

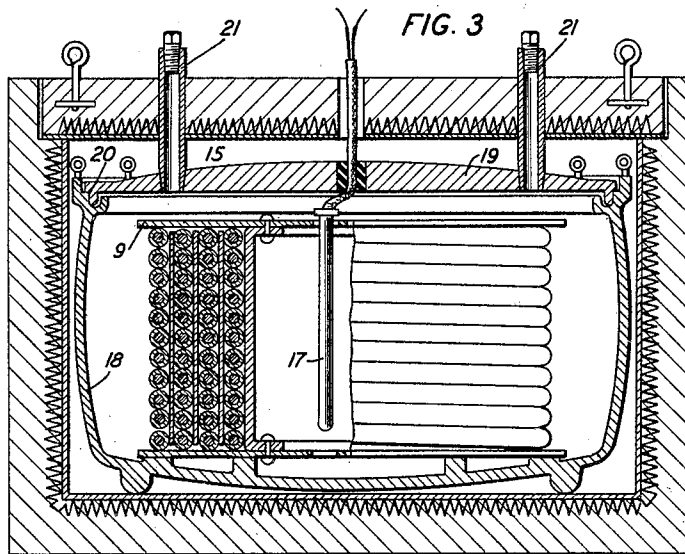
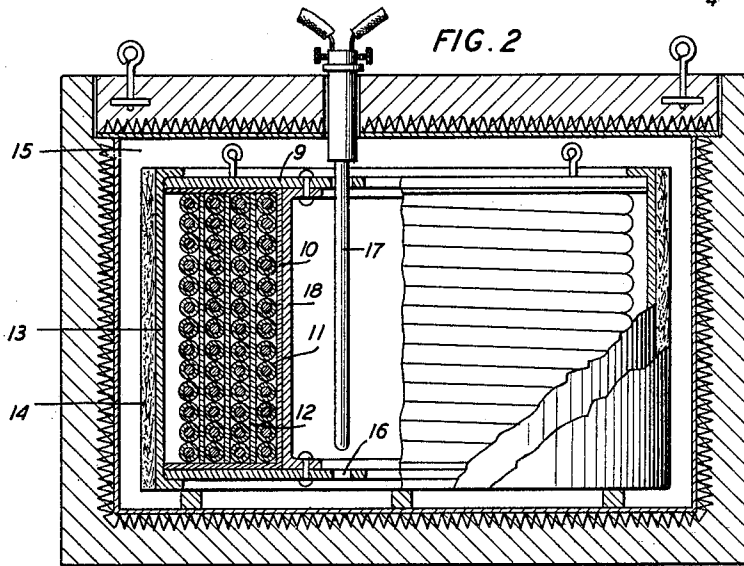
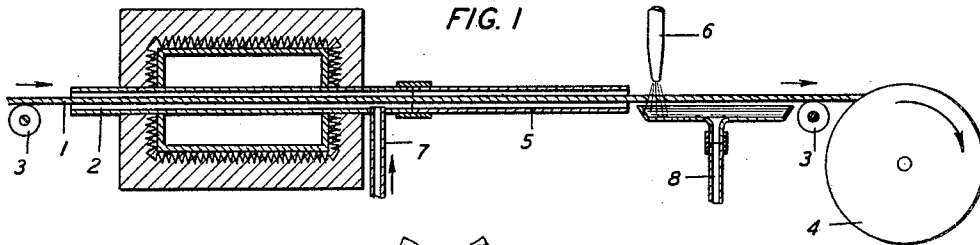
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HEAT TREATING LOADED CONDUCTORS

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HEAT TREATING LOADED CONDUCTORS

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This invention relates to the manufacture of magnetically loaded electrical conductors of the kind in which an alloy of high initial permeability, such as an alloy of iron and nickel with or without cobalt, copper, molybdenum, chromium, manganese or tungsten, singly or in groups, is used for the loading material.

According to the present invention in the manufacture of a loaded conductor, after the loading material of the nature specified has been applied to the conductor the loaded conductor is first submitted to a continuous heat treatment for example, by being drawn continuously through a furnace, and is thereafter coiled up and subjected to a heat treatment while so coiled. After the first or continuous heat treatment, the loaded conductor is cooled quickly, for example, by means of a water spray or jet of other suitable liquid directed thereupon. This has the advantage among other things, of increasing the permeability. This first heat treatment is preferably of short duration and at a high temperature, for example, about 950° C.

The second heat treatment of the loaded conductor in coiled form, is preferably of relatively long duration, for example about four hours, and may be at a lower temperature such as 475° C.

During the two heat treatments it is desirable that the risk of oxidation or other chemical change taking place in the components of the loaded conductor be minimized. The first or continuous heat treatment is, therefore preferably carried out in an inert atmosphere such as an atmosphere of nitrogen. The second heat treatment of a loaded conductor in coiled form is preferably also carried out in such a manner that the contact of chemically active gases such as oxygen with the loaded conductor is minimized. To this end a loaded conductor is wound upon a reel or drum in such a manner that it is substantially totally enclosed by a sheath of metal preferably readily oxidizable metal, such as copper, and an atmosphere of air is maintained within the furnace oven or annealing pot.

A feature of the invention, therefore, comprises

winding the loaded conductor upon a reel lined with sheet copper and applying over each layer of conductor wound upon the reel a layer of sheet copper before the next layer of loaded conductor is wound on. Over the top layer of loaded conductor upon the reel a layer of heavy sheet copper may be applied and the copper sheets lining the sides or flanges of the reel may be brought into intimate contact with the outermost layer of heavy sheet copper.

Fig. 1 is a longitudinal cross section through a furnace and conductor in the process of receiving the continuous heat treatment.

Fig. 2 is a cross section through a furnace and reel having a loaded conductor wound thereon receiving the second heat treatment; and

Fig. 3 is a cross section similar to that of Fig. 2 but showing the conductor in an annealing pot in a furnace suitable for vacuum treatment or treatment in gas such as nitrogen.

In a particular instance of carrying out the invention in practice the loaded conductor, which consists of a stranded or solid copper conductor of any known form surrounded by loading material applied thereto in the form of tape or wire, or sprayed or otherwise coated thereupon, is drawn through a main furnace tube 24.4 metres long maintained throughout its length at a temperature of 950° C. The furnace tube consists of a suitable heat resistant alloy and has an inside diameter of about 1 to 1½ cm. for a loaded conductor of the size commonly used in submarine electrical signalling cables. The movement of the loaded conductor through the tube may be effected by means of a caterpillar and reeling device of a known type. In the drawing the conductor is indicated as progressing over rollers 3, 3 and onto a reel 4. The speed of travel of the loaded conductor through the furnace may be about 2.0 metres per minute.

At the said end of the furnace tube a cooling tube 5, of the same diameter and length as the furnace tube itself, is connected. The loaded conductor on emerging from the fur-

nace tube 2 passes into this cooling tube 5 and is fairly rapidly cooled thereby. A stream or jet of water from a nozzle 6 may be directed upon the loaded conductor at a distance of approximately 25 cm. from the end of the cooling tube in order to cool the loaded conductor to substantially atmospheric temperature at this point. Pipe 8 carries away the waste water. An incidental advantage of cooling the conductor by a stream or jet of water is that the rubber feet of the caterpillar device are protected from contact with the still heated conductor.

In order to prevent any chemical action between the atmosphere in the furnace and the components of the loaded conductor, nitrogen containing not more than 0.5% of oxygen is circulated through the furnace. For this purpose between the annealing tube and the cooling tube is placed a pipe 7 through which the nitrogen is supplied. The nitrogen flows equally in both directions along the furnace tube and along the cooling tube. Nitrogen may be supplied to the pipe connection 7 at the rate such as 3 litres per minute.

After cooling to atmospheric temperature in the manner described the loaded conductor is wound upon reel 9 in such manner as substantially to prevent oxidation thereof in the subsequent lower temperature anneal. See Fig. 2. The reel 9 upon which the loaded conductor is wound is lined both over its cylindrical portion and over its flanges with thin sheet copper 10. A layer 11 of loaded conductor is wound on over the lined cylindrical portion of the reel and thereafter a layer of sheet copper is wound on. A further layer of loaded conductor is wound on the reel and then another layer of sheet copper is wound thereon, and these steps are repeated until the reel is sufficiently full. A layer 13 of sheet copper of heavy gauge is wound over the reel and covers the outermost layer of loaded conductor upon the reel, and the edges of the layer 13 are bent over into intimate contact with the edges of the reel. Thus, it will be seen that the loaded conductor upon the reel is completely enclosed within a sheath of copper and the layers of loaded conductor upon the reel are separated from one another by layers of sheet copper. A layer 14 of asbestos approximately one millimetre thick may be laid over the outermost layer of thick copper sheet to protect this, and the outer layers of the conductor from excessive temperatures through direct radiation from the walls of the furnace oven or annealing pot.

The reel of loaded conductor so prepared is supported in a furnace oven 15 or annealing pot with its axis vertical and in a central position so as to allow of free circulation of air around the outside of the reel and through openings 16 in the core of the reel near the axis thereof. A thermocouple 17 for meas-

uring temperature may be inserted through one of the openings near the axis of the reel and placed at a central point within the reel and about 10 cm. from the inner wall 18 of the cylindrical portion of the reel.

The temperature of the furnace oven or annealing pot is then raised as rapidly as is convenient, until the thermocouple indicates a temperature of 475° C. The temperature is held at this value for about four hours. Then the reel containing the loaded cable is removed from the furnace and allowed to cool to atmospheric temperature in the air.

Throughout the process and in subsequent handling of a cable every care should be taken to avoid slack, backlash or unevenness while winding the loaded conductor. Precautions should be taken to prevent the loaded conductor from passing over rough surfaces, sharp edges or rollers of small diameter. For example, tapered bushings may be provided for the tubes of the first furnace. In reeling the conductor care should be taken to avoid abrasion of the loading material or sharp bending of the loaded conductor. A layer of paper should preferably be applied over each layer of conductor upon the final or storage reels to prevent abrasion of the loading material by the succeeding layer of loaded conductor.

It will be appreciated that the invention is not limited to the precise details such as times and temperatures given since obviously these may be varied according to different circumstances. The invention provides a process whereby the initial and maximum permeability, hysteresis losses and other properties of the loading material may be varied to suit particular requirements.

Alternatively the second heat treatment in coiled form may be carried out in the absence of oxygen, for example in a vacuum, or in an atmosphere of inert gas such as nitrogen without any special precaution for preventing the gas coming in contact with the loaded conductor. In this case, however, it is preferable that layers of copper or other material should be interposed between the layers of loaded conductor in order to prevent abrasion of one layer of conductor by another.

An arrangement for doing this is illustrated in Fig. 3 in which the reel 9 is enclosed within a pot 18 before being put into the furnace oven 15. The cover 19 is provided with a tight joint 20 to give an air tight or substantially air tight joint. By means of one or more pipes 21, 21 extending through the furnace cover 22 the air may be pumped out of the pot or special gases such as nitrogen, hydrogen or carbon dioxide supplied.

The invention is particularly useful for heat treating the magnetic material of a loaded conductor comprising a stranded con-

ductor of deoxidized copper wrapped with one or more layers of a magnetic alloy containing mainly nickel, iron and cobalt and in which it is desired to develop low hysteresis and a low but fairly constant permeability at magnetizing forces such as those encountered in signalling.

What is claimed is:

1. The method of treating a metallic conductor having magnetic material applied thereto for increasing the inductance which comprises first passing the conductor through a furnace and heat treating it by a continuous method therein, cooling the conductor shortly after its exit from the furnace by the direct application thereto of a jet of fluid, and then maintaining the conductor for a relatively long time at a lower temperature in the neighborhood of 450° C.

2. The method of heat treating a metallic conductor having magnetic material applied thereto for the purpose of increasing the inductance, which comprises completely surrounding the conductor and applied magnetic material with a shield of oxidizable material and heating the conductor and magnetic material thus surrounded to an annealing temperature.

3. The method of heat treating a metallic conductor having magnetic material applied thereto for the purpose of increasing the inductance which comprises completely surrounding the conductor with a tightly fitting shield of sheet copper and heating the conductor thus surrounded to an annealing temperature.

4. The method of heat treating a metallic conductor having magnetic material applied thereto for the purpose of increasing the inductance, which comprises exposing several strands of such conductor to a source of heat and equalizing the application of heat thereto by protecting the strands nearest the source with a layer of heat insulating material.

5. The method of heat treating a conductor and preventing oxidation of a component thereof which comprises enclosing the conductor in a shield of copper sheet, applying heat externally to the shield and equalizing the application of heat to the conductor by providing a shield of material of light heat conducting properties external to at least a portion of the surface of the copper shield.

6. The method of heat treating an electrical conductor having magnetic material applied thereto for the purpose of increasing the inductance which comprises first drawing the conductor through a continuous process heat treating furnace, applying the conductor to a reel, covering the reel with a layer of readily oxidizable material and thereafter heat treating the conductor while so covered at an annealing temperature.

7. The method of preparing a conductor having magnetic material applied thereto for heat treatment which consists in applying the conductor to a reel in a plurality of layers of turns and applying layers of sheet metal between the layers of turns.

In witness whereof, I hereunto subscribe my name this 13th day of September, 1930.

VICTOR E. LEGG.

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