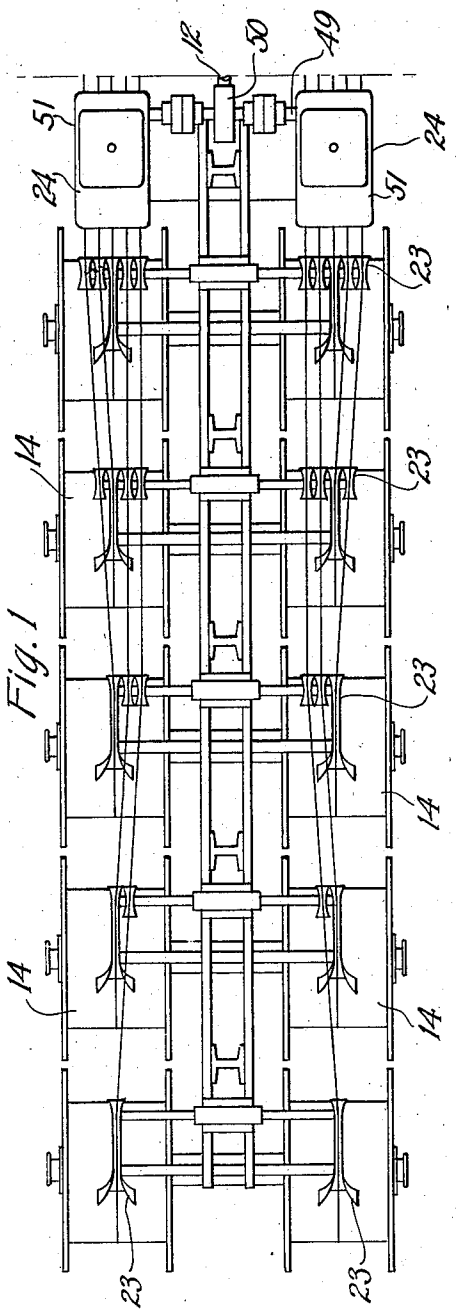
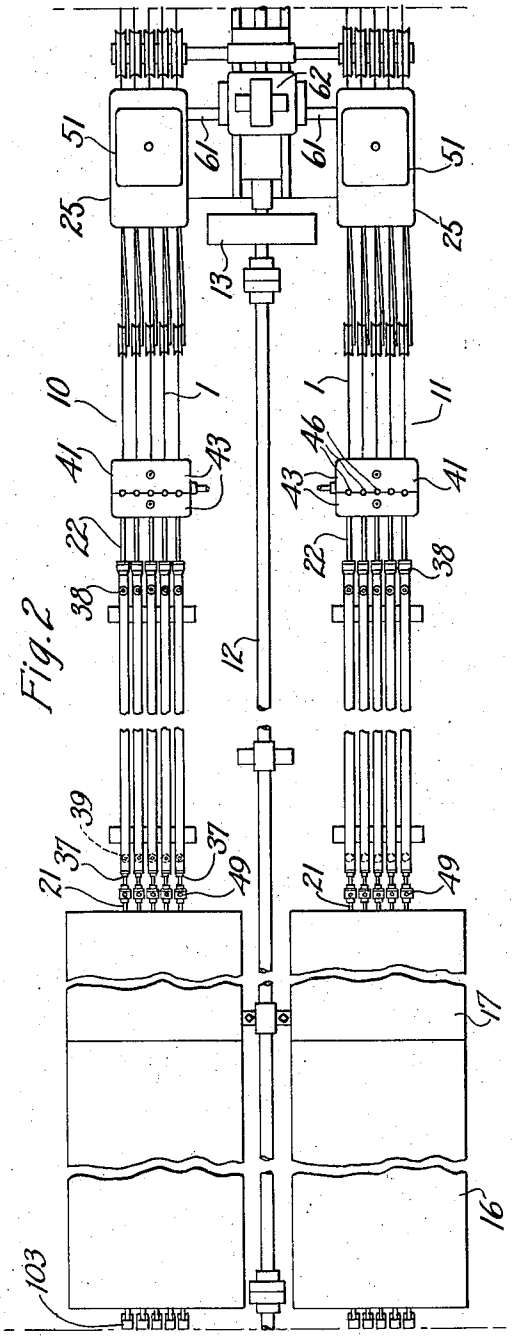
April 12, 1927. F. S. KOCHENDORFER 1,624,668

APPARATUS FOR HEAT TREATING METALS

Filed Nov. 15, 1922 5 Sheets-Sheet 1





Inventor:
Frederic S. Kochendorfer.
by H. A. Pattison Atty.

April 12, 1927. F. S. KOCHENDORFER 1,624,668

APPARATUS FOR HEAT TREATING METALS

Filed Nov. 15, 1922 5 Sheets-Sheet 2

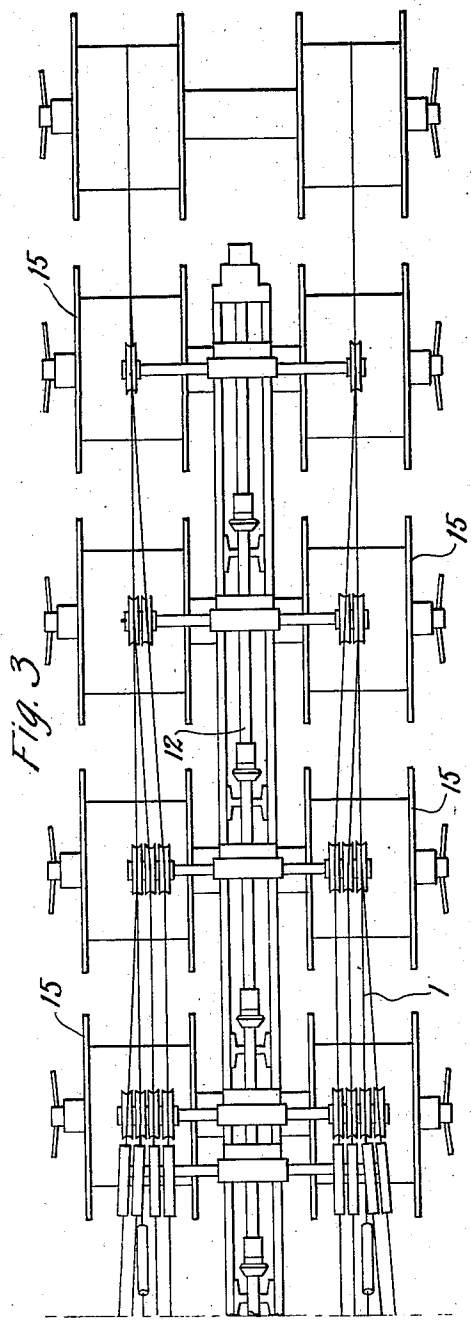


Fig. 3

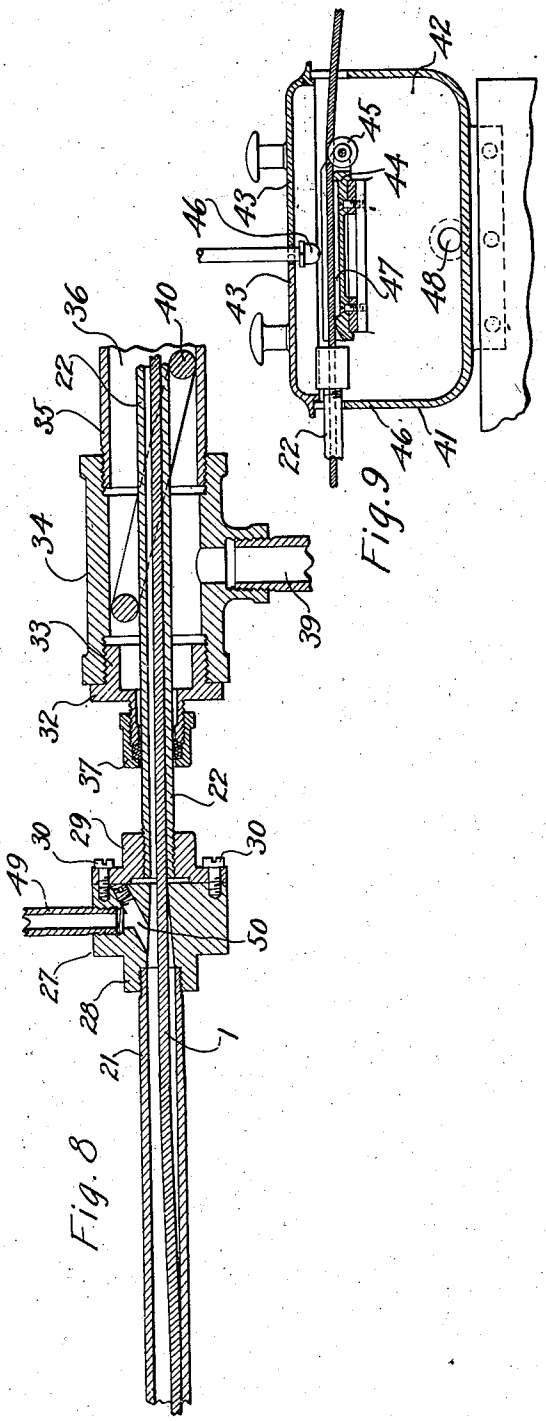


Fig. 8

Fig. 9

Inventor:
Frederic S. Kochendorfer.
by H. A. Pattison Att'y.

April 12, 1927. F. S. KOCHENDORFER 1,624,668

APPARATUS FOR HEAT TREATING METALS

Filed Nov. 15, 1922 5 Sheets-Sheet 3

Fig. 4

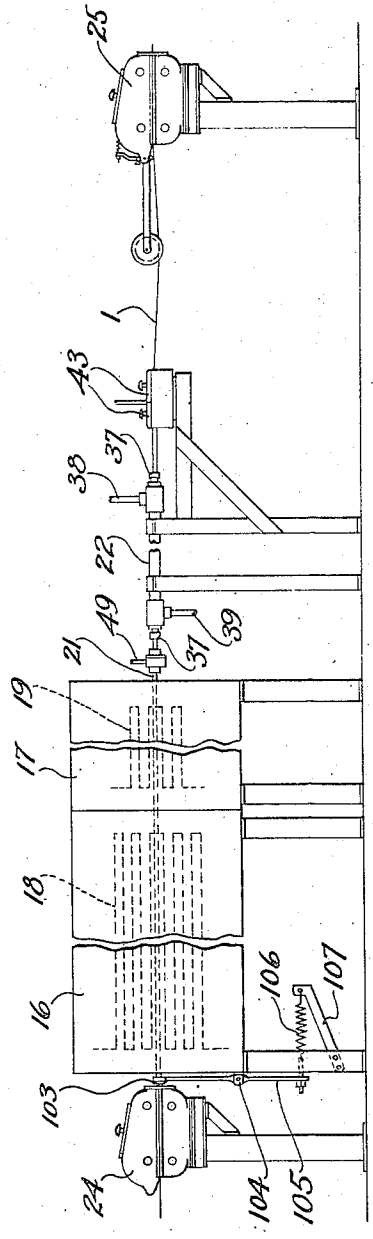
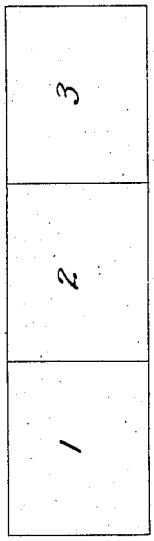


Fig. 13



Inventor:
Frederic S. Kochendorfer.
by H. A. Pattison Atty.

April 12, 1927. F. S. KOCHENDORFER 1,624,668

APPARATUS FOR HEAT TREATING METALS

Filed Nov. 15, 1922 5 Sheets-Sheet 4

Fig. 5

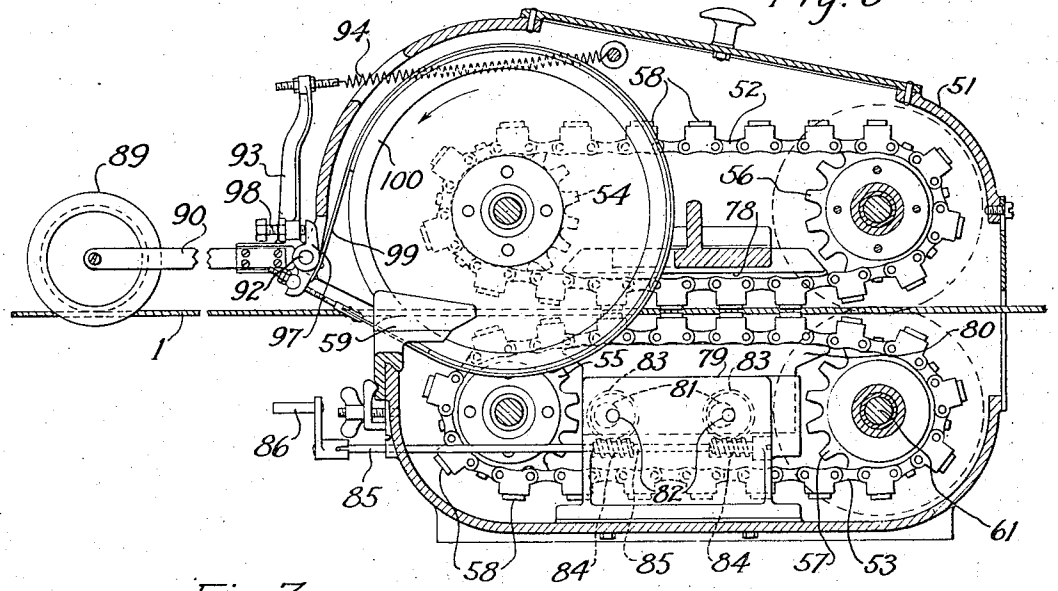


Fig. 7

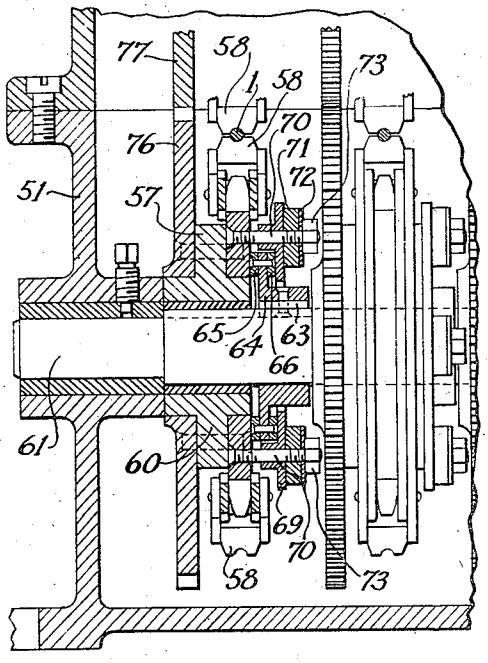
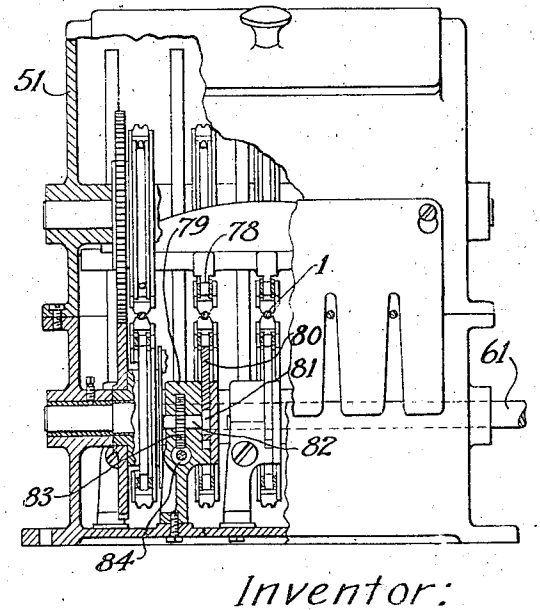


Fig. 6



Inventor:
Frederic S. Kochendorfer,
by H. A. Pattison Att'y.

April 12, 1927. F. S. KOCHENDORFER 1,624,668

APPARATUS FOR HEAT TREATING METALS

Filed Nov. 15, 1922 5 Sheets-Sheet 5

Fig. 11

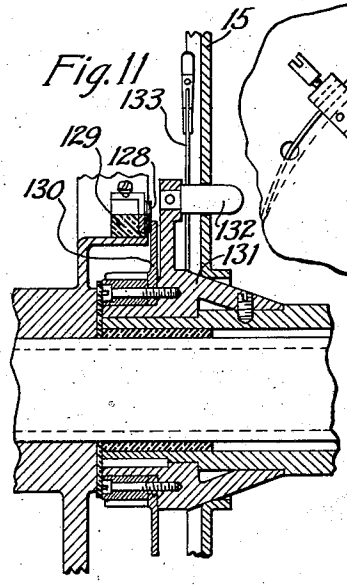


Fig. 10

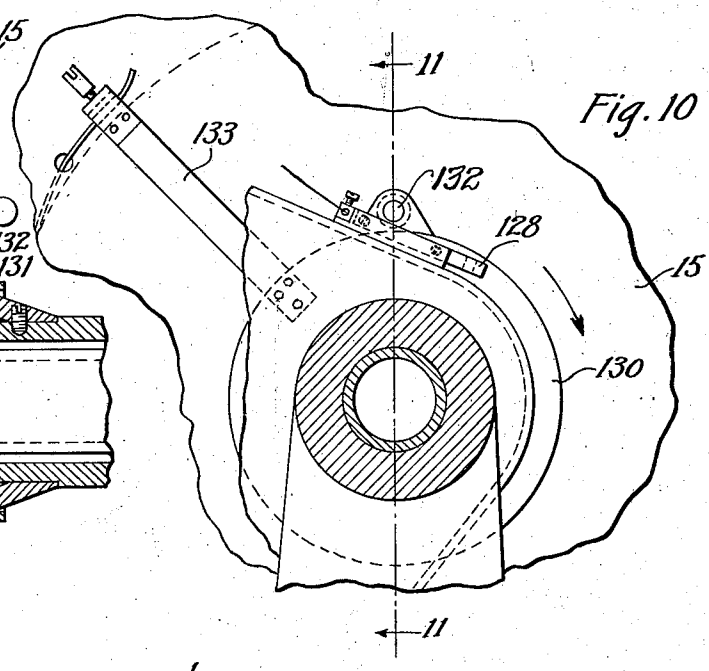
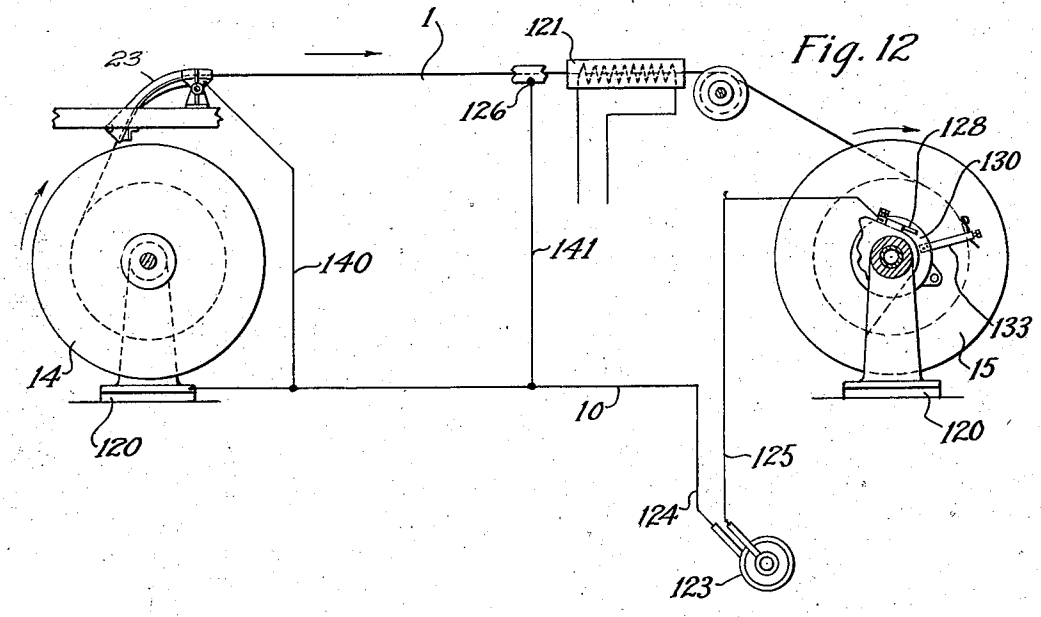


Fig. 12



Inventor:
Frederic S. Kochendorfer,
by H. A. Pattison. Att'y.

Patented Apr. 12, 1927. 1,624,668

UNITED STATES PATENT OFFICE.

FREDERIC S. KOCHENDORFER, OF RIVER FOREST, ILLINOIS, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

APPARATUS FOR HEAT-TREATING METALS.

Application filed November 15, 1922. Serial No. 601,021.

This invention relates to apparatus for heat treating metals.

An object of the invention is to provide such an apparatus in which the heating and cooling of the metal may be continuously performed and the temperature of the heating and cooling regulated within close limits.

Another object of the invention is to provide means for continuously feeding a metallic strand through the apparatus for administering the heat treatment without subjecting the strand to substantially any tension.

One feature of the invention resides in an improved means for conducting heat away from the metal subsequent to its subjection to the heating means.

Another feature of the invention consists in introducing under pressure a non-oxidizing and non-reducing gas into the heating and cooling chambers of the apparatus.

Another feature of the invention relates to means provided for measuring electrical characteristics of the strand continuously with the treatment thereof.

Other objects, features, and advantages of the invention will be set forth in detail in the following description and particularly pointed out in the claims.

In the accompanying drawings which illustrate one embodiment of the invention;

Figs. 1, 2, and 3, when placed together in the manner illustrated in Fig. 13, comprise a top plan view of an apparatus made in accordance with the invention.

Fig. 4 is a reduced side elevation of the apparatus partly broken away, with the omission of the supply and take up apparatus at each end;

Fig. 5 is an enlarged vertical sectional view showing the construction of the caterpillar feeding device at the take up end;

Fig. 6 is a rear elevation partly broken away and also in vertical section, of the mechanism shown in Fig. 5;

Fig. 7 is an enlarged vertical sectional view of the lower left hand corner of the mechanism shown in Fig. 6 showing the friction drive for the caterpillar grippers;

Fig. 8 is an enlarged vertical sectional view of the left hand end of the cooling tube;

Fig. 9 is an enlarged vertical sectional view of the quenching apparatus;

Fig. 10 is fragmentary vertical sectional view through the take up reel support showing the mechanism associated with the take up reel for measuring the electrical characteristics of the strand after the heat treatment;

Fig. 11 is a vertical section on the line 11—11 of Fig. 10;

Fig. 12 is a diagrammatic illustration and showing the circuit connections of the mechanism for continuously measuring the electrical characteristics of the strand after the heat treatment; and

Fig. 13 illustrates the manner in which Figs. 1, 2 and 3 should be assembled.

Although the apparatus disclosed in the drawings is particularly designed for heat treating metal in strand form, it is understood that the apparatus may be modified to treat metal in strip, sheet or other forms without departing from the spirit and scope of the invention.

As illustrated in the drawings, referring particularly to Fig. 2, the complete apparatus comprises two units 10 and 11 positioned side by side with their operating parts driven from a single drive shaft 12 carrying a pulley 13. The units 10 and 11 comprise mechanism for handling five strands, therefore at one end of the apparatus there is suitably arranged a plurality of supply reels 14 (Fig. 1) and at the opposite end a plurality of storage reels 15 (Fig. 3).

As each of the mechanisms for handling the strand is identical in all its parts, the following description will be confined to the first mechanism from the bottom of the unit 11 (Fig. 2).

16 and 17 indicate two furnaces which are in juxtaposition. These furnaces may be of any suitable type and heated in any desired manner. They are illustrated as being electric furnaces heated by coils diagrammatically illustrated at 18 and 19 respectively, (Fig. 4). The furnace 16 is longer than the furnace 17 and is maintained at a higher temperature, the purpose of which will be hereinafter explained. Instead of two furnaces, it is to be understood that a single furnace having two zones

maintained at different temperatures may be utilized, or the heating means may be otherwise modified, without departing from the spirit and scope of the invention.

Suitably supported within the furnaces 16 and 17 is a metallic heating tube 21 which communicates with a cooling tube 22, as shown in Fig. 8.

The strand 1 to be heat treated is fed from the supply reel 14 (Fig. 1) over suitable curved guides 23—23, and pushed through the tubes 21 and 22 by means of a caterpillar feeding mechanism 24, which will be hereinafter described in detail, suitably driven from the drive shaft 12. As the strand passes from the discharge end of the heating apparatus, it is acted upon by a second caterpillar feeding mechanism 25, which serves to take up any excess slack in the strand, in a manner hereinafter described, the heat treated strand being taken up on the storage reel 15, which is suitably driven from the drive shaft 12.

In the heat treatment of the metallic alloy tape heretofore referred to, it has been found desirable to relatively gradually heat the tape to a predetermined temperature, maintain the tape at, or above this temperature for a certain time interval and then reduce the temperature of the tape to a predetermined degree within a certain period of time. Since the apparatus disclosed is particularly designed for performing this heat treatment, the furnace 16 is heated to a degree slightly higher than the temperature at which it is desired to maintain the tape for the predetermined length of time, the tape leaving the furnace 16 and entering the furnace 17 which is kept at the temperature at which it is desired to maintain the tape for a certain length of time. By heating the furnace 16 to a temperature above that at which it is desired to maintain the tape, it is possible to keep the tape at an even predetermined temperature during its passage through the furnace 17. The furnace 16 is made considerably longer than the furnace 17 in order that the tape may be raised to the required temperature during its passage through the furnace, the length of the furnace 16 determining the speed at which the conductor having the tape wrapping may be pushed therethrough. Since the tape is approximately the desired temperature when it enters the furnace 17, this furnace may be of a length just sufficient to maintain the tape at the desired heat for the desired length of time.

For a full disclosure of the composition of the alloy tape, its application to the conductor and the subsequent heat treatment thereof, reference is made to Patents 1,586,884 to G. W. Elmen, June 1, 1926, 1,586,874 to O. E. Buckley, June 1, 1926 and 1,586,887 to G. W. Elmen, June 1, 1926.

Although the furnace construction and arrangement described above is particularly adapted for heat treating the metallic tape above referred to, it may be found desirable to use such a furnace arrangement in the heat treating of other metals, and the invention is to be limited only by the spirit and scope of the appended claims.

The heating tube 21 and cooling tube 22 are connected by a coupling 27 comprising two sections 28 and 29. (Fig. 8). The heating tube 21 is screw threaded into the section 28 which also affords an inlet for nitrogen gas, the purpose of which will hereinafter be described. The cooling tube 22 is screw threaded into the section 29 and the two sections are bolted together by screws 30. Mounted concentrically with the cooling tube 22 is a plug 32 having an external screw threaded flange 33 upon which a T pipe fitting 34 is threaded. Screw threaded into the end of the fitting 34 opposite the plug 32 is a pipe 35 which is concentric with the cooling tube 22, but spaced apart therefrom as shown in the drawing, so as to form a tubular chamber 36 between the tube 22 and pipe 35. Both ends of the chamber 36 are closed by suitable stuffing boxes 37 (Figs. 8 and 4) through which the ends of the cooling tube 22 project.

A suitable cooling fluid such as water or oil is constantly circulated through the chamber 36 entering by a pipe 38 and being discharged through a pipe 39 (Fig. 4), the said fluid being circulated by a pump or other suitable means (not shown). In order to insure a thorough circulation of the cooling fluid around the cooling tube, a coil spring 40 (Fig. 8) is fitted within the chamber 36 surrounding the cooling tube, the spring forming a tortuous passage through which the cooling fluid is forced from the entrance pipe 38 to the exit pipe 39.

To reduce the temperature of the strand 1 quickly after leaving the furnace, to such a degree that it will not melt or harm the rubber gripping shoes of the caterpillar mechanism 25 to be described later, the strand after passing through the tube 21 passes through a quenching apparatus (Figs. 2, 4 and 9). To pass the strand through a cooling tube only, would require a tube of great length, consequently occupying a large amount of space. The quenching apparatus comprises a chamber 41, provided with a two section cover 43. Suitably mounted in the chamber 41 are a plurality of trough like members 44—44 (Fig. 9) each equipped at one end with a roller 45 over which the strand passes on its way to the storage reel 15. The cooling tube 22 enters the chamber through a suitable opening formed in one end wall and adjacent to the receiving end of the member 44. The opposite end wall of the chamber is provided with a suitable

opening for the passage of the strand after leaving the roller 45. Passing through suitable openings formed in the two section cover 43, and centered with each strand as it passes through the trough like member 44, are a plurality of nozzles 46—46 for spraying water or any other suitable cooling liquid upon the strand as it passes thereunder. The trough like member 44 is provided with a depression 47 which is always being filled with cooling liquid from the nozzle 46. The over-flow from the depression 47 passes between the receiving end of the member 44, and the under side of the strand to the bottom of the chamber 41 which is provided with a drain port 48. In operation the spray from the nozzle 46 strikes the strand, cools it, and is immediately turned to steam. The steam thereafter condenses and fills the depression 47.

In order to provide both a non-oxidizing and non-reducing atmosphere in the heating tube 21, nitrogen under pressure is forced into the tube through a pipe 49, (Fig. 8) screw threaded in the section 28 of the coupling 27 which is provided with a passage 50 formed at an angle so as to direct the gas into the heating tube 21 and in a direction opposite to that in which the material being treated is moving. The nitrogen entering through the pipe 49 is forced into the heating tube 21 and provides both a non-oxidizing and non-reducing atmosphere, and in its passage through the tube 21 sweeps out any other gases that may be present therein.

It has been found desirable in the heat treatment of the metallic tape heretofore mentioned to subject it to a heat treatment in the presence of nitrogen or some other gas which is both non-oxidizing and non-reducing, but the use of nitrogen in the manner above described may be found to be of advantage in the heat treatment of other metals, and this feature of the invention is only to be limited by the spirit and scope of the appended claims.

In the heat treatment of conductors of the type for which this apparatus is designed it is very essential that substantially no tension be put on the conductor along its length while it is being treated. To insure this, the conductor is pushed through the furnace, and the cooling apparatus, by the caterpillar mechanism 24 at the forward end of the furnace which comprises a pair of chains carrying rubber gripping shoes. The chains are positively driven at a suitable fixed speed in a direction which will push the conductor through the apparatus, causing a certain amount of slack beyond the heating chamber.

The caterpillar mechanism 25 at the exit end of the annealing apparatus functions to feed the treated strand to the storage reel 15 under a certain substantially uniform degree of tension. Due to slippage between the gripping shoes of the caterpillar mechanisms 24 and 25, the slackness between the exit end of the furnace and the caterpillar mechanism 25 will vary. To maintain this slackness substantially uniform means is provided for varying the speed of the caterpillar mechanism 25, which means is responsive to the slackness in the strand.

The mechanism 25 (Figs. 5, 6 and 7) and its operation will now be described.

Within a housing 51 are chains 52 and 53 mounted one above the other at one end upon sprockets 54 and 55, respectively, and at the opposite end upon sprockets 56 and 57, respectively, all of said sprockets being carried upon suitably mounted shafts. Each chain link is provided with a gripping shoe 58 composed of rubber which is recessed to conform to the shape of the strand being treated. The strand enters the housing 51 passes over a suitable stationary shoe 59, and then between the shoes 58. The sprocket wheel 57 (Fig. 7) is suitably secured on a collar 50 mounted to rotate freely upon a drive shaft 61 driven at a suitable speed by gearing carried in a gear box 62 (Fig. 2) connected to the drive shaft 12. Adjacent the collar 60 and secured to the shaft 61 by a key 63 is a friction coupling ring 64 equipped with friction rings 65 and 66 one upon each side and at its peripheral edge. The rings 65 and 66 are preferably made of leather but any suitable material will serve the purpose.

The friction ring 65 bears against one side of the sprocket 57 and the ring 66 bears against a ring 69 carried by a plurality of pins 70—70 suitably secured to the sprocket 57 and equally disposed radially about the axis thereof. The pins 70—70 project through the ring 69, and mounted thereon are compression washers 71 preferably composed of rubber. One face of the washer 71 bears against the face of the ring 69, the opposite face against a washer 72 on the pin 70. Upon the end of the pin 70 is a screw threaded nut 73, and by turning it upon the pin 70, to the right or left, it will readily be seen that the friction between the rings 65 and 66 and the faces of the sprocket 57, and the ring 69, respectively, may be regulated.

Secured to the collar 60 by the same means securing the sprockets 57 thereto, is a gear 76 which meshes with a similar gear 77 suitably secured to the sprocket 56 directly thereabove for driving the chains 52 and 53 in unison.

To vary the pressure of the shoes 58—58 upon the strand, a stationary shoe 78 (Figs. 5 and 6) is suitably mounted between the sprockets 54 and 56 and engaging the inside of the lower run of the chain 52. Ad-

justably mounted in a housing 79 is a shoe 80 which bears against the inside of the upper run of the chain 53. The shoe 80 is carried upon two cams 81 each secured to a separate shaft 82 having a bearing in the housing 79. The shafts 82 each carry a worm gear 83 which meshes with a worm 84 secured upon a shaft 85 supported at one end in the housing 79 with its other end projecting through the housing 51 and having a bearing therein. Upon this end of the shaft is a crank 86, and by turning this crank one way or the other, the shoe 80 will be moved vertically either up or down to vary the pressure between the shoes 58—58 on the chains and the strand to give the required traction.

Bearing on the strand between the heat treating apparatus and the endless chains 52 and 53 of caterpillar mechanism 25, is a roller 89 secured to the end of a tension lever 90 pivotally supported on the housing 51 at a point 92. The roller is allowed to bear on the strand with enough pressure to cause a certain amount of slackness at this point (Fig. 4) as will be hereinafter described.

Adjacent the pivot point of the lever 90, the lever is provided with an upwardly extending arm 93, to the upper end of which is adjustably secured one end of a tension spring 94. The other end of the spring 94 is suitably secured to the housing 51. By adjusting the tension of the spring at its point of connection with the arm 93 it will readily be seen that the downward pressure of the roller 89 upon the strand, may be regulated to a nicety. Mounted on the pivot point 92 is a lever 97, the upper end of which engages an adjustable pin 98 mounted in the lever 90. Secured to the lever 97 in line with its pivot is one end of a brake band 99 preferably made of steel. The brake band 99 passes around a brake drum 100 with its other end adjustably secured to the lower end of the lever 97. The brake drum 100 is secured to turn with the sprocket 54 and when the band 99 is tightened thereon, the chains 52 and 53 are slowed up. When this happens a slippage occurs between the friction surfaces on the coupling ring 64 and the face of the sprocket 57 on one side and between the ring 69, carried by the sprocket 57 on the other side.

In starting the machine the end of the spring 94 is secured to the arm 93 under a desired tension which allows the roller 89 to bear on the strand with the desired pressure to allow an initial slackness therein at this point. The pin 98 is adjustable in the arm 93 to engage the upper end of the lever 97 and the end of the brake band 99 attached to the lower end of the lever 97 is adjusted to give the correct contact with the break drum 100. At times the strand will not be pushed by the mechanism 24 at the desired constant speed due to slippage between the shoes carried on the chains and the strand. This causes momentarily too much of the slack in the strand to be taken up by the mechanism 25 which draws the strand as fast as it is pushed by the mechanism 24. This increased tension causes the roller 89 to move upward due to the slackness in the strand being taken up by the mechanism 19. The roller 89 in moving up, rocks the lever 90 about its pivot point 92 thereby rocking the lever 97 about its pivot due to the upper end thereof engaging the pin 98. This movement of the lever 97 moves the lower end thereof upward and draws the brake band 99 tighter around the break drum 100 thereby holding back the endless chains 52 and 53 from drawing the strand until the desired slackness again occurs in the strand which will allow the roller 89 to move down thereby loosening the brake band upon the brake drum and allowing the chains 52 and 53 to draw the strand at their normal speed.

If slippage occurs between the strand and the shoes on the endless chains of the mechanism 25 an increase in the slackness of the strand will occur which will allow the roller 89 to move downward. The roller 89 in moving down rocks the lever 90 about its pivot 92 allowing the lever 97 to move counterclockwise about its pivot, thereby decreasing the grip of the brake band 99 upon the brake drum 100. When this occurs the chains will be driven faster and, when the excess slackness has been taken up the roller 89 will have moved back to its normal position, thereby causing the brake band to grip the brake drum with the initial amount of friction.

The above detailed description of the caterpillar mechanism 25, also describes the caterpillar mechanism 24 with the exception that the friction drive for the chains is not used. The chains in mechanism 24 are positively driven at a fixed speed and consequently the tension lever 90 and its connecting mechanism is omitted.

Means is provided for taking care of the expansion and contraction of the furnace tube 21, to hold it straight and to prevent its curling. Were such means not provided, the tube would bend causing the strand to be subjected to increased friction and consequently tension, as it was pushed through the tube. This means will now be described.

The tube 21 projects a short distance from the forward end of the furnace 16 and has suitably secured thereto a collar 103, (Fig. 4). Pivotally supported upon the end of the furnace, at a point 104, is a lever 105 provided with a bifureated upper end which is positioned around the tube 21 and behind the collar 103. To the lower end of the lever is secured one end of a tension spring 106, the other end of the spring being secured

to a stationary support 107. It will readily be seen that when the tube expands as it is heated, the tension stored in the spring will act to move the lever 105 counterclockwise about its pivot to keep the bifurcated upper end pressing against the collar 103 secured to the tube, thereby keeping the heated tube 21 under tension as it expands and preventing it from curling.

When the furnace is cooling the tube will gradually contract and will move the lever 105 in a clock-wise direction about its pivot due to the engagement of the bifurcated end thereof with the collar 103. This last movement will be against the action of the spring 106 and will hold the tube under tension as it cools, and thereby prevent it from curling.

When the apparatus heretofore described is utilized for heat treating a conductor wrapped with the metallic tape heretofore mentioned, it is found desirable to continuously measure electrical characteristics of the said tape after the heat treatment is completed. The means herein provided for measuring electrical characteristics of the tape will now be described.

Referring to Fig. 12, 14 is the supply reel and 15 is the storage reel. The supports for the reels 14 and 15 are insulated from the ground by blocks 120 made of suitable insulating material. A helix 121, separately supported, surrounds the conductor 1 at a point between the exit end of the annealing apparatus and the storage reel, and is connected to a suitable amplifier and measuring instrument circuit (not shown).

An alternator or other source of alternating current 123 supplies a suitable current to the leads 124 and 125. The lead 124 is connected to the support for the supply reel 14, to the curved guide 23 over which the conductor travels, and at a point 126 to the cooling tube near the helix 121, a plurality of connections being provided to insure a current flow through the moving strand. The lead 125 is connected to a brush 128 (Figs. 10 and 11) carried on the support for the storage or take-up reel 15, and insulated therefrom by a block of insulation material 129. The brush 128 contacts with a slip ring 130 suitably secured to a driving element 131, which through a pin 132 carried thereon entering a suitable hole in the reel 15, drives the said reel. Suitably secured to the slip ring 130 is an arm 133 which is adapted at its end to receive the end of the conductor 1 after it had been secured to the reel 15. The circuit may be traced as follows: from the current source 123, conductor 124, conductors 140 and 141 to the conductor 1, through the said conductor 1, to the arm 133, slip ring 130, brush 128, and conductor 125 back to the current source. This alternating current sets up a magnetic field around the conductor 1 which induces an electromotive force in the helix 121. The alternating electromotive force is measured by any suitable mechanism (not shown). The details of a suitable measuring apparatus are disclosed Patent 1,586,962, issued June 1, 1926 to O. E. Buckley.

It is to be understood that by the language "substantially no tension" is meant that the tension applied is at most only so great that, when acting conjointly with the pushing force, friction between the strand and the tube is overcome and the strand kept in motion.

What is claimed is:

1. In a heat treating apparatus for metals in strand form, a heating chamber, means for passing the strand through said chamber, and means controlled by the tension of the strand for regulating the operation of said first named means to limit the tension on said strand to that necessary to effect said passage.

2. In a heat treating apparatus for metals in strand form, a heating chamber having two zones, one of higher temperature than the other, a cooling chamber, means for pushing the strand through said chambers and means controlled by the strand for regulating the operation of said pushing means to limit the tension on said strand to that necessary to effect said passage.

3. In a heat treating apparatus for metals in strand form, a heating chamber having two zones, one of higher temperature than the other, a cooling chamber, means for feeding the strand first through the zone of higher temperature, then through the zone of lower temperature, and finally through the cooling chamber, and means controlled by the strand for regulating the operation of said feeding means to limit the tension on the strand to that necessary to effect said passage.

4. In a heat treating apparatus for metals, a heating chamber, mechanism engaging the metal at a plurality of points in substantially the same line for feeding the metal to be treated through the heating chamber and means for storing the heat treated metal.

5. In a heat treating apparatus for metals, a heating chamber, and a caterpillar mechanism for feeding the metal to be treated through the heating chamber.

6. In a heat treating apparatus for metals in strand form, a heating chamber having two zones, one of higher temperature than the other, a cooling chamber, and a caterpillar mechanism for pushing the strand through said chambers whereby the strand is subjected to an amount of tension which is limited to that necessary to effect the passage of the strand through the heating chamber.

7. In a heat treating apparatus for metals,

a heating chamber, means for producing a non-oxidizing and non-reducing atmosphere in said heating chamber, a cooling chamber, means for feeding the metal to be treated through the said chambers, and means controlled by the strand for regulating the operation of said feeding means to limit the tension on said strand to that necessary to effect said passage.

8. In a heat treating apparatus for metals in strand form; a heating chamber, means for producing a non-oxidizing and a non-reducing atmosphere in said heating chamber, a cooling chamber, means for pushing the strand through said chambers, and means controlled by the strand for regulating the operation of said pushing means to limit the tension on said strand to that necessary to effect said passage.

9. In a heat treating apparatus for metals in strand form, a heating chamber, means for feeding the metal to be treated through said chamber, means for supplying under pressure a non-oxidizing and non-reducing gas to said chamber, and baffling means for directing said gas into said chamber in a direction opposite to that in which the strand is being fed.

10. In a heat treating apparatus for metals in strand form, a heating chamber, a gripping device for pushing the strand through the heating chamber, a second gripping device acting upon said strand, said gripping device operated in such manner that the strand is subjected to a tension limited to that necessary to effect its passage through the heating chamber during the heat treating operation, a take up reel for the strand and means for driving the take up reel at such speed that tension is exerted on the strand between the last mentioned gripper and the take up reel.

11. In a heat treating apparatus for metals in strand form, a heating chamber, means for feeding the strand through the heating chamber in such manner that the strand is subjected to a tension limited to that necessary to effect its passage through the heating chamber, a take up reel for the strand, and means for driving the take up reel at such speed that tension is exerted on the strand between said feeding means and the take up reel.

12. In combination with a heat treating apparatus for metals in strand form, means for maintaining an electrical circuit through a portion of the strand for measuring an electrical characteristic of the strand affected by the heat treatment, said means including a source of current, means engaging the strand and connected with said source of current, a take-up mechanism for the strand, and means connecting said take-up mechanism with said source of current.

13. In combination with a heat treating apparatus for metals in strand form and a take-up mechanism for the treated metal, means for measuring an electrical characteristic of the heat treated strand continuously with the heat treatment thereof, said means including a source of current and contact devices so connected with the strand that the electrical characteristic of the heat treated portion thereof, including that stored by the take-up mechanism, is measured.

14. In combination with a heat treating apparatus for metals in strand form and a take-up reel for the treated metal, means for maintaining an electrical circuit through a portion of the strand for measuring an electrical characteristic of the strand affected by the heat treatment, said means including a source of current electrically connected with the strand, a pair of contact members connected with the source of current, one movable with the take-up reel and in engagement with the strand being taken up, and the other a stationary contact electrically connected with said source of current and in engagement with said first contact to complete a circuit through the strand.

15. In combination with a heat treating apparatus for metals in strand form, a take-up reel for the treated metal and a driving element therefor, means for maintaining an electrical circuit through a portion of the strand for measuring an electrical characteristic of the strand affected by the heat treatment, said means including a source of current electrically connected with the strand, a slip ring movable with the driving element and electrically connected with said source of current, means for electrically connecting the strand with the slip ring, and a stationary contact electrically connected with said source of current and in engagement with the slip ring to complete a circuit through the strand.

16. The method of feeding material in strand form through a heating chamber, which comprises simultaneously pushing and pulling successive portions of the strand lengthwise between two points, maintaining a part of the strand between said points in a fixed path, permitting the path of another portion of the strand between said points to vary with the variation of the applied forces and regulating the relation of said forces by means of the variations of the strand in said variable path.

17. A method of passing metal in strand form through a substantially horizontal heating chamber, which comprises simultaneously pushing and pulling said strand between two points and allowing a portion between said chamber and one of said points to sag.

18. In a heat treating apparatus for metals in strand form, a heating chamber, means for propelling the strand through said chamber, and means controlled by the tension

of the strand for controlling the magnitude of the propelling force.

19. In a heat treating apparatus for metals in strand form, a heating chamber, means for propelling the strand through said chamber, and means controlled by lateral movement of said strand for controlling the magnitude of the propelling force.

20. In a heat treating apparatus for metals in strand form, a heating chamber, means for pushing the strand into said chamber, take-up means for receiving the strand after its passage through said chamber, and a control element between said heating chamber and one of said means and operated by the strand for controlling the stresses therein.

21. In a heat treating apparatus for metals in strand form, a heating chamber, a gripping device for pushing the strand through the heating chamber and a second gripping device acting upon said strand to take up slack therein.

22. In a heat treating apparatus for metals in strand form, a heating chamber, a caterpillar mechanism for pushing the strand through the heating chamber, and a second caterpillar mechanism acting upon said strand to take up slack therein.

In witness whereof, I hereunto subscribe my name this 4th day of November A. D., 1922.

FREDERIC S. KOCHENDORFER.