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HEAT TREATMENT OF SIGNALING CONDUCTORS

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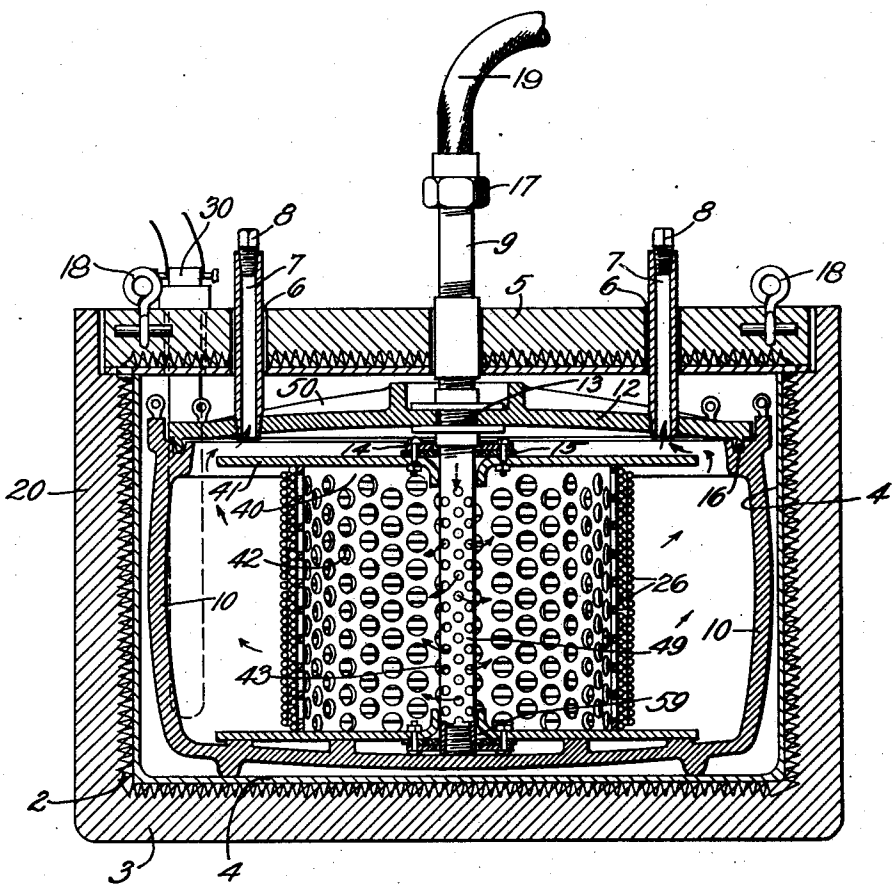

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HEAT TREATMENT OF SIGNALING CONDUCTORS

Application filed February 24, 1928. Serial No. 256,661.

The present invention relates to improvements in the manufacture of conductors and more especially continuously loaded signaling conductors.

An object of the invention is to so control the atmosphere in which a continuously loaded conductor is to be heat treated, as to improve the physical and magnetic properties of said conductor.

A more specific object of the invention is to prevent the copper of a signaling conductor from having its ductility and tensile strength impaired during the heat treatment thereof.

Another object of the invention is to develop a certain desired initial permeability, a high degree of constancy of permeability for magnetizing forces employed in signaling, low hysteresis loss, and other desirable properties, in the magnetic material surrounding a copper conductor in the form of continuous inductive loading.

Signaling conductors continuously loaded with iron-nickel alloys were found to be greatly benefited by giving them a heat treatment consisting in passing them slowly through an annealing furnace such as the one described in U. S. Patent 1,586,897, June 1, 1926, to J. W. Harris. In U. S. Patents 1,715,541, 1,715,646, 1,715,647, all patented June 4, 1929, there is disclosed an iron-nickel-cobalt alloy exhibiting certain advantages, such as high constancy of permeability, over iron-nickel alloys. It has been found that these alloys, especially if used for continuously loading signaling conductors require, for best results, a heat treatment differing from those of the iron-nickel alloys.

Small proportions of oxygen are usually contained in copper. When copper is heated in a reducing atmosphere, the reducing agent attacks the oxygen, and thereby embrittles the metal. This damage may be prevented, the above-mentioned objects attained, and other advantages realized, in the case of a loaded conductor, by way of example, by coiling the conductor upon a reel of a radius sufficiently large to avoid excessive straining of the loading material in uncoiling, and suitably controlling the atmosphere in which the heat treatment takes place. Preferably the flat end surfaces perpendicular to the axis of the reel are connected to the cylindrical portion in airtight manner, while the cylindrical surface itself is provided with apertures. The reel with the conductor wound around is inserted in an annealing pot, and the pot is placed in the heat treating furnace. At a suitable point of the furnace a gas supply pipe penetrates the furnace wall in such a way that it may be connected to the center of the pot and reel. By this means an insert gas, such as nitrogen, may be supplied under pressure to the inside of the cylindrical portion of the reel in such a fashion that it is caused to flow out through the apertures of said cylindrical portion and maintains the desired neutral atmosphere around the convolutions of the conductor and loading material; or the air may be removed from the pot through said pipe, so that annealing takes place in a highly evacuated space.

The improved method of heat treating copper conductors in accordance with the present invention may be carried out by the apparatus illustrated in the accompanying drawings.

In the drawings the electric resistance furnace 20 has heating elements 2 between a layer of fire clay 3 and a lining of refractory material 4. The removable lid 5 of the furnace is provided with a number of openings 6 symmetrically arranged and spaced at equal distances from the perpendicular axis of the furnace. Through these openings a plurality of pipes 7 extend to the lid 12 of anealing pot 10 and are fitted thereto in an airtight manner. Only two pipes 7 are shown in the drawings; however, more than two may be advantageous by insuring a more uniform distribution of the gaseous atmosphere around the convolutions of the conductor. Lid 12 is provided with radial reenforcing ribs 50. Pipes 7 are adapted to be opened and closed by means of threaded nuts 8. In the center of furnace lid 5 another opening is provided for the purpose of admitting gas supply or air exhaust pipe 9, which pipe extends into the interior

of annealing pot 10, and into the center of reel 40. Connected to reel 40, as indicated, is clamping ring 14 and asbestos packing ring 15. The passage of pipe 9 through lid 12 of pot 10 is such as to make an air tight seal at 13. Another air tight seal is provided around the periphery of lid 12 by the fact that ridge 16 is made of plastic metal which under the influence of pressure and heat closely fits into the corresponding groove. Perforated pipe 49 is an extension of pipe 9 and has its lower extremity closed by means of screw plug 59; its perforations are indicated at 43. The cylindrical surface of reel 40, provided with apertures 42, carries the layers of wire conductor to be treated in accordance with the invention.

The detailed operation of the method when heat treating copper conductors in nitrogen or other suitable inert atmosphere is as follows: The loaded or unloaded copper conductor is wound upon the reel in a suitable number of layers. The reel is then inserted into the annealing pot 10 and the lid together with pipes 9 and 49 permanently attached to the lid, are lowered through the reel and on to the support respectively, and the lid carefully fitted upon the circumferential seat of the pot. Screw nuts 8 are removed from the pipes 7. The cover 5 having been removed from the annealing furnace by means of hooks 18, the annealing pot and contents are placed in the furnace. The furnace cover is then put in its place and the joints between cover and furnace coated with refractory material. Gas supply hose 19 is connected to pipe 9 by means of threaded nut 17. The current for heating the resistance elements 2 is switched on and the nitrogen admitted at a suitable pressure. Pyrometer 30 is provided for the purpose of measuring the temperature. It is preferably connected with a indicating recorder so that the temperature prevailing in the furnace at any given time may be accurately read. As the temperature of the furnace and contents increases, carbonaceous materials always incidentally present on the surface of the copper conductor and loading material normally tend to combine with the oxygen of the atmosphere and generate reducing gases which in turn combine with the oxygen contained in the copper, thereby embrittling said copper. In accordance with the operation of the apparatus described, however, this is avoided since the nitrogen supplied under pressure to the center of the reel carrying the layers of conductors is forced continually through the interstices of said layers and thereby quickly carries off the carbonaceous materials at the moment of their vaporization, expelling them through tubes 7 into the atmosphere as indicated by the arrows, and maintaining a neutral atmosphere around the hot copper conductors.

An equivalent method is to cause the inert gas to flow from the outside of the coil through the interstices into the interior of the reel and to be drawn off from the interior through the pipe 9.

Conductors loaded with alloys of iron, nickel, and cobalt with or without the addition of fourth substances may be treated, by using the apparatus described at temperatures and in accordance with the principles outlined in British specification 273,638, filed August 16, 1926, (which corresponds to U. S. Patent No. 1,715,647, June 4, 1929), or in accordance with any desired variations of those methods. For treating unloaded copper conductors in a neutral atmosphere to prevent embittling any desired temperature such as 1000° C. may be employed.

The apparatus described herein may be used for heat treating loaded or non-loaded copper conductors in a highly evacuated space and when so used the operation is as follows:

After the copper conductor has been inserted into the annealing pot and the annealing pot into the heat treating furnace in the manner described above, threaded nuts 8 are securely screwed to pipe 7 and an air exhaust pump (not shown) is connected to pipe 9. As the air is evacuated from vessel 10, the atmospheric pressure forces lid 12 on to its support in such a manner that projection 14 which, as has been stated, is made of plastic metal such as copper, or plastic bronze, effects a hermetic seal around the periphery of the lid. Preferably the wall thickness of pipe 49 is so dimensioned as to enable this element to resist the effect of the atmospheric pressure, and the shape of pot 10 is slightly spherical for the same reason. In treating magnetic materials of the kind described in Patent No. 1,715,647, and those mentioned above, the materials may be heated to a temperature above 600° C. for at least an hour and cooled while the atmosphere within the vessel is maintained rarefied. When the temperature of the annealing pot and contents rises, carbonaceous material adhering to the surface of the copper conductor or loading material evaporates or is converted into gaseous material and is carried off immediately owing to the suction of the air pump. The heat treatment will, therefore, take place in an atmosphere devoid of any medium capable of attacking the oxygen contained in the copper conductor and embrittling is thereby avoided.

As an equivalent to the vacuum-pot-annealing we may mention, by way of example, the use of a vacuum furnace by means of which the atmosphere surrounding the conductor may be more highly evacuated.

What is claimed is:

1. Method of improving the properties of a continuously loaded conductor which com-

prises coiling said conductor upon a supporting reel, said reel having perforations in the cylindrical surface touching said conductor, inserting said reel and conductor in an annealing pot, placing said pot and contents in an annealing furnace and supplying a neutral atmosphere to the center of said supporting reel, whereby deleterious gases formed during heat treating are carried off from the surface of said conductor and loading material.

2. Means for heat treating magnetic material in the form of continuous loading around a coiled signaling conductor, comprising a heating chamber, supporting means for receiving said coiled conductor, a closed vessel inside said heating chamber for receiving and surrounding said supporting means and magnetic material, means for causing an inert gas to flow through the interstices between the convolutions of said elongated conductor, in such a fashion that said inert gas is maintained in constant direct contact with said conductor and magnetic material during at least a portion of the heat treatment.

3. Method of heating long lengths of copper wire contaminated with materials which are capable of forming reducing gases during the heat treatment of said wire, which comprises heating said wire in a coil and forcing a neutral atmosphere through the interstices of the coil during the heat treatment.

4. Process of heat treating great lengths of copper wire containing oxygen and having magnetic loading material applied thereto, which includes coiling said wire upon a supporting reel of a radius sufficiently large to avoid straining the loading material during uncoiling, placing the reel and wire into an annealing pot supplied with a neutral atmosphere, such as nitrogen, heating the vessel and contents to a temperature below the melting point of the wire, causing the neutral atmosphere to flow into said vessel, through the interstices of the coiled wire and make its exit from the vessel during at least a portion of the heat treatment.

5. The method of heat treating a copper signaling conductor continuously loaded with a magnetic material for the purpose of improving the magnetic properties of the magnetic material, which includes placing said conductor in the form of a coil inside a closed vessel, heating to an annealing temperature, and cooling said conductor and removing during the heat treating process reducing gases produced in the vessel from contaminating materials or other sources, whereby embrittling of said conductor is avoided.

In witness whereof, I hereunto subscribe my name this 20th day of February, 1928.

VICTOR E. LEGG.