

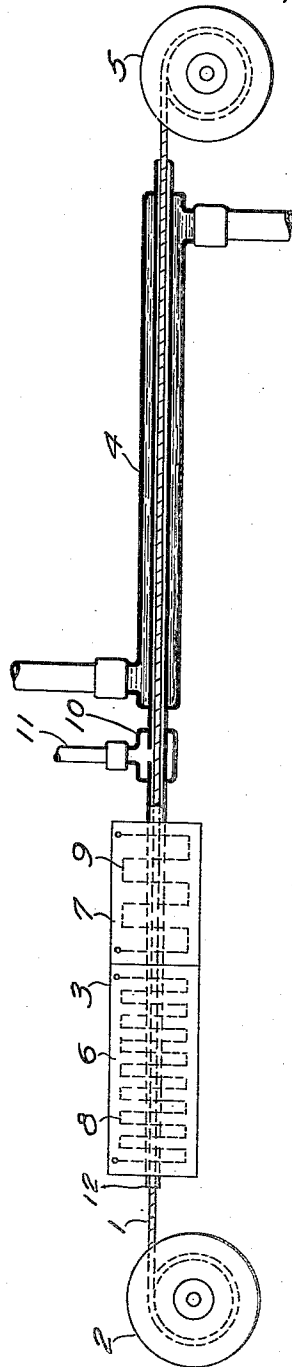
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HEAT TREATMENT OF METALS

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HEAT TREATMENT OF METALS.

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This invention relates to heat treatment of metals and more particularly to the heat treatment of material containing two or more metals, one of which would be harmed by an active oxidizing atmosphere and another of which would be injured by an active reducing atmosphere. An example of such a material is an electrical conductor of copper, covered with a layer of spirally wound wire or tape of a nickel-iron alloy to increase inductance, the alloy requiring a heat treatment after being wound upon the conductor to increase its permeability. This invention originated during the development of the heat treatment of such an inductively loaded conductor.

An object of the invention is to provide a suitable atmosphere for use during the heat treatment of material, such for example as that just mentioned, which cannot be subjected to the action of a reducing or to more than a slightly oxidizing agent.

Another object is to provide means for permitting a compound conductor to be heat treated without resultant brittleness and without the production of oxide upon the surface of the materials.

Investigations have recently been in progress looking toward the improvement of submarine telegraph cables. As a result of these researches it has been found that the speed of signaling over long submarine cables can be greatly increased by inductively loading the cable conductor with wire or tape of a certain nickel-iron alloy applied as a spiral wrapping, the wrapped conductor being given a certain heat treatment in order to increase the permeability of the loading material. The loaded conductor preferably consists of a central cylindrical copper wire covered by a layer of contiguous strands or tapes of the same material having a spiral lay.

The preferred method of applying the heat treatment to the loaded conductor is to pass it slowly through a furnace and then through a cooling chamber. The alloy should first be brought to a temperature above the transition temperature, which is about 850° or 900° C. and then allowed to remain at that temperature for a definite period, which appears to be necessary to insure a uniform molecular structure, after which it should be cooled slowly through

the transition temperature and then further cooled at a rate between that necessary to anneal and rates which would set up mechanical stresses in the material when cold.

For a complete description of the alloy mentioned herein; the method of preparing it, its use as an inductive loading material and the manner of applying it to the conductor to be loaded, reference is made to the following United States applications: G. W. Elmen, 473,877, filed May 31, 1921; O. E. Buckley, 492,725 and 492,726, filed August 16, 1921; G. W. Elmen, 557,928, filed May 2, 1922 and G. W. Elmen 602,287 filed November 20, 1922.

The invention is fully described in the following specification. The accompanying drawing is a diagram of the furnace and cooling chamber for applying a heat treatment to an inductively loaded conductor together with means for supplying a desired atmosphere to the region about the heated conductor in accordance with the invention.

Referring to the drawing, a conductor 1 having a layer of wire or tape of magnetic material spirally wound thereon, is slowly unreel from the supply reel 2, passed through the furnace 3 and the cooling chamber 4 and rewound upon the receiving reel 5. The furnace 3 is in two sections 6 and 7 which have separate heating means 8 and 9 of different heating capacity, such as electric resistance coils of different sizes. The furnace 6 is maintained at such a temperature, well above the transition temperature, that as it leaves this furnace, it is at or somewhat above the transition temperature. A second furnace or furnace section 7 is maintained at or just above the transition temperature and is of such a length that at the velocity with which the conductor is moved, the latter will be maintained at this temperature the required time. The cooling chamber 4, which is illustrated as a water jacket, cools the alloy at a rate between that necessary for annealing and rates which would set up stresses in the material when cold.

A tube 12 which may be in two or more sections, extends throughout the length of the furnace and cooling chamber, the portion within the furnace being of heat resisting material such as nickel; and this or similar material may be used for the section

of the tube extending from the furnace to a point within the cooling chamber at which the temperature of the conductor is materially lower than when it leaves the furnace.

5 The internal diameter of the tube 12 is preferably not much greater than the external diameter of the taped conductor. A jacket 10 surrounds the tube 12 between the furnace and the cooling chamber and may
10 be supplied with any desired gas under pressure through the pipe 11. The tube 12 is perforated within the jacket 10. The pressure at which the gas is supplied is dependent upon the rate at which the conductor is
15 moved through the tube 12 and the temperatures of the furnaces.

A heavy coating of oxide upon the surface of the alloy of the taped conductor after the heat treatment above described is
20 highly objectionable. If the atmosphere surrounding the tape while it is hot is of a reducing nature, a bright unoxidized surface is maintained on the tape and on the conductor. However, all copper wire of
25 high conductivity which it is possible to obtain on the market contains some dissolved cuprous oxide. At the temperature to which the conductor is heated, if a reducing atmosphere such as hydrogen, for example,
30 is maintained, the copper oxide dissolved in the copper conductor becomes reduced, with the effect that the copper of the conductor, both the central solid conductor and the tapes surrounding it, become embrittled.
35 In order to avoid any embrittling of the copper conductor and yet maintain a reasonably bright surface on the loading tape or wire, an atmosphere of nitrogen is preferably employed. This is supplied
40 through the pipe 11 under a pressure which will produce a very small rate of flow. It flows both to the right and to the left through the tube 12 around the heated conductor, escaping from the open ends of this
45 tube. The passage of the gas to the right is relatively unimportant, the chief object being to keep the conductor in this atmosphere until it has been materially reduced in temperature in the cooling chamber. The passage
50 of the gas to the left is of greater importance, an important function being to sweep from the tube harmful reducing or oxidizing gases, such as those which tend to be drawn in by the taped conductor as it
55 enters the tube 12, and those which may be produced in the furnace by the action of heat upon foreign substances such, for example, as traces of oil upon the conductor. This object could not be accomplished by
60 flowing the gas from left to right through the tube 12, in the furnace, since any air drawn in with the taped conductor would be carried at once into a region of higher temperature, and, before it could be swept
65 out at the opposite end, would enter into

chemical combinations. Likewise, the injurious effect of reducing gases liberated by the heat within the tube 12 can be more effectively avoided by sweeping such gases
70 at once into a region of lower temperature, than by attempting to pass them through a region of the same or higher temperature.

A further feature of the invention is the use of small amounts of oxygen mixed with the nitrogen. Oily or carbonaceous matter upon the loaded conductor in the furnace gives
75 rise to a certain amount of reducing atmosphere which may react adversely on the copper conductor. If, however, a very small amount of oxygen is present, this tends to
80 expend itself largely in oxidizing such carbonaceous or reducing material. A slight tarnishing of the tape results from the presence of this oxygen, but not enough to be
85 harmful. It is found that from .3 to 1% of oxygen is ordinarily present in commercially prepared nitrogen, although occasionally as high as 3% occurs. The former values
90 are about those necessary for the oxidizing of reducing material carried into the furnace on the conductor and the latter value, while larger than desired is not prohibited, so that it is not necessary to separately provide
95 chemically pure nitrogen and oxygen. The cost of the desired gas mixture is thus kept at a low value. The amount of oxygen could of course be reduced if desired, if the velocity of the nitrogen stream
100 through the tube 12 were increased, the sweeping action of the nitrogen stream then carrying away a greater amount of any reducing atmosphere produced in the furnace from carbonaceous matter upon the conductor.

While this invention was developed in
105 connection with the heat treatment for conductors loaded with magnetic alloy, it is obvious that the invention is broader than that in scope and this has been borne in mind in drafting the appended claims. For
110 example one feature of the invention is the use of certain gas or gases as described above, and it is within the scope of the invention to use such atmosphere with or without the added feature of producing a constant
115 flow of the gas or gases.

What is claimed is:

1. Means for heat-treating metallic material comprising a heating chamber, means to continually pass the metallic material
120 into said chamber through an opening, and means for causing a substantially non-oxidizing and non-reducing gas to pass continually into said chamber and out through said opening at a rate high enough to sweep
125 back any entering gas before it has time to appreciably affect said metallic material.

2. Means for heat-treating a wire or cable comprising a heating chamber, means for
130 passing the wire or cable continually into

said chamber through an opening, means for causing a liberation of gas of a reducing nature in said chamber, and means for causing gas to pass continually into said chamber and out through said opening at a rate high enough to sweep back through said opening at least a portion of any gas of a reducing nature liberated in said chamber before said reducing gas has time to appreciably affect said wire or cable.

3. Means for heat-treating an electric conductor comprising copper, said means comprising a heating chamber, means for feeding the conductor to said heating chamber through an opening, and means for causing gas to pass into said chamber and out through said opening, said gas being of a nature to prevent said copper from becoming embrittled under the action of heat in said chamber.

4. Means for heat-treating a copper wire or cable comprising a heating chamber, means for feeding the wire or cable into said chamber when the latter is heated, and means for maintaining an atmosphere of gas in said chamber of such a nature as to prevent the copper from becoming embrittled under the action of heat, as it would in the presence of reducing gas.

5. Means for heat-treating a metallic wire or cable comprising a heating chamber, means for feeding the wire or cable into said chamber, means for supplying an atmosphere to said chamber comprising non-reducing and oxidizing gases, the latter sufficient only in amount to slightly oxidize the surface of the wire or cable and unite with a portion at least of any reducing substances produced from impurities upon said wire or cable by the heat, and means for causing a steady movement of said atmosphere outward through said opening to sweep out reducing gas not acted upon by said oxidizing gas.

6. Means for heat-treating a compound conductor comprising a copper core upon which is spirally wound a layer of wire or tape of a magnetic material requiring heat-treatment to increase its permeability and of a nature to oxidize rapidly under such treatment in the presence of oxygen, said heat-treating means comprising a heating chamber, means for feeding the conductor to said chamber, means for supplying to said chamber an atmosphere which will not cause said copper core to become brittle under the action of heat, and which has an oxidizing effect only great enough to slightly oxidize the metallic surfaces and to assist in eliminating reducing action upon the copper of agents liberated by heat action from impurities upon the metals.

7. Means for heat-treating a compound conductor comprising copper and magnetic material, the latter requiring heat-treatment

to increase its permeability and of a nature to oxidize rapidly under such heat treatment in an atmosphere rich in oxygen, said heat-treating means comprising a heating chamber for applying such heat treatment to the conductor, and means for maintaining a non-reducing and only slightly oxidizing atmosphere in said chamber.

8. Means for heat-treating a compound conductor comprising a copper core upon which is spirally wound wire or tape of magnetic material requiring a heat treatment to increase its permeability and of a nature to oxidize rapidly under such treatment in an atmosphere rich in oxygen, said heat-treating means comprising a heating chamber for applying such heat treatment to the conductor and means for supplying to said chamber a non-reducing and only slightly oxidizing atmosphere comprising nitrogen containing a small amount of oxygen.

9. Means for heat-treating a compound conductor comprising copper and magnetic material, the latter requiring heat-treatment to increase its permeability and of a nature to oxidize rapidly under such treatment in an atmosphere rich in oxygen, said heat-treating means comprising a heating chamber for applying such heat treatment to the conductor, and means for maintaining in said chamber an atmosphere of commercially prepared nitrogen which contains a slight amount of oxygen.

10. Means for heat-treating a compound conductor comprising a copper core upon which is laid the material requiring heat treatment, and of a nature to oxidize rapidly under such heat treatment in an atmosphere rich in oxygen, said heat-treating means comprising a heating chamber for applying such heat-treatment to the conductor, and means for maintaining an atmosphere of gas in said chamber of a nature to prevent the copper from becoming embrittled under the action of heat and not to cause excessive oxidation of the metallic surfaces.

11. Means for heat-treating a compound conductor comprising copper and magnetic material, the latter requiring heat-treatment to increase its permeability and of a nature to oxidize rapidly under such heat treatment in an atmosphere rich in oxygen, said heat-treating means comprising a heating chamber for applying such heat treatment to the conductor and means for maintaining an atmosphere consisting principally of nitrogen in said chamber to prevent the copper from becoming embrittled under the action of heat and to prevent excessive oxidation of the surfaces of the metals.

12. Means for heat-treating an electric conductor made in part at least of copper, comprising a heating chamber, means for passing the conductor continuously into said chamber through an opening, and means for

causing gas to pass continually into said chamber and out through said opening at a rate high enough to sweep back through said opening at least a portion of any gas of a reducing nature liberated in said chamber before said reducing gas has time to appreciably affect said conductor.

13. Means for heat-treating a compound conductor comprising copper and magnetic material, the latter requiring heat-treatment to increase its permeability and of a nature to oxidize rapidly under such treatment in an atmosphere rich in oxygen, said heat-treating means comprising a heating chamber for applying said heat treatment to the conductor and means for causing a substantially non-oxidizing and non-reducing gas to pass continually into said chamber and out through said opening at a rate high enough to sweep into a region of lower temperature a portion at least of any gas of a deleterious nature liberated in said chamber before said deleterious gas has time to appreciably affect the materials of said conductor.

14. Means for heat-treating a composite

conductor comprising a plurality of elements, each of which is deleteriously affected by reducing agents at high temperatures but unaffected by slightly oxidizing agents, said heat-treating means comprising a heating chamber, means for passing said conductor through said chamber in the presence of a reducing agent, and means counteracting the action of said reducing agent.

15. Means for heat-treating a composite conductor comprising a plurality of elements, each of which is deleteriously affected by reducing agents at high temperatures but unaffected by slightly oxidizing agents, said heat-treating means comprising a heating chamber, means for passing said conductor through said chamber in the presence of a reducing agent, and means for supplying an inert gas to said conductor to prevent said deleterious action of said reducing agent.

In witness whereof, I hereunto subscribe my name this 21st day of November A. D., 1922.

JONATHAN W. HARRIS.