July 2, 1946. G. CAMILLI 2,403,340

INSULATED CONDUCTING MEMBER AND METHOD OF APPLYING THE INSULATION

Filed June 16, 1942 2 Sheets-Sheet 1

Fig. 1.

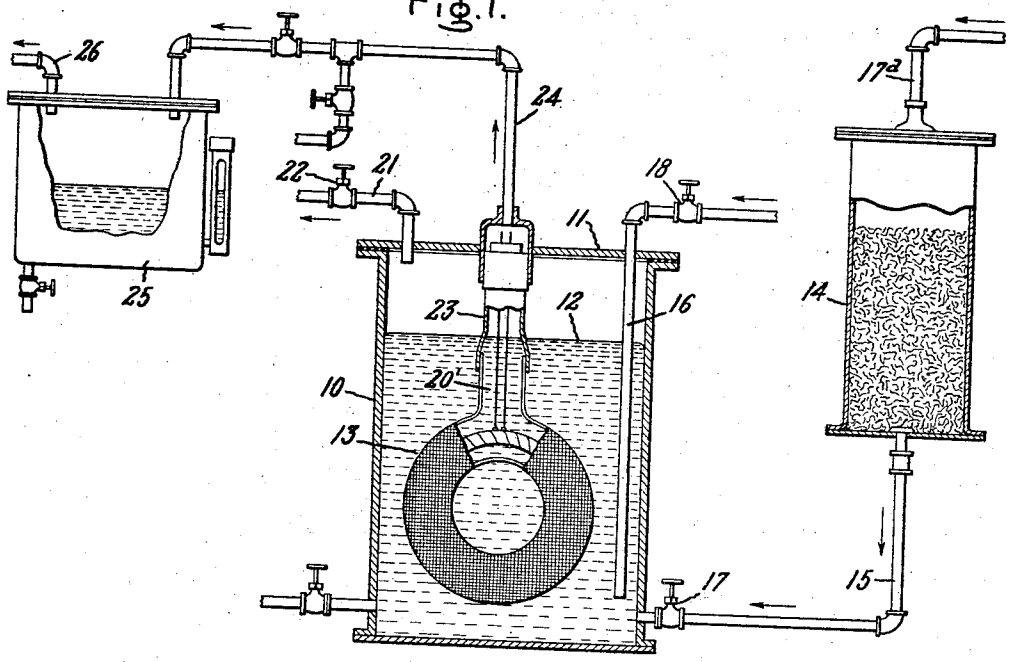


Fig. 2.

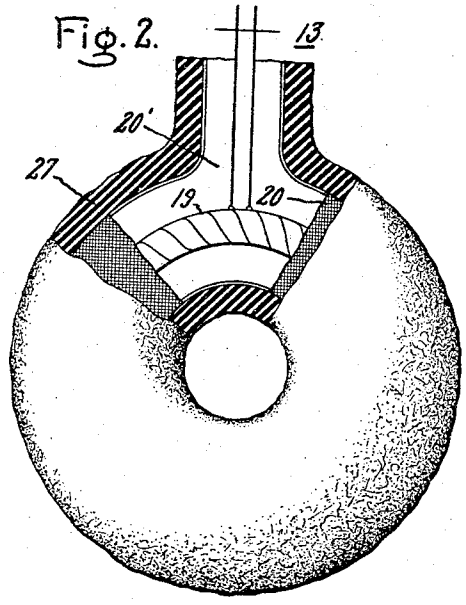


Fig. 3.

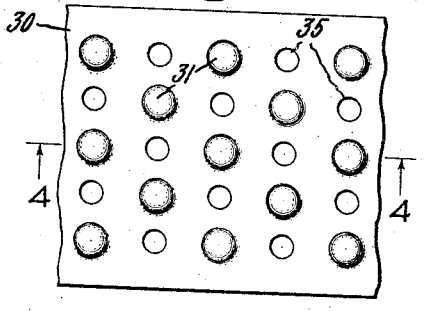
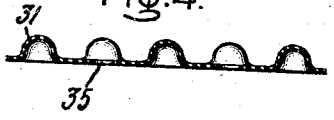


Fig. 4.



Inventor:
Guglielmo Camilli,
by Harry E. Dunham
His Attorney.

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Filed June 16, 1942 2 Sheets-Sheet 2

Fig. 5.

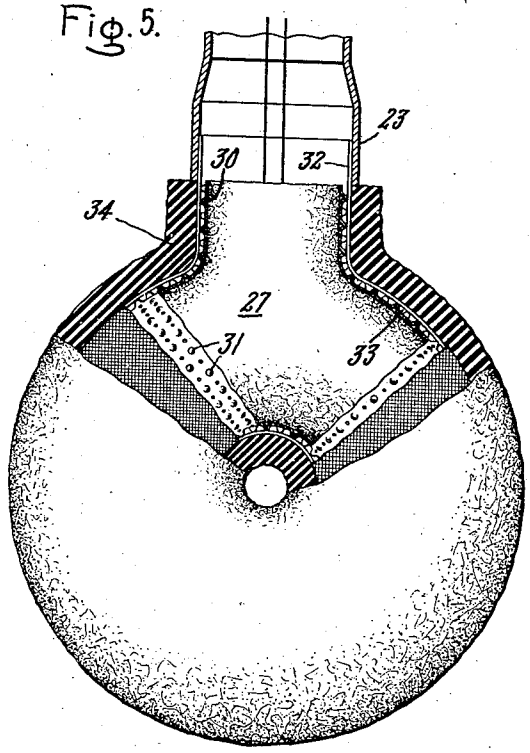


Fig. 6.

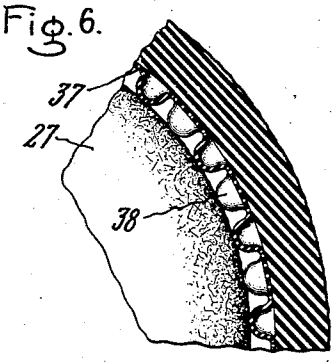


Fig. 7.

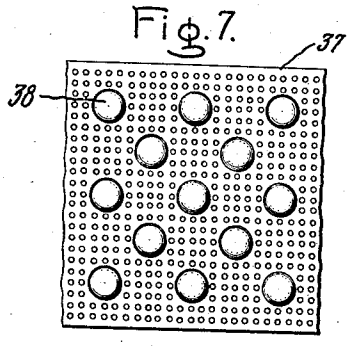
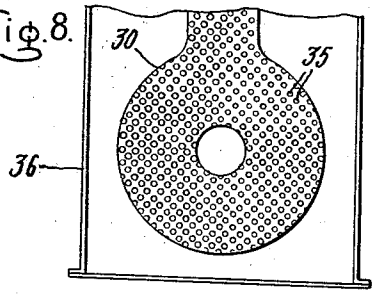


Fig. 8.



Inventor:
Guglielmo Camilli,
by Harry E. Dunham
His Attorney.

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2,403,340

UNITED STATES PATENT OFFICE

2,403,340

INSULATED CONDUCTING MEMBER AND METHOD OF APPLYING THE INSULATION

Guglielmo Camilli, Pittsfield, Mass., assignor to General Electric Company, a corporation of New York

Application June 16, 1942, Serial No. 447,220

6 Claims. (Cl. 175—21)

1

My invention relates to electrical insulation, and to an improved method of applying the insulating material to an electrically conducting article, and to the article which is so insulated.

Heretofore, it has been common practice when applying high voltage insulation to a conducting article such as some coils, to apply a suitable tape, such as crepe paper, by taping the coil by hand. Such a procedure is a relatively costly and tedious operation, and an improved arrangement for hydraulically applying an insulating covering to an electrically conducting article, such as a coil, at a relatively rapid rate, is described and claimed in a copending application, S. N. 326,042 of Camilli, Hemphill and Endicott, filed March 26, 1940, and assigned to the same assignee as this present invention, and which issued on July 21, 1942 as Patent No. 2,290,671.

It is, therefore, an object of my invention to provide an improved method of the type described and claimed in the above-mentioned application for electrically insulating a conducting member.

Another object of my invention is to provide a conducting member with an improved composite insulating covering.

Further objects and advantages of my invention will become apparent from the following description referring to the accompanying drawings, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In the drawings:

Fig. 1 diagrammatically illustrates apparatus which may be employed to apply the insulated covering: Fig. 2 is a side elevation in partial section of a winding having one covering of my improved composite insulation; Fig. 3 is a side view of a spacer arrangement which is employed to produce my improved composite covering; Fig. 4 is a sectional side elevation taken along the lines 4—4 of Fig. 3; Fig. 5 is a side elevation, in partial section, of the winding of Fig. 2, after a second covering of my composite insulation has been applied; Fig. 6 is a fragmentary sectional side elevation illustrating a modified arrangement of employing my improved screen; Fig. 7 is a side view of the screen employed in Fig. 6 and which screen is a modification of the screen shown in Figs. 3 and 4, and Fig. 8 is a side view partially in section illustrating a transformer having my improved insulated winding.

The improved method described in the above-mentioned copending application of insulating an electrically conducting article, such as a coil

2

winding, includes the steps of placing a permeable screen around the article to be coated and spacing the screen from the article to provide a fluid channel. The article is then placed in a bath including a fluid having finely divided particles or bits of insulating material suspended therein. A difference of pressure is produced between the fluid inside and outside the screening so that the fluid may pass through the screen and deposit its suspension. The thickness of a covering which may be so deposited may, of course, be dependent on such factors as the relative values of pressure between that inside and outside of the screen, the size of the insulating particles suspended in the fluid, and the type of fluid. Furthermore, as the insulating covering builds up, the fluid which deposits its suspension must pass through the already deposited insulation, so that a pressure drop will obtain through the covering which has already been applied. Assuming constant conditions, therefore, a point will be reached when no further fluid will pass through the already deposited insulating covering so that no further insulation will be deposited.

Referring to the drawings, in Fig. 1 I have illustrated an apparatus in which my invention may be carried out, but it is to be understood that any other suitable apparatus may be employed. This apparatus, which is described in the above-mentioned copending application, includes a tank 10 which is provided with a suitable pressure tight cover 11. In this tank is placed a suitable fluid, such as a liquid 12 which has suspended therein the material which is to be coated upon an article 13. Any suitable insulating material may be used, it being only necessary to use one which when beaten or broken into bits will have such characteristics that it will not pass in appreciable amounts through a suitable perforated or screen member. Examples of suitable materials are mica and such fibrous materials as paper and asbestos. However, it is to be understood that other materials which may be broken into particles, or fibers, or bits of proper size may also be applied according to this method. When applying the method to a high voltage coil, a cellulosic material such as kraft paper, produces an efficient insulating covering. Such paper ordinarily comes from the mills in thick sheets so that it is necessary to get the paper in proper condition so that it may be hydraulically applied. This paper is, therefore, broken into particles or bits so that it becomes a mass of fibrous material which may be mixed with a liquid, such as water. In order to thoroughly hydrate the paper it may be beaten

while in water so that it becomes a wet mash. This pulp may then be placed into a tank 14 which leads to the tank 10 through a piping system 15. In order to proportion properly the amount of liquid with the pulp there may be provided an intake pipe 16 in the tank 10 for the liquid. In order to obtain the desired amount of mixture 12 of liquid and paper pulp in the tank 10, a measured amount of pulp is caused to flow into the tank 10 by opening a valve member 17 and forcing it under suitable pressure such as air or water pressure which may be applied through a pipe 17a. Water is then allowed to flow into the tank by opening a control valve 18. Any suitable proportion of paper pulp to water may be used, such as about one part of paper pulp by weight to 99 parts of water, when a screen of about 200 mesh is employed.

The article to be insulated as shown in Fig. 1 includes a high voltage coil winding for an electric induction apparatus, such as a transformer which includes turns 19 which may be covered with a suitable permeable envelope or screen of any suitable material 20, which has at least a portion thereof spaced from the winding or from a portion of the turns 19 so as to provide a suitable fluid channel arrangement 20'.

In order to produce a difference in pressure between the liquid inside the screen 20 and that surrounding the screen, water pressure may be applied to the tank 10 through the pipe 16. Excess water may be drawn off through a pipe 21 having a valve 22. A pressure differential between that inside and outside the screen may also be provided through a suitable pumping arrangement which may be connected to the screen member 20 through a pipe member 23. This pipe member is in turn connected through a pipe system 24 to a sump 25, the sump being connected to a pump through a pipe 26. Thus, it will be seen that if water pressure is applied by opening the valve 18 and the pump attached to the pipe 26 is operated, the water adjacent the screen member 20 will flow through the screen and pass out through the channel arrangement 20', and pipe 24. Instead of using both pressure and vacuum, either may be used separately. As described in the above-mentioned application, this movement will cause suspended particles or bits in the water to be deposited on the outside surface of the screen or perforated member 20. Any suitable pressure differential may be developed depending upon the thickness and type of hydraulically applied coating which is desired. During the coating operation, since water is constantly entering and leaving the tank 10, a proper proportion of liquid and pulp may be kept by constantly introducing pulp into the tank 10 through the pipe 17 at a suitable rate. Assuming constant pressure conditions, the coating will continue to build up to a thickness until the fluid stops flowing through the covering which has already been deposited. After the coil has been removed a hydraulically applied coating 27, as shown in Fig. 2, will cover the outside surface of the screen 20.

In hydraulically applying an insulating covering to a coil in the manner described above, I have found that after a predetermined time under a given set of conditions during which the insulating bits are deposited, the particles which are then applied will not adhere sufficiently to the already applied covering. This covering which is applied after this predetermined time may fall off while the coil is being removed from the bath, or if it remains, the insulation will be of an inferior quality. It appears that this is due to the fact that after a predetermined thickness has been built up for a given set of conditions, the fluid passes through the already applied insulating covering at such a low rate that bits deposited by this slowly moving fluid do not adhere sufficiently to the already applied insulating covering. Therefore, when it is desired to apply an insulating covering of a greater thickness than that which obtains before the rate of flow of the carrying fluid drops below a predetermined value, (which predetermined rate may be determined by experiment for any given set of conditions) the coil may be removed from the bath while the fluid is still flowing through the already deposited insulation at a sufficient rate to produce a relatively tight covering; a second screen arrangement may then be applied over the already applied insulating covering 27 and another hydraulically applied coating produced on the outside surface of the second screen. Thus, the coil is removed before that time when the fluid stops all flow through the already deposited insulation and, of course, the coil may be actually physically removed at this predetermined time, that is, when the rate of flow drops to a predetermined value, after turning off the vacuum and pressure and removing the cover 11 from the tank 10. Therefore, in describing that the coil is removed from the bath while the fluid is still flowing through the already deposited insulation at a sufficient rate to produce a relatively tight covering is, of course, meant that the coil is removed at that predetermined time in any suitable manner, such as upon turning off the means for creating the higher pressure in the fluid surrounding the envelope.

In Fig. 3 I have illustrated a suitable screening arrangement 30 which may be applied over the insulation 27 in any suitable manner such as by taping it around the outside surface. The tape 30 forming the spacer portion of the screen may be of any suitable material, such as cellulose acetate with a plurality of protrusions 31 extending therefrom. These protrusions may be formed in any suitable manner such as by passing a flat piece of cellulose acetate tape over a pair of hot rollers, one of which has outwardly extending portions and the other cooperatively receiving indentations which expands portions of the tape to provide the protrusions 31. The tape may, therefore, be applied over the insulation 27 with the protrusions extending outwardly as is illustrated in Fig. 5. A screen arrangement 32 of any suitable type such as cloth may then be applied over the tape 30, and a plurality of protrusions 31 will space the screen from the tape 30 providing a fluid channel arrangement 33 similar to the channel arrangement 20'. The pipe 23 may then be connected to this channel arrangement and the article then placed in the bath of Fig. 1 and a second coating 34 produced thereon in the manner which has already been described.

It will be seen in Fig. 3 that the tape 30 has a plurality of openings or perforations 35. Thus, when the coil is placed in a suitable casing 36 as illustrated in Fig. 6 and impregnated with a suitable insulating fluid, this fluid may permeate through the various composite layers through the perforations 35 of the screen portion 30.

In Fig. 6 I have illustrated a spacer arrangement 37 around the covering 27, the spacer, as illustrated in Fig. 7, having a plurality of pro-

trusions 38, the tape being so wound that the protrusions extend inwardly adjacent the covering 27. The tape 37 is perforated with sufficiently small openings that when the so taped article is placed in the bath the bits of insulating material will not pass in appreciable amounts through the screen 37.

Although I have shown and described particular embodiments of my invention. I do not desire to be limited to the particular embodiments described, and I intend in the appended claims to cover all modifications which do not depart from the spirit and scope of my invention.

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

1. An insulated coil winding for an electric apparatus including a conductor turn, screen means permeable to a fluid surrounding said conductor turn, means spacing at least a portion of said screen from said turn in order to form a fluid channel between said turn and said screen, a hydraulically applied insulating material surrounding and closely fitting said screen, said screen having a fluid passage connected to said channel through which a fluid may pass during application of said hydraulically applied insulating material, means surrounding said hydraulically applied insulation providing a second screen, integral protrusions extending from said second screen means to space said screen means from said insulation and provide a channel, and a hydraulically applied insulating material surrounding and closely fitting said second screen means.

2. An insulated coil winding for an electric apparatus including a conductor turn, screen means permeable to a fluid surrounding said conductor turn, means spacing at least a portion of said screen from said turn in order to form a fluid channel between said turn and said screen, a hydraulically applied insulating material surrounding and closely fitting said screen, said screen having a fluid passage connected to said channel through which a fluid may pass during application of said hydraulically applied insulating material, a second screen means surrounding said hydraulically applied insulation, flexible sheet means adjacent said insulation and having outwardly extending integral protrusions for spacing said second screen means from said insulation, and a hydraulically applied insulating material surrounding and closely fitting said second screen, said flexible sheet means being perforated so that an impregnating fluid for said coil may permeate said insulating covering through the flexible sheet means.

3. An insulated electrical conductor comprising, in combination, a plurality of superposed layers of insulation surrounding said conductor,

and perforated spacing means separating said layers from each other and separating the innermost layer from said conductor, said spacing means which are between said layers having integral fluid conducting channels, said layers comprising relatively tightly matted insulating fibers hydraulically deposited on the outer surface of the respective perforated spacing means, each layer being substantially of the maximum thickness consistent with tight matting of the fibers that it is practicable to deposit hydraulically, the total thickness of all the layers being substantially greater than the maximum thickness to which it is possible to deposit a single layer regardless of tightness of matting of the fibers.

4. A conductor coil having a predetermined amount of surrounding solid insulation, a layer of perforated insulation mounted on said solid insulation and in direct contact therewith, said perforated layer including a plurality of integral channels extending generally parallel to the surface of said solid insulation, and a homogeneous layer of tightly matted fibrous insulation hydraulically deposited on said layer of perforated insulation.

5. The method of hydraulically depositing tightly matted multi-layer fibrous insulation to any desired thickness on an electrical device including the steps of wrapping a channelled and perforated layer of insulation on top of and in contact with an underlayer of insulation, submerging said device in a liquid bath having fibrous insulation held in suspension, causing said liquid to flow through said perforations and out of said channels at a predetermined rate so as to deposit said fibers on said perforated layer, stopping said flow when a predetermined thickness of deposit has been built up, and repeating said steps until the desired total thickness of tightly matted insulation is deposited.

6. The method of hydraulically depositing tightly matted multi-layer fibrous insulation to any desired thickness on an electrical device including the steps of wrapping a channelled and perforated layer of insulation on top of and in contact with an under layer of insulation, submerging said device in a liquid bath having fibrous insulation held in suspension, causing said liquid to flow through said perforations and out of said channels at a predetermined initial rate so as to deposit said fibers on said perforated layer, stopping said flow substantially before the maximum thickness of deposit has been built up and while the outer surface of said deposit is relatively tightly matted, and repeating said steps until the desired total thickness of tightly matted insulation is deposited.

GUGLIELMO CAMILLI.