Oct. 15, 1935. J. E. HARRIS 2,017,657

CONTINUOUSLY LOADED CONDUCTOR

Filed June 8, 1929

FIG. 1

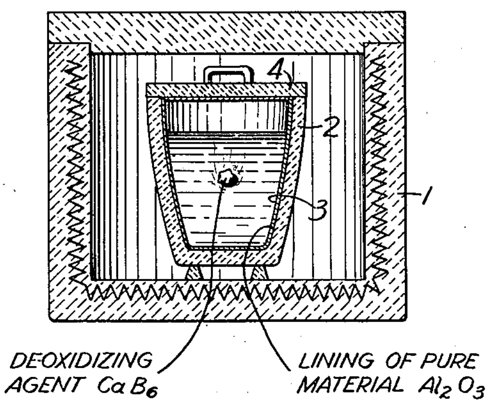


FIG. 2

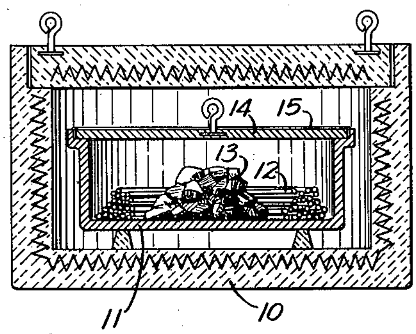
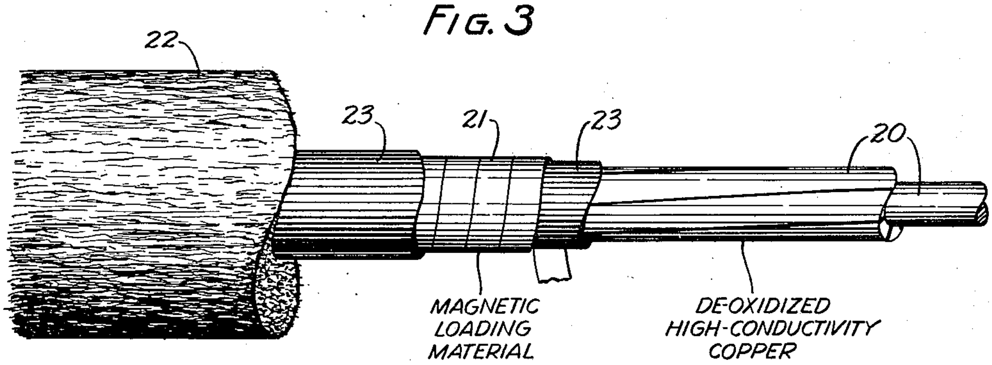


FIG. 3



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CONTINUOUSLY LOADED CONDUCTOR

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8 Claims. (Cl. 178—45)

This invention relates to continuously loaded conductors and particularly to conductors of this type which require a heat treatment after the loading material has been placed about the conductor in order that one or more of its properties may be developed.

An object of the invention is to provide a continuously loaded conductor which may be heat treated to temperatures between 600° and 1000° C. in the presence of reducing agents without suffering loss of conductivity and without material reduction in the elongation of the conductor.

The loading materials used for loading of the conductor in modern communication cables usually require a heat treatment subsequent to their application to the conductor. This heat treatment involves temperatures between 600° and 1000° C. In the process of manufacture of the copper wire and the loading wire or tape a certain amount of oil or other organic matter becomes lodged on the surfaces thereof. During the heat treatment some of these substances generate reducing gases in the heating chamber which have been found to have an embrittling effect upon copper of the commercial kind which until now has been used for conductors of this type. Other reducing gases may be present in the heating chamber due to incomplete combustion of the heating fuel with a similar deteriorating effect upon the copper. Commercial copper usually contains a small proportion of oxygen mostly in the form of oxides lodged at the crystal boundaries. When such copper is subjected to these high temperatures the reducing gases or other agents present in the heating chamber rapidly diffuse into the copper and combine with the oxygen to form carbon dioxide or steam which causes a dislocation of the crystals with the result that the copper becomes brittle.

It has lately become possible to commercially produce copper from which the copper oxides have been removed at high temperatures and which differs from similar copper treated by older methods by having a very high conductivity, in some cases higher than 100% (Matthissen standard) and which is not brittle but has an elongation of from 20 to 40% or even higher. One method of producing copper of this type is described in a copending patent application, Serial No. 321,627, filed November 24, 1928 by V. E. Legg. Another method is described in a copending patent application, Serial No. 345,258, filed March 8, 1929 by J. E. Harris and J. H. White.

In accordance with the present invention the difficulties of heat treating loaded conductors after their assemblage are overcome by the use of non-embrittling copper, such as just described, for the conducting core.

In the accompanying drawing, Figs. 1 and 2 show different arrangements whereby copper may be deoxidized for the purposes of this invention, and Fig. 3 shows a portion of a submarine cable core made in accordance with the invention.

When ordinary commercial copper has been used for loaded conductors of this type the embrittling effect was more or less prevented by thoroughly cleaning the copper and the loading strands and by passing a stream of inert gas through the heating chamber during the heat treatment to rapidly remove such reducing gases as were formed at the entrance thereof. By the use of non-embrittling or deoxidized copper the careful cleaning may be dispensed with and no measures need be taken to blow out the reducing gases formed in the heating chamber.

A great advantage gained by the use of non-embrittling copper in accordance with this invention resides in the elimination of the uncertainty of securing, by any practical method, an absolutely continuous, effective stream of inert gas for removing the reducing gases in order that every inch of the conductor shall be in good condition.

It has been the practice to employ spacing materials between the conductor and the loading material in order to secure a slight looseness between these elements. The materials used for such spacing had to be selected with the utmost care in order that they too should be prevented from generating reducing gases which would have an embrittling effect upon the copper. The present invention offers another advantage in permitting the use of organic and other spacing materials without detrimental effect upon the conductor.

The invention is applicable to continuously loaded conductors of any type such as used for telephone or telegraph signaling and whether they be land cables or submarine cables.

In accordance with the method of deoxidizing copper for the purposes of this invention, described in the application, Serial No. 345,258, referred to above, the apparatus shown in Fig. 1 may be used. In this figure the furnace 1 is of the electric resistance type and encloses a crucible 2 which may be made of any suitable material. The inside of the crucible 2 is lined with a layer 3 of aluminum oxide (Al_2O_3) and the cover 4 is provided with a lining of the same material. Pieces of commercial, electrolytic cathode copper are placed in the crucible which then is inserted in the furnace 1. The current is then turned on and after the copper is molten and, just before pouring, a deoxidizing agent such as calcium boride is added in an amount of about .1% of that of the copper and mixed well with the copper by stirring. The melt is then immediately turned into molds or ingots and after solidification is ready for rolling or forging into conducting strands. This procedure furnishes a copper which may be subsequently heated in a reducing atmosphere without becoming embrittled and which at the same time may possess a conductivity of 101% (Matthisson standard).

In accordance with the method of deoxidizing copper, described in patent application, Serial No. 321,627 referred to above, an equipment such as shown in Fig. 2 may be used. In Fig. 2 the furnace 10 encloses a vessel or pot 11 which contains commercial copper to be treated. The copper is in the form of a coil or wire 12. The vessel also contains a deoxidizing agent 13 which may be in the form of coal or charcoal, the proportions being about one pound of charcoal for every 10 pounds of copper. The cover 14 of the pot is luted by means of fireclay 15. The pot and its contents are heated in the furnace for about one hour at a temperature of about 1000° C. and is allowed to cool to room temperature. The wire is then cold worked by passing it through rolling mills or wire drawing benches, rolled in reels, reinserted in the furnace, and again heated in the presence of fresh charcoal in the same proportion as before, to the same temperature and for the same length of time. Immediately after cooling the copper wire may be drawn or rolled into the desired size or shape.

The present invention in all its aspects is not limited to the above methods of producing non-embrittling copper but copper prepared by other equivalent methods may be employed.

Fig. 3 is a simplified showing of the core of a submarine cable in which 20 is the conductor which is made from previously deoxidized copper having a conductivity of at least 95% and an elongation of at least 20%; 21 is the loading material, which, in the preferred form, comprises a narrow tape of magnetic material which requires a heat treatment after it has been placed about the conductor in order that its magnetic properties may be properly developed; and 22 is a layer of insulation which in the case of a submarine cable may be gutta percha or other similar material. The loading material is floated in an insulating compound 23, 23 which is semi-fluid even at sea-bottom temperatures, and which serves to relieve the loading material from mechanical strains which would otherwise impair the magnetic properties of the loading. The conductivity and elongation of the copper in the cable illustrated will remain unaffected by the heat treatment to which the conductor 20 is subjected after the loading material 21 has been applied. For this heat treatment no special precautions need be taken to prevent the effect of reducing gases upon the conductivity or elongation of the copper in the conductor 20.

It is within the scope of the invention to use deoxidized copper for only such parts of the conductor as are most directly exposed to the effect of the reducing gases. Thus in the case of the preferred embodiment shown in the drawing where the conductor 20 comprises a central strand and a plurality of outer strands which completely surround the central strand, it may be found to be satisfactory to use ordinary commercial copper for the central conductor and deoxidized copper for the outer strands.

What is claimed is:

1. As a new article of commerce, a heat treated ferro-magnetic metal covered copper wire, whose copper portion consists of commercial copper substantially completely freed of copper oxide.

2. A continuously loaded conductor having a conducting core of copper and a layer of loading material surrounding said core, said loading material being of a magnetic alloy of the type which requires a heat treatment to temperatures above 600° C. after being applied to the conductor to develop its magnetic properties and said copper being sufficiently freed from copper oxide and other impurities to have after said heat treatment an elongation of at least 20% before breaking and a conductivity of at least 95%.

3. A continuously loaded conductor having a conducting core of copper and a layer of loading material surrounding said core, said loading material being of a magnetic alloy which requires a heat treatment to temperatures above 600° C. after being applied to the conductor to develop one of its properties and said conducting core comprising inner and outer strands, the copper of said outer strands being of a purity such that it will retain a conductivity of at least 95% and an elongation of at least 20% before breaking after being subjected to the presence of reducing gases during said heat treatment.

4. A continuously loaded conductor in accordance with claim 2 having a separator between said conducting core and said layer of loading material, said separator being of a material which will develop reducing gases during said heat treatment.

5. As a new article of commerce, a heat treated metal covered wire having a copper conductor composed of copper completely deoxidized in the melted state.

6. As a new article of commerce, a heat treated ferro-magnetic metal covered copper wire, whose copper portion consists of copper completely deoxidized in the melted state.

7. As a new article of commerce a heat treated iron covered copper wire, whose copper portion consists of copper completely deoxidized in the melted state.

8. As a new article of commerce, a heat treated ferro-magnetic metal covered copper wire, whose copper portion consists of copper substantially completely deoxidized in the solid state at temperatures near its melting point.

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