Jan. 5, 1932. H. W. TURNER 1,840,139

ELECTRICAL COIL

Filed Feb. 26, 1929

Fig. 1

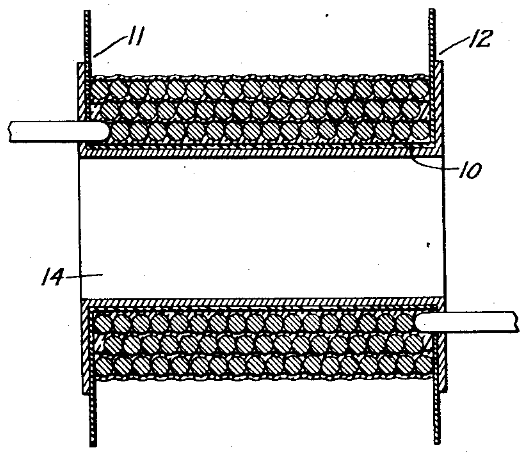
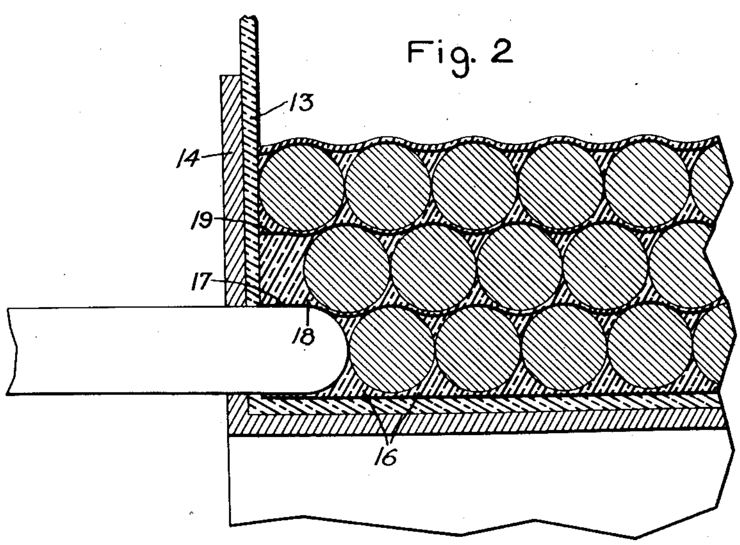


Fig. 2



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UNITED STATES PATENT OFFICE

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ELECTRICAL COIL

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My invention relates to electrical coils, more particularly to electromagnet coils, and has for its object the provision of an improved method and means for winding and insulating an electrical coil whereby a simple, rugged, and efficient coil is provided.

Although it obviously has other applications, my invention is particularly applicable to electromagnet coils such as employed in magnetic ore separators and like apparatus wherein the coils are subjected to the action of moisture, dirt and dust, and to exceptional vibration.

In the manufacture of coils for various types of electrical apparatus, it has heretofore been customary to provide a cloth, silk or asbestos covered conductor and after the coil has been wound to impregnate the coil with a suitable insulating compound. This method has proven to be more or less unsatisfactory not only because the coil was relatively large, but also because the coil readily deteriorated in certain kinds of service. Thus, it has been found at times that the electromagnet when heavily loaded would attain a temperature sufficiently high to melt the insulating compound with the result that the compound would flow from the spaces into which it has been forced whereby voids would be formed. By reason of this the coil was weakened mechanically, the insulated conductors were exposed to the action of moisture, dirt, dust, etc., and the coil operated at higher and higher temperatures because the voids or air pockets prevented an effective emission of heat. Moreover when subjected to vibrational or like disturbing forces, the turns of the coil were displaced and the insulation chafed to a dangerous degree.

My invention contemplates the provision of a mechanically strong electrical coil, one having a relatively small weight of copper conductor, a relatively small insulation space factor, and a relatively cool operating temperature.

In carrying my invention into effect in one form thereof, I embed the conductor turns in a plastic mineral compound applied during the winding operation. After the conductor has been wound and the turns thereof thoroughly packed with the plastic compound, I subject the coil concurrently to heat and pressure and finally allow the coil to cool whereby the compound hardens to securely hold the turns in place. Preferably I employ a suitable insulating asphalt compound mixed with proper proportions of soapstone. Moreover, I prefer to employ an enameled copper or an oxidized aluminum conductor.

For a more complete understanding of my invention, reference should be had to the accompanying drawings in which Fig. 1 is a sectional view of a magnet coil wound in accordance with my invention; and Fig. 2 illustrates a portion of the coil of Fig. 1 on an enlarged scale.

Referring to the drawings, I have shown my invention in one form as applied to an electromagnet winding which, though suited for general use in various electrical apparatus is particularly applicable to electromagnets employed in magnetic ore separators and like apparatus. As shown, the electromagnet comprises a spool or winding body having a central clyindrical winding portion or surface 10 and end flanges 11 and 12 suitably dimensioned to provide a winding space large enough to accommodate the desired number of turns. The spool body may be made of any suitable material. Preferably, and as shown, I form this body of sheet metal reinforced flexible sheet mica. Thus, the spool will comprise a winding surface of sheet mica 13 reinforced by an external sheet of metal armor 14. It will be understood that the sheet mica provides effective insulating means between the conductor turns and the spool. The mica sheets may be formed by binding together mica flakes into a flexible sheet by asphaltum varnish.

In order to reduce the space factor, I prefer to form the coil of an enameled copper or of an oxidized aluminum conductor. It will be understood that any suitable enameled wire may be employed, the particular enamel forming no part of my invention.

It will be understood that this conductor will be wound upon the spool in a plurality of layers. Moreover, as previously stated, each layer will be embedded in a suitable plastic mineral compound.

This compound, it will be understood, will serve not only to secure the various layers which form the coil, but will also serve to thoroughly insulate the turns from each other and to readily conduct heat from the interior portions of the coil so that the coil will operate at a comparatively cool temperature even though heavily loaded.

To meet these requirements I provide an insulating and binding material in the form of a plastic putty. This putty preferably comprises a suitable cementing and insulating varnish of hydro-carbon composition mixed with proper portions of a suitable filling mineral powder, which preferably will be of a refractory character. I have found that a mixture comprising approximately 40% by weight of cementing and insulating asphaltum varnish and approximately 60% by weight of powdered soap stone gives very satisfactory results. Preferably the asphaltum varnish should comprise a large per cent of asphalt dissolved in a hydro-carbon solvent. It will be understood that the asphaltum of the mixture performs the functions both of suitably binding the mixture and of insulting the conductor and it will be further understood that the soap stone performs both the functions of insulating the coils and of conducting heat therefrom whereby the heat in the various layers of the conductor will be equalized and diffused and a large radiating surface for the coils will be afforded. It is to be noted that this plastic putty will not destroy the enamel insulating provided for the conductors.

In winding the coil in accordance with my invention, the mineral compound or putty will be progressively applied as the successive layers are wound. Thus, the spool body will be prepared for the first layer of turns by coating it thoroughly with a layer 16 of the putty. It will be understood that the putty may be applied in any suitable manner. Thus, the composition may be applied conveniently with a brush. The first layer of turns will then be wound so as to be embedded in the layer of putty 16. It will be understood that the channels or gutters above and between the turns will be packed with the insulating putty. This layer of turns will then be wound with a strip 17 of suitably treated cotton tape. It will be understood that this tape is not indispensable but is desirable for the purpose of preventing damage to the enamel insulation on the conductors by chafing during the winding operation. Moreover, the tape serves to secure the putty both during the winding operation, and thereafter in the event the putty should become so soft that it would run. It will be understood that any suitable tape may be provided for this purpose. Preferably I use a tape treated by baking it to drive out the moisture and then submerging it in a suitable asphaltum varnish, which is flexible when air dried, so that the tape after treatment will be flexible.

After this tape has been wound and secured, a layer 18 of the putty will be applied to the tape and the second layer of turns will be wound so as to be embedded in this layer of putty. Preferably this layer will be wound so that its turns will be spaced laterally with respect to the turns of the first layer so as to be wound in the gutters or channels between these later turns. This construction obviously makes possible a very large winding factor commensurate with the winding space. This layer of turns will then be wound with a strip 19 of the treated cotton tape.

Each succeeding layer likewise will be embedded in a layer of the insulating putty and will be wound with the binding tape.

After the coil has been completely wound, the whole will be subjected concurrently to heat and pressure whereby the volatile constituents will be driven off and the coil be molded into a compact homogeneous structure. Preferably, the coil will be heated intermittently so that the volatile constituents will not be ejected too voilently. Thus, with coils of certain sizes, very good results will be obtained by heating initially to approximately 120° C. for a period of approximately 40 minutes. The coil will then be allowed to cool for a period of approximately 60 minutes after which it will be heated to approximately 160° C. Again it will be allowed to cool this time for a period of approximately 100 minutes after which it will be heated probably up to a temperature as high as 200° C. It will be understood, however, that the above figures serve merely for purposes of illustration. Thus, the volatiles may be driven out during a single heating stage or for intermittent heating both the temperatures at which the coil is heated and the periods during which it is heated and cooled may be varied in accordance with the particular coil being treated. Preferably the putty will be heated by passing an electric current through the conductor so that the volatile constituents will be forced outwardly from the interior portions of the putty.

The pressure which is applied continuously during the heating and cooling periods may be either mechanical or hydrostatic. Thus, weights may be applied directly to the coil or it may be placed in a suitable tank in which it will be subjected to hydrostatic pressure. It will be found that the above heat and pressure treatment will thoroughly compact the coil into a homogeneous solid mass.

After the heat and pressure treatment just described, the coil will be baked at a temperature of approximately 120° C. for a period of approximately 12 hours in order to insure that the putty will be set. The baking temperature and period, however, may be suitably varied, the size of the particular coil being a controlling factor. After the putty has been allowed to cool, it will be hardened to such a degree that it will hold the layers rigidly in place. It will be understood that the entire outer surface of the coil may be covered with a suitable layer of sheet mica. This layer may be and preferably is secured by inturning the outer edges of the metal reinforced mica strip 13. The entire outer surface of the coil may then be covered with a suitable protective varnish.

It is to be noted that the putty not only performs the function of securely holding the turns in place but also fills all dead air spaces and voids between the turns and therefore so diffuses and equalizes the heat in the coil that much larger heat radiating surfaces are provided than in the case of the ordinary windings so that the windings operate at a much lower temperature than the customary windings.

The thermal emission of the coil is further enhanced by using an enameled conductor rather than an asbestos or cotton or similarly insulated conductor since the conductors may be placed closer together. Moreover, the metal spool lining 14 serves to conduct heat away from the coil.

Also it is to be noted that the plastic nature of the putty permits expansion of the conductor without the formation of air holes and pockets. As a result the radiating power of the coil is not diminished. Moreover, the finished coil presents an absolute continuous surface whereby the entrance of oil, dirt, water, air, etc., is prevented. Moreover, due to the plastic nature of the putty vibrations and like disturbing forces will not displace the conductor turns and thus all danger of chafing the conductor insulation is eliminated.

It will be observed that I have greatly reduced the space factor. Thus, for example, if there is space for a given number of turns of wire with a diameter of ten (10) mils over its insulation, the use of the enameled wire will provide 70% more copper cross section than with the use of single silk covered wire and over five times as much copper cross section as with the use of single cotton covered wire.

Consequently, the copper losses will be greatly reduced or else the size of the coil itself may be greatly reduced.

While I have in accordance with the provisions of the patent statutes described my invention as embodied in concrete form and operating in a specific manner, it should be understood that I do not limit my invention thereto, since various modifications thereof will suggest themselves to those skilled in the art without departing from the spirit of my invention, the scope of which is set forth in the annexed claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of securing the turns of an electrical coil which consists in embedding the turns of said coil in a plastic mineral compound comprising approximately 60% soapstone and 40% asphaltum, said compound being progressively applied during the winding operation, and then intermittently heating the coil to a temperature high enough to drive off the volatile constituents while applying pressure to compact said coil, said pressure being applied continuously as the mineral compound cools and hardens whereby said turns are bound into a solid homogeneous mass.

2. The method of securing the turns of an electrical coil which consists in embedding the turns of said coil in a plastic mineral asphaltum compound, said compound being progressively applied during the winding operation, then intermittently heating the coil to a temperature high enough to drive off the volatile constituents while applying pressure to compact said coil to a homogeneous mass and thereafter baking said coil so as to set said plastic mineral compound.

3. The method of making an electrical coil wherein an enameled electrical conductor is used which consists in providing a metallically reinforced mica winding spool body for said conductor, winding said conductor on said spool body in a plurality of layers, packing an electrically insulating, heat conducting, plastic mineral asphaltum putty into intimate contact with the turns of said coil, heating said putty to a temperature high enough to drive off the volatile constituents while applying pressure to compact the turns of said coil and then cooling said putty so that said putty is hardened whereby the turns of said coil are securely bound and held in place.

4. The method of making an electrical coil wherein an enameled electrical conductor is used which consists in providing a metallically reinforced mica winding spool body for said conductor, winding said conductor on said spool body in a plurality of layers, the turns of each layer being wound into the channels between the turns of the preceding layer, and packing said layers with an electrically insulating and heat conducting plastic mineral compound.

5. The method of making an electrical coil wherein an enameled electrical conductor is used which consists in providing a metallically reinforced mica winding spool body for said conductor, winding said conductor on said spool body in a plurality of layers, providing a putty comprising approximately 60% soap stone and 40% asphaltum, packing each layer with said putty, heating said

putty to a temperature high enough to drive off the volatile constituents while applying pressure to compact the turns of said coil, and thereafter baking said coil so as to set said putty.

6. An electrical coil comprising a spool having a relatively high heat conductivity, an electrical conductor wound upon said spool in a plurality of layers and an electrically insulating material also having a relatively high heat conductivity packed into intimate contact with each layer of said conductor whereby heat generated in each of said layers is readily conducted to said spool and to the outer edges of said coil where it is dissipated.

7. An electrical coil comprising a spool having an electrically insulated metallic winding body, an electrical conductor wound upon said metallic winding body in a plurality of layers and an electrically insulating plastic material packed into intimate contact with each layer of said conductor whereby said layers are secured, said plastic material having a relatively high heat conductivity whereby heat generated in each of said layers is conducted to said spool and to the exterior of said coil.

8. An electrical coil comprising a metallically reinforced mica spool having a winding body, an enameled electrical conductor wound upon said winding body in a plurality of layers, the turns of each layer being wound into the channels between the turns of the preceding layer, and an electrical insulating, heat conducting, plastic mineral compound packed into intimate contact with each layer of said conductor so as to securely hold said layers in position in a compact homogeneous mass.

9. An electrical winding comprising a metallically reinforced mica spool having a winding body, a coil wound in a plurality of layers upon said winding body and an electrically insulating, heat conducting, plastic refractory material packed into intimate contact with the layers of said coil whereby they are securely held in position and heat is readily conducted therefrom.

10. An electrical coil comprising a metallically reinforced mica spool having a winding body, an enameled electrical conductor wound upon said winding body in a plurality of layers and an insulating, heat conducting, plastic mineral refractory compound packed into intimate contact with each layer of said conductor so as to securely hold said layers in position in a compact homogeneous mass.

In witness whereof I have hereunto set my hand this 25th day of February, 1929.

HARRY W. TURNER.