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INSULATED ELECTRICAL CONDUCTORS

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This invention relates to an improved type of insulated electrical conductor and to a method of making the same.

One of the objects of the invention is to produce an insulated wire or conductor capable of withstanding high temperatures without melting, decomposing and without destruction of insulation resistance of the insulation.

Other objects of the invention will be apparent as the description thereof proceeds.

In my prior Patent No. 1,908,792 dated May 16th, 1933, I describe an insulation resistance which commercially has been proved to withstand temperatures as high as 1200° C. without electrical leakage or mechanical breakage. In the patent above mentioned, the coating is used to form an integral refractory unit with an element such as tungsten.

In this invention, the coating described in Patent No. 1,908,792 finds its chief use when applied to good conductors such as copper and has been found to eliminate many of the difficulties experienced with insulated wires of the prior art.

In the prior art, there have been used organic forms of insulation coating such as rubber, which tend to carbonize and lose their insulation resistance, especially if operated at high temperatures or they tend to oxidize by virtue of high tension production of ozone. In the case of fire proof coating such as asbestos used in combination with a cotton base for support, carbonization of the base occurs.

In the wire of my invention, in a preferred form, the coating is of the inorganic type and comprises forming a layer integral with the conductor base, of aluminum oxide by means of aluminum chloride as the suspension and reacting material.

Where high temperatures are encountered, I have found that the most important factor in the coating is to have no binder or residual inactive element, which at high temperatures tends to become a conductor, or if volatilized out, leaves the coating in a weakened mechanical condition. The coating material must be such as will adhere closely to the base at low temperature during coating operation, thus permitting the application of an even coating. Neither should it be affected by atmospheric conditions as by the presence of moisture or carbon dioxide.

I have found that a mixture of aluminum oxide (Al_2O_3) and a solution of aluminum chloride ($AlCl_3$) in water as a suspension material readily adheres as a coating and when baked and sintered forms a tough, dense, hard and smooth layer

that does not chip or flake. Due to the integral structure obtained, sufficient flexibility is obtained for bending around forms or winding on spools.

In preparing the mixture, the crystallized aluminum oxide is finely ground and added to a 25% solution of aluminum chloride. The coating is preferably applied by machine methods in the following manner:

The wire (copper preferably) is chemically cleaned and is passed over a rotating pulley which rotates in a cup containing the insulation mixture. In passing over the pulley, the wire is uniformly coated with a thin layer of the insulation. The coating is then passed through a furnace which is maintained at about 700° C. On entering the heater, the coating is dried and the higher temperature decomposes the aluminum chloride and eliminates hydrogen chloride by its substitution for oxygen. The important factor is involved in the oxychloride reaction



This treatment and reaction is repeated three times, after which the wire is spooled on a large diameter spool. The thickness of the finished coating is about 5 mils. The heating furnaces and coating pulley are mounted in a straight line so that when the untreated and cleaned wire is passed over the three coating cups and through the furnaces it is in finished state and ready to wind on the large spool.

When the reactions are completed, it will be found that the wire has been coated with a very desirable insulation resistance material. The insulation resistance depends upon the thickness of coating and the size of the aluminum oxide crystals.

The first or relatively low temperature hardening is probably due to the formation of an oxychloride and melting of the aluminum chloride crystals ($2AlCl_3 \cdot 6H_2O$). Another cementation agent is probably the cupric chloride formed at the surface of the copper wire, for it is noted that the wire becomes etched due to a reaction that occurs at its surface when heated in contact with the coating.

If the coating is applied to a wire that will withstand 1000° C. without melting, for example, where the coated wire is used to wind resistances with nickel or nichrome wire, it is heated to a temperature which will cause further hardening due to the formation of an allotropic modification of alumina and produces a change in specific gravity from 2.8 to 4. This accounts for the external hardness and toughness of the coating.

The aluminum oxide used is preferably composed of crystals formed by any of the several methods, such for example, by fusing alumina or heating amorphous aluminum to 600° in a hydrochloride atmosphere under pressure. The aluminum chloride can be made by dissolving aluminum in hydrochloric acid or by dissolving gelatinous aluminum hydroxide in hydrochloric acid.

- 10 Aluminum chloride has been found the most practical of the halogen compounds of aluminum; but aluminum fluoride or bromide can also be used. Other insulating oxides such as beryl, beryllium oxide, can be used with aluminum chloride as the halogen compound.

15 In general, the fundamental requirement for the suspension material of this invention is to use a salt capable of disassociating and displacing its halogen component for oxygen so as to leave only an active material which, due to the almost infinitesimal size, builds up a material within the intercrystalline space of the solid oxide, this condition giving strength and insulating resistance otherwise not obtainable.

- 20 Where excessively high temperatures are not encountered a small percentage of a binding or

fusible earth material can be added or other fusible material such as lead borate.

When the refractory oxide coated copper wire is used on a coil, I have found that it is of advantage to have a thin layer of enamel over the finished coating. This facilitates winding and prevents abrasion. Rubber or other protective coatings may also be used over the oxide.

What is claimed is:

1. A non-refractory conductor having a coating of aluminum oxide derived from a mixture of ground aluminum oxide and a halogen compound of aluminum applied to the conductor and heated to the decomposition point of the halogen compound.
2. A non-refractory conductor having a coating of aluminum oxide derived from a mixture of ground aluminum oxide and aluminum chloride applied to the conductor and heated to the decomposition point of the chloride.
3. A copper wire having a coating of aluminum oxide derived from a mixture of ground aluminum oxide and a halogen compound of aluminum applied to the conductor and heated to the decomposition point of the halogen compound.

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