by a temperature control apparatus having a thermoelectric couple 24 connected therewith and projecting into the heating chamber preferably at a point adjacent the housing for the heated contact roller 6 and shown in the drawings as in the lower wall of the horizontal chamber 12 at a point where the opening 13 into the housing is

provided. The wires or strip material are preferably carried upon individual reels or spools 25 which may be held under slight tension by any suitable means and extend upwardly therefrom over a contact roller 26 and thence through the individual apertures 16 into the horizontal casing 12, and over the contact roller 6 in the housing 5, and thence downwardly through the chamber 14 to a guide roller 27, and thence to a series of take-up reels 28. The take-up reels may be actuated to draw the wire through the apparatus or may have merely take-up tension, and have other power driven means to advance the strands of material through the casing.

Any suitable means of advancing the wires through the casing may be employed other than that indicated, and if desired, the contact rollers 6 and 26 may be in the form of individual rollers such as were shown in Figure 4 of pending application Serial No. 606,494, heretofore referred to, such rollers being electrically connected but mechanically disconnected, and the take-up drums being independently rotated and the various contact elements being independently rotatable according to different speeds of the wires, but electrically connected so as to secure the benefit of current equalization, as will be hereinafter explained. This mechanical separation is not necessary because of any unequal heating requirement of the wires, but more from unequal working requirements. For example, one use for heating the wires is to anneal them between independent passages through wire-drawing dies. Due to accidental causes, such as the rate of drawing wires of different sizes, or the accidental breakage of wires it is desirable in some cases like this to have the strands move independently.

Irrespective of whether the strands move independently or simultaneously, or whether there are one or more strands, it is desirable in most instances to provide means for interrupting the heating circuit when an emergency arises. This is accomplished by positioning adjacent the contact roller 26 an insulated roller 10 carried on an armature 20 of a solenoid 30 having a circuit 40 to a separate source of E. M. F. 50 and having a switch 60 adapted to be manually operated or actuated by a magnet 70 having a separate source of E. M. F. 80 with a circuit closing device 90, which may be in the form of a spring finger riding upon the wire under control and closing the circuit upon the breaking thereof, or operated in any other manner. Each of the wires will be provided with a roller 10 beneath the same and associated mechanism, and upon the actuation of the solenoid the wire affected will be lifted from its contact roller 26 and the heating current through such wire will be interrupted and damage to the apparatus or material passing therethrough will be prevented.

With an apparatus of the character illustrated, the operation is initiated after the wires are suitably threaded over the various guide and contact rollers and the circuit is closed to the heating units 7 and the desired atmosphere within the casing is provided for by the introduction of suitable aeroform medium and the water or other fluid is circulated at the desired rate through the water jacket, and then the circuit to the driving elements of the mechanism is switched on and the wire take-up reels, or other wire moving mechanism, are set in motion. The wire heating circuit is then switched on to place the sections of the wires extending between the con-

tact rollers 6 and 26 under the electrical resistance heating effects of the current. Such wires will immediately be brought to the desired temperature through the regulation of the initial current and the control thereof by the thermo-electric couple heretofore referred to. Differences in conducting capacity of the wires of the series will be equalized in accordance with the principles set forth in our prior application Serial No. 606,494, heretofore referred to. Thus, through such automatic compensation all of the wires will be subjected to substantially equal temperature conditions and after they are drawn through the apparatus will receive graduated cooling in descending through the chamber 14 and past the water jacketed section 29 thereof.

As has heretofore been explained, whenever wires are referred to in the specification and claims, it is done with the understanding that other elongated material adapted for heat treatment under like conditions may be used in place of wires, such as light or heavy strips of metal of various cross section, or still heavier material where rivet forming operations are in contemplation as with the apparatus illustrated in Figure 7 hereinafter to be described.

It should be pointed out that in connection with apparatus of the type shown in Figures 1 to 4 herein, a great saving in time is effected in the treatment of wire or the like as a continuous operation, and that a great saving in expense is also brought about through carrying on the operations in apparatus of relatively small extent as compared with a heating or annealing furnace of the type at present in general use.

It should also be pointed out in connection with the apparatus shown in Figures 5, 6 and 7, that in addition to the advantages of continuously handling material so as to anneal or otherwise condition the same as a step to a fabricating process such as wire drawing, rivet forming, or the like, there is no loss of time between the end of the temperature conditioning operation and the next mechanical step of the process, and that no pickling or cleansing operations upon the stock undergoing fabrication are required, and that the stock will always exhibit a clean surface free of oxidation or other coating, unless the formation of a particular oxidized or other coating is embodied as a part of the process, as in giving colors to brass or copper wire or forming a special black surface coating on steel wire.

When wire drawing operations are conducted in the usual manner, after the passage of the wire through the dies the same is transported to an annealing furnace where a long period of annealing treatment is usually required, and this is frequently followed by pickling and thereafter coating the wire with lime to act as a lubricant and to neutralize the acid preliminary to a further wire drawing stage. The wire may also be oven dried preliminary to a second passage through one or more drawing dies and thereafter again subjected to the furnace and pickling and neutralizing steps. It is needless to point out that such procedure is costly in the time involved in the process, as well as in the equipment and labor necessary to carry through the various treatments in each of the intermediate and final stages of the operations after the wire drawing steps of the operation.

In the invention herein set forth, such various operations may be carried on continuously and a great saving effected as stated, not only in the time and labor costs involved, but in the installa-

tion, maintenance, and operative costs of the necessary equipment. The product resulting from the process herein set forth is of superior quality in that almost exact uniformity of production can be assured, and the material protected from beginning to end of the process from injury through mechanical handling, unfavorable atmospheric effects, or through accidental temperature conditions or variations which with other equipment might be unavoidable.

The method of supporting the roller where a single roller is utilized for the several strands is illustrated in Figure 2, wherein the ends of the shaft 31 carrying the roller 6 are extended through the casing and are formed with reduced bearing sections 32, 33 at the respective ends which are received in bearing terminals 34, 35 suitably secured by means of screws 36 or the like to the sides of the casing with suitable insulation in the form of a sheet 37 and collars 38 to insulate the roller from electrical contact with the casing. The one end of the shaft may have a further extension 39 to which is attached a conducting disk 41 upon the circumference of which a contact finger 42 bears, such finger being connected with the circuit 22 heretofore referred to. Substantially the same construction is used in connection with the roller 26 which is positioned outside of the casing and serves as the contact at the lead-in end for the wires to be heated. In place, however, of having the roller supported on the casing, brackets 43, 44 may be provided to receive the reduced ends 45 of the shaft. The disk 46 and contact finger 47 may be substantially the same as those connected with the roller 6, the contact finger being also attached to a conducting member forming part of the circuit 22. Any other means of conveying current to the contact roller may be employed such as a direct connection with the bearing terminals 34, 35.

The construction shown in Figure 5 provides two units 51, 51 for annealing the wire, said units being similar in construction to those illustrated in Figures 1 to 3. The units are set up in line so as to provide a continuous process of wire drawing and annealing. Each of the wires to be treated is mounted upon a reel 52, passing thence through a drawing die 54 of conventional design and being drawn therethrough by means of a pulling device 55 in the form of a power driven drum about which the wire makes one or more turns, and thence over an idler wheel 56 positioning the wire properly with reference to the pulling device, and thence over a take-up roller 57 serving to provide an area of slack to compensate for variations in operation. The take-up roller preferably comprises a grooved roller supported upon a frame 58 having a fixed pivot 59 upon the supporting structure, and may be held by gravity or suitable auxiliary springs or other devices into the desired degree of tension in connection with the wire. The wire travels upwardly from the tension roller over the contact roller 26 and thence through the casing and over the other contact roller 6, and thence downwardly over an idler roller 61 whence it passes through a second drawing die 62, being pulled therethrough by means of the pulling device 63 which is similar to the pulling device 55 heretofore described, and thence over an idler 64 and a tensioning device 65 similar to the devices heretofore described, as well as over the contact roller 26 and the second contact roller 6 in the casing and thence over a pulling device 66 and to take-up reels (not shown) which may be fric-

tion driven to prevent the accumulation of slack material after the final stage of annealing.

The structure shown in Figure 6 differs from that shown in Figure 5 in that in place of utilizing a casing to gradually cool and thus anneal the wire, particularly steel wire, the apparatus is especially constructed for use with brass or copper wire, which when heated may be cooled at once. The apparatus accordingly incorporates a quenching bath whereby the wire after being drawn and heated may be suddenly cooled to save time involved in slow cooling. In the apparatus shown in Figure 6, the reel 71, drawing die 72, pulling device 73, idler roller 74, tensioning roller 75, are all substantially identical with that of the apparatus shown in Figure 5, and the wire in passing upwardly extends over a contact roller 76, and thence downwardly through a casing 77, within which the heating of the wire is carried on in an atmosphere provided by a suitable aeriform fluid. The wire, after being heated, passes downwardly over the second contact roller 78 which is positioned adjacent the quenching bath 79 whereby the hot wire is plunged into the tempering bath and suddenly cooled to complete this step of the process. The wire, immediately after being quenched, passes over the idler roller 81 and thence through a die 82, being drawn there-through by means of the pulling device 83, and thence passing over the idler roller 84, and under the tensioning roller 85, to the contact roller 76 and through a second casing 77 similar to the casing heretofore described, and thence over the contact roller 78 and into the quenching bath 79, being drawn therefrom by means of the pulling device 89, and thence passing to take-up reels (not shown) preferably actuated by suitable friction-driven mechanism.

The step of cooling or quenching, above described, may be carried out by means of any suitable liquid bath or in many instances may be satisfactorily accomplished by means of one or more contact rollers adapted for abstracting heat quickly from the wire. Various other heat abstraction agencies may be used in place of the quenching bath, including air or other fluid jets whether of liquid or gaseous form.

The apparatus shown in Figure 7 illustrates the use of a modified form of the construction shown in the preceding figures, wherein the heating of the wire in a conditioning atmosphere is followed by a fabricating step, in this instance the manufacture of rivets. As shown, the wire is supported on a reel 91, passes over a pulling device 92, idler pulley 93, tension pulley 94, and contact roller 95, through the casing 96 provided with a suitable conditioning atmosphere, and thence over a heated contact roller 97 in an electrically heated housing 98 similar to the housing 5 heretofore described, and with heating elements and connections thereto similar to those heretofore described and shown in Figures 1 to 3 inclusive. The housing is preferably large enough to enclose the wire feeding or pulling mechanism. This may vary in form but as shown comprises a pair of continuously operating horizontally positioned friction rollers 101, 102, which serve to draw the wire from the casing 96 and a pair of intermittently operating horizontally positioned friction rollers 103, 104, at the extreme end of the housing 98. Between the pairs of rollers there is provided a certain amount of slack wire to compensate for intermittent action of the forming mechanism presently referred to. The wire, after being heated and maintained in heated condition

within the housing, is discharged from the housing by the pair of friction rollers 103 104 which are intermittently actuated so as to feed the heated wire intermittently to a die 105 forming part of a heading or upsetting mechanism of conventional design and having a reciprocating hammer 106 and a shear member 107, when the machine is intended to form rivets as is illustrated in the specimen mechanism. Apparatus of this type is adapted to condition stock for various hot metal working operations. Where rollers are used to feed the stock instead of drum pulling devices, heavier stock can be readily handled whether such stock be raw stock or previously treated or partly fabricated stock.

While the electrical heating of the wire in the last-named instance has been described as for preparing the same for fabricating in heated form, and has been shown as a rivet heading machine, it is to be understood that uses other than the particular machine may also be served by the heating apparatus and the feeding mechanism for the hot wire associated therewith. After the mechanical modification of the wire in any desired form, if the elements are not sheared, the annealing or conditioning of the fabricated parts may be carried on in a casing similar to that shown in Figures 1 to 4 or the sudden cooling of the parts to prevent excess softening of certain types of material may be carried on in an apparatus similar to that shown in Figure 5.

Other modes of applying the principle of our invention may be employed instead of those explained, change being made as regards the means and steps herein disclosed, provided the means and steps stated by any of the following claims or the equivalent of such stated means and steps be employed.

We therefore particularly point out and distinctly claim as our invention:

1. A method of heating and conditioning wire which includes the steps of supporting and heating sections thereof progressively in an electric heating circuit between spaced contact members, and supplying heat from a source external to the wire heating circuit to the immediate area adjacent the contact member in the direction of motion of the heated wire to control heat losses of the wire while passing over the contact member in the direction of motion of the heated wire.
2. A method of heating and conditioning wire which includes the steps of supporting and heating sections thereof progressively in an electric heating circuit between spaced contact members, supplying heat from a source external to the wire heating circuit to the immediate area adjacent the contact member in the direction of motion of the heated wire to control heat losses of the wire while passing over the contact member in the direction of motion of the heated wire, and controlling the loss of heat of said wire beyond the last-named contact member.

3. A method of heating and conditioning wire which includes the steps of supporting and heating sections thereof progressively in an electric heating circuit between spaced contact members, supplying heat from a source external to the wire heating circuit to the immediate area adjacent the contact member in the direction of motion of the heated wire to control heat losses of the wire while passing over the contact member in the direction of motion of the heated wire, controlling the loss of heat of said wire beyond the last-named contact member, and providing a con-

ditioning atmosphere enveloping the heated area of said wire.

4. A method of heating and conditioning wire which includes the steps of supporting and heating a plurality of strands thereof progressively in an electric heating circuit between spaced contact members connecting said strands in parallel, and supplying heat from a source external to the wire heating circuit to the immediate area adjacent the contact member in the direction of motion of the heated wire to control heat losses of the wire while passing over the contact member in the direction of motion of the heated strands of wire.

5. A method of heating and conditioning wire which includes the steps of supporting and heating a plurality of strands thereof progressively in an electric heating circuit between spaced contact members connecting said strands in parallel, supplying heat from a source external to the wire heating circuit to the immediate area adjacent the contact member in the direction of motion of the heated wire to control heat losses of the wire while passing over the contact member in the direction of motion of the heated strands of wire, and disconnecting any of said parallel connected strands.

6. A method of heating and conditioning wire which includes the steps of supporting and heating a plurality of strands thereof progressively in an electric heating circuit between spaced contact members connecting said strands in parallel for automatically equalizing the heating effect in each of the strands, and supplying heat from a source external to the wire heating circuit to the immediate area adjacent the contact member in the direction of motion of the heated wire to control heat losses of the wire while passing over the contact members in the direction of motion of the heated strands of wire.

7. A method of heating and conditioning wire which includes the steps of supporting and heating sections thereof progressively in an electric heating circuit between spaced contact members, supplying heat from a source external to the wire heating circuit to the immediate area adjacent the contact member in the direction of motion of the heated wire to control heat losses of the wire while passing over the contact member in the direction of motion of the heated wire, and fabricating portions of said wire upon its emergence from said heating circuit.

8. A method of heating and conditioning wire which includes the steps of supporting and heating sections thereof progressively in an electric heating circuit between spaced contact members, supplying heat from a source external to the wire heating circuit to the immediate area adjacent the contact member in the direction of motion of the heated wire to control heat losses of the wire while passing over the contact member in the direction of motion of the heated wire, abstracting heat from said wire after it has passed the final contact member of said heating circuit, and subjecting said wire as a continuous operation to reduction in size and thereafter again heating said wire and conditioning the same as first stated.

9. A method of heating and conditioning wire which includes the steps of supporting and heating sections thereof progressively in an electric heating circuit between spaced contact members, and controlling heat losses of the wire while passing over the contact member in the direction

of motion of the heated wire by restricting said contact to small mass.

10. A method of heating and conditioning wire which includes the steps of supporting and heating sections thereof progressively in an electric heating circuit between spaced contact members, and controlling heat losses of the wire while passing over the contact member in the direction of motion of the heated wire by restricting said contact to an element having low heat-abstracting characteristics.

11. Apparatus for heating and conditioning wire comprising spaced contact members supporting and heating sections of such wire progressively in an electric heating circuit between such spaced contact members, the contact member in the direction of motion of the heated wire being of small mass whereby losses of heat of the wire passing thereover are restricted.

12. Apparatus for heating and conditioning wire comprising spaced contact members supporting and heating sections of such wire progressively in an electric heating circuit between such spaced contact members, the contact member in the direction of motion of the heated wire being a roller of low heat abstracting characteristics whereby losses of heat of the wire passing thereover are restricted.

13. Apparatus for heating and conditioning wire comprising in combination a source of electro-motive force, two contact members spaced apart and connected to said source, a wire to be heated extending between and in running contact with said members and having its more highly heated portion in the direction of motion, and temperature means independent of the wire heating circuit associated with the immediate area adjacent the contact member in the direction of motion for controlling the temperature thereof and the wire supported thereon.

14. Apparatus for heating and conditioning wire comprising in combination a source of electro-motive force, two contact members spaced apart and connected to said source, a wire to be heated extending between and in running contact with said members and having its more highly heated portion in the direction of motion, temperature means independent of the wire heating circuit associated with the immediate area adjacent the contact member in the direction of motion for maintaining said member at substantially the temperature of the wire passing thereover.

15. Apparatus for heating and conditioning wire comprising in combination a source of electro-motive force, two contact members spaced apart and connected to said source, a wire to be heated extending between and in running contact with said members and having its more highly heated portion in the direction of motion, temperature means independent of the wire heating circuit associated with the immediate area adjacent the contact member in the direction of motion for controlling the temperature thereof and the wire supported thereon, and means for controlling the loss of heat from said wire beyond the contact member in the direction of motion of the wire.

16. Apparatus for heating and conditioning wire comprising in combination a source of electro-motive force, two contact members spaced apart and connected to said source, a wire to be heated extending between and in running contact with said members and having its more highly heated portion in the direction of motion.

temperature means independent of the wire heating circuit associated with the immediate area adjacent the contact member in the direction of motion for controlling the temperature thereof and the wire supported thereon, and fluid means for controlling the loss of heat from said wire beyond the contact member in the direction of motion of the wire.

17. Apparatus for heating and conditioning wire comprising in combination a source of electro-motive force, two contact members spaced apart and connected to said source, a wire to be heated extending between and in running contact with said members and having its more highly heated portion in the direction of motion, temperature means independent of the wire heating circuit associated with the immediate area adjacent the contact member in the direction of motion for controlling the temperature thereof and the wire supported thereon, means for controlling the loss of heat from said wire beyond the contact member in the direction of motion of the wire, and means providing a conditioning atmosphere for said wire during its changes in temperature.

18. Apparatus for heating and conditioning wire comprising in combination a source of electro-motive force, two contact members spaced apart and connected to said source, a wire to be heated extending between and in running contact with said members and having its more highly heated portion in the direction of motion, temperature means independent of the wire heating circuit associated with the immediate area adjacent the contact member in the direction of motion for controlling the temperature thereof and the wire supported thereon, fluid means for controlling the loss of heat from said wire beyond the contact member in the direction of motion of the wire, and means providing a conditioning atmosphere for said wire during its changes in temperature.

19. Apparatus for heating and conditioning wire comprising in combination a source of electro-motive force, two rotary contact members spaced apart and connected to said source, a wire to be heated extending between and in running arcuate contact with said members and having its more highly heated portion in the direction of motion, and temperature means independent of the wire heating circuit associated with the immediate area adjacent the rotary contact member in the direction of motion for controlling the temperature thereof and the wire supported thereon.

20. Apparatus for heating and conditioning wire comprising in combination a source of electro-motive force, two rotary contact members spaced apart and connected to said source, a wire to be heated extending between and in running arcuate contact with said members and having its more highly heated portion in the direction

of motion, temperature means independent of the wire heating circuit associated with the immediate area adjacent the rotary contact member in the direction of motion for controlling the temperature thereof and the wire supported thereon, and means for controlling the loss of heat from said wire beyond the rotary contact member in the direction of motion of the wire.

21. Apparatus for heating and conditioning wire comprising in combination a source of electro-motive force, two rotary contact members spaced apart and connected to said source, a wire to be heated extending between and in running arcuate contact with said members and having its more highly heated portion in the direction of motion, temperature means independent of the wire heating circuit associated with the immediate area adjacent the rotary contact member in the direction of motion for controlling the temperature thereof and the wire supported thereon, means for controlling the loss of heat from said wire beyond the rotary contact member in the direction of motion of the wire, and means providing a conditioning atmosphere for said wire during its changes in temperature.

22. An apparatus for heating and conditioning a plurality of strands of wire comprising in combination a source of electro-motive force, spaced supporting and contact members parallel electrically connected at each of the respective terminal contact areas of said strands of wire and including said strands as part of the heating circuit, and temperature means independent of the wire heating circuit for maintaining the immediate area adjacent contact and supporting members for said strands, in the direction of motion of the heated strands of wire, at a predetermined degree of temperature.

23. A supporting roller contact element for use with apparatus for electrically heating and conditioning a strand of wire between spaced contact elements, over which said wire travels after being heated providing a heat-absorbing area of small mass in contact with the heated wire, and an insulated housing of small area around said roller, said housing having temperature controlling means independent of the wire heating circuit for maintaining said roller at a predetermined temperature.

24. A supporting roller contact element for use with apparatus for electrically heating and conditioning a strand of wire between spaced contact elements, over which said wire travels after being heated providing a heat-absorbing area of small mass in contact with the heated wire, and a housing for said roller with heating elements in said housing independent of the wire heating circuit, for maintaining said roller at a predetermined temperature.

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CERTIFICATE OF CORRECTION.

Patent No. 2,019,555.

November 5, 1935.

WILLIAM H. WOOD, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 6, second column, lines 36, 48 and 61, and page 7, first column, lines 1, 16, 33 and 50, and second column, lines 1, 16 and 33, claims 13, 14, 15, 16, 17, 18, 19, 20, 21 and 22 respectively, after "temperature" insert conditioning; page 7, second column, line 35, claim 22, after "adjacent" insert the; and lines 43 and 54, claims 23 and 24 respectively, for "heat-absorbing" read heat-abstracting; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 21st day of January, A. D. 1936.

(Seal)

Leslie Frazer
Acting Commissioner of Patents.