Jan. 3, 1933. V. G. APPLE 1,893,262

REENFORCED ELECTRICAL COIL

Filed Nov. 20, 1930

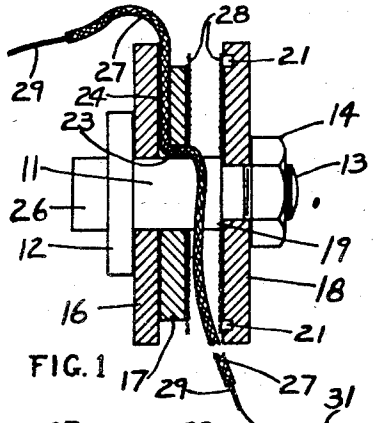


FIG. 1

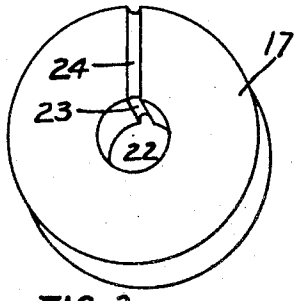


FIG. 2

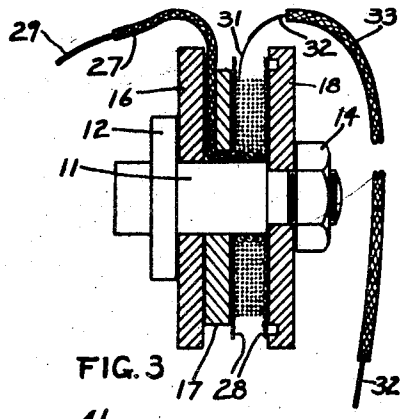


FIG. 3

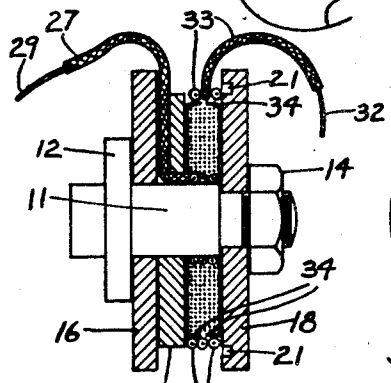


FIG. 4

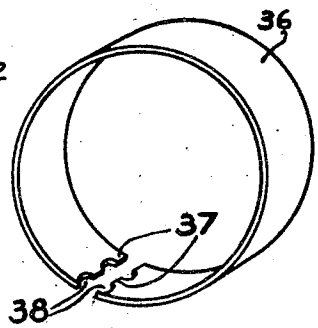


FIG. 5

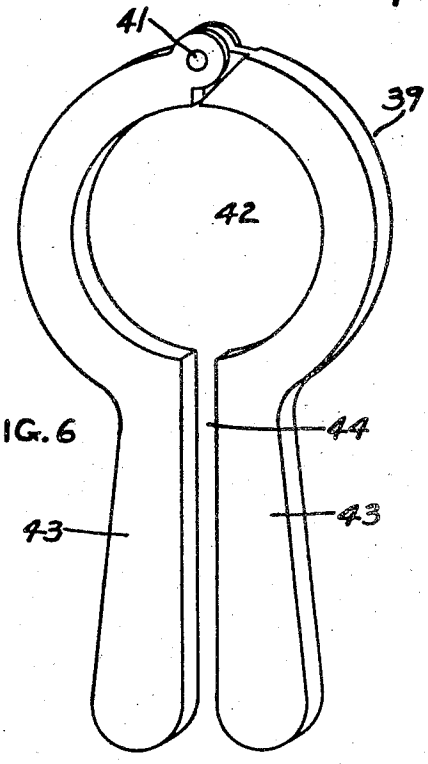


FIG. 6

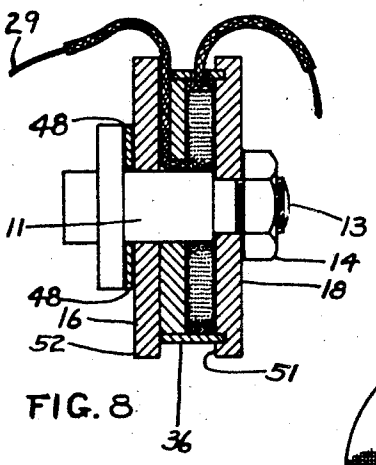


FIG. 8

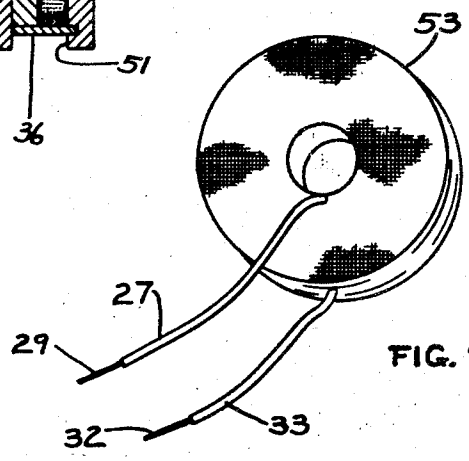


FIG. 9

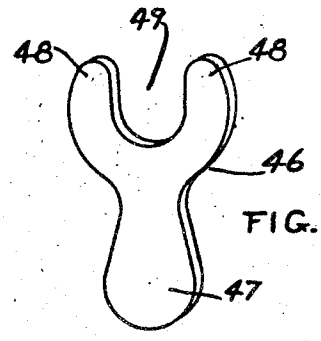


FIG. 7

INVENTOR

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Patented Jan. 3, 1933 1,893,262

UNITED STATES PATENT OFFICE

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REENFORCED ELECTRICAL COIL

Application filed November 20, 1930. Serial No. 496,847.

This invention relates to electrical coils and has special reference to coils comprising reenforcing means which renders them substantially indestructible even when subjected to severe usage.

An object of the invention is to provide a coil in which the individual turns are imbedded in and spaced apart by a mass of insulating cement which renders the coil self supporting.

Another object is to enclose the turns of the coil in an insoluble and infusible covering.

Another object is to provide a coil having a fabric reenforced covering of insulation whereby it may be subjected to great physical abuse.

Another object is to provide a coil which is unusually accurate as to shape and size.

Another object is to provide a coil having improved means for securing flexible terminals to the ends of the turns whereby less failures of the joints so made may occur.

Another object is to provide means and formulate a procedure for practicing the invention with minimum loss of labor or material.

I attain these objects by the structure, method and tools disclosed in the following description, said description being facilitated by reference to the drawing, wherein,

Fig. 1 is an axial section through a winding spool as it appears when ready to have a coil wound upon it.

Fig. 2 is a special washer which is part of the winding spool shown in Fig. 1.

Fig. 3 shows the spool with the winding in place.

Fig. 4 shows the spool after the several finishing turns have been wound.

Fig. 5 is a spring ring used for accurately forming the outside of the coil.

Fig. 6 is a tool used to apply the ring shown in Fig. 5 to the coil.

Fig. 7 is a spacing fork used to determine the thickness of the coil.

Fig. 8 is an axial section through a coil and its spool when the structure is ready to be baked.

Fig. 9 shows a completed coil.

Similar numerals refer to similar parts throughout the several views.

In my copending applications Serial No. 356,586, filed April 19th, 1929, Serial No. 430,864, filed February 24th, 1930 and Serial No. 455,296, filed May 24th, 1930, I disclose a procedure whereby liquid insulation is deposited in a relatively thick layer around a wire while the wire is uncoiled, then dried just enough to prevent its being pressed out from between the turns when it is being wound into coils, but not heated enough to convert it into the insoluble and infusible state until after it is wound into the coils.

This method of applying liquid insulation to the individual turns of a coil may be substantially followed in the present invention, and while there are now available a number of liquid insulating materials which have the necessary insulating qualities as well as the requisite cementing properties, and which will harden by the application of heat to an insoluble and infusible state, the insulating material selected from those available must be determined with regard to the use to which the coils are to be put, some of the insulating materials being especially resistant to one thing and some to another.

It is well known that, of all the sheet insulating materials available, those having the highest tensile strength and which will stand the greatest physical abuse are made by thoroughly saturating a sheet of loosely woven cloth or canvas with liquid insulation and compressing it to a thinner section and curing out the insulation. I will therefore have attained the principal objects of my invention when I have selected a proper liquid insulation, placed a considerable layer of it around each individual turn of the coil, formed a covering of insulation-impregnated non-metallic fabric completely around the outside of the coil and, while holding it to a definite size, converted the insulation into an insoluble and infusible state in which the insulation surrounding the wires and that in the meshes of the fabric has been fused together into one continuous mass from which stranded coil terminals emerge.

In the drawing a stud 11 has a head 12,

and is threaded on the end 13 for nut 14. Washers 16 and 17 are slidably fitted to stud 11 while a third washer 18 is held against the shoulder 19 by nut 14. Washer 18 has a shallow annular groove 21 in the inner face. Washer 17 is shown in detail in Fig. 2 and has a shallow groove extending through the edge of the central opening 22 as at 23 thence radially outward in the face of the washer as at 24. The end 26 of the stud 11 is adapted to be held in a revolving chuck or other device, not shown, to rotate the spool when the coil is being wound.

A length of loosely woven sleeving 27 of non-metallic fabric of a size sufficient to fill the grooves 24 and 23 in washer 17 and as much longer as is required to make enough turns around the stud 11 to cover it, is provided. This sleeving is thoroughly impregnated with suitable liquid insulation, except that portion which lies in the grooves 24 and 23. The liquid insulation absorbed by the sleeving 27 is dried sufficiently to expel the greater part of the solvent so that it may be conveniently handled. The washers 28 are cut from thick loosely woven cloth which has been heavily impregnated with the liquid insulation, the fabric compressed and dried, not enough to bring about the reaction which converts the insulation into an infusible solid but just enough to make it sufficiently stiff to hold its shape while the coil is being wound.

The spool in condition to have the wire wound upon it is shown in Fig. 1, but the order in which the several parts of the spool are thus assembled may preferably be described. To assemble the spool as shown in Fig. 1 the end 26 is preferably held in the chuck of the winding spindle, the washer 16 put on the stud 11, a length of stranded terminal wire 29, slightly longer than the sleeving 27 is joined to the end of the insulated wire 31, the terminal wire 29 threaded through the sleeving 27, the terminal wire and sleeving through the opening 22 of washer 17 and laid in grooves 23 and 24, the washer 17 placed on stud 11, two washers 28 put on, and the washer 18 secured to the stud 11 by the nut 14. After assembly as shown in Fig. 1 the coil may be wound, care being taken that the sleeving 27 is so wound as to completely cover the stud 11 thus forming the inner layer of the coil.

The wire 31 is preferably of copper and preferably of the kind having a cotton or other porous covering which has been impregnated and coated with liquid insulation and dried as described in my copending applications hereinbefore referred to, and when the proper number of turns have been wound on the spool the wire 31 is cut off and a length of stranded terminal wire 32 joined to it. Another length of sleeving 33 is placed over the terminal wire 32 as shown in Fig. 3. This length of sleeving has, like sleeving 27 been thoroughly impregnated in the liquid insulation and dried. The sleeving 33 is of sufficient length to compose the outer layer of the coil, but before it is wound on the coil the washers 28 are preferably turned inward as at 34, Fig. 4. The outer layer of the coil is then formed of the several turns of the sleeving 33 wound over the inturned edges 34 of the washers 28, the end of the sleeve being preferably inserted under the last round and drawn up taut.

When a coil has been wound as shown in Fig. 4 with the inner and outer layers covered with insulation treated fabric sleeving and the sides covered with insulation treated fabric washers the coverings are preferably compressed slightly to make them more dense and to make the coil more accurate as to size. To so compress the covering I provide the several tools shown in Figs. 5, 6 and 7.

The spring ring 36, Fig. 5 has an inner diameter equal to the outer diameter of the finished coil when the ends 37 of the ring are brought together. Half holes 38 are provided in the ends 37 to clear the sleeving 27 and 33. The width of the ring 36 is equal to the width of the space between the washers 16 and 18, Fig. 4.

The clamp 39, Fig. 6 is made in two main parts hinged at 41. The opening 42 is equal to the outside diameter of the ring 36 when the handles 43 are still spaced apart as at 44. The spacer 46, Fig. 7 comprises a handle 47 and the forked ends 48, the opening 49 between the forked ends being slightly larger than the stud 11.

To compress the coverings tightly up to the coil Fig. 4, the ring 36 is first sprung over the washer 18 with the sleeving 27 and 33 coming out between the ends 37 of the ring. The clamp 39 is then placed around the ring with the ends 37 of the ring corresponding to the opening 44 between handles 43. The handles 43 are pressed together until the ends 37 come together with the sleeving 27 and 33 emanating from the half holes 38. The ring 36 now closely surrounds the washer 17 at one edge and at the other is in alignment with the annular groove 21. The washer 16 being loose on stud 11 is now forced by a suitable press toward the washer 18 to compress the fabric washers 28 sidewise against the coil and to enter the edge of the ring 36 in the annular groove 21. When the edge of the ring 36 has been forced to the bottom of the annular groove 21 there will be just enough space between the head 12 and the washer 16 to permit the ends 48 of the tool 46 to be inserted. After insertion of the ends 48 under the head 12 the clamp 39 may be removed and the coil remains under pressure within the enclosing spool, but while the procedure comprising reduction of the dimensions of

the coil coverings to make them more dense and to more firmly unite them with the turns of the wire is much preferred, a process omitting this step but otherwise following the procedure outlined is considered within the spirit of the invention.

Fig. 8 shows a coil on the spool with the ring 36 holding the diameter of the coil to size and the ends 48 of the spacer 46 holding the coil under axial pressure. In this condition the coil is baked to bring about the final reaction of the insulating material whereby the insulation between the individual turns of the wire and the insulation carried by the fabric covering is first fused together into a single mass then by further heating converted into an insoluble and infusible state. The baking is preferably kept at a low heat for a considerable period of time inasmuch as a too rapid baking tends to generate gas within the coil and drive the insulation to the surface, but with proper regulation of the baking temperature just enough of the insulating material is brought to the outside to make the fabric covering on the coil a smooth surface.

When reaction of the insulating material is complete the coil may be removed from the spool. This is preferably done by a series of steps comprising removing the nut 14, holding the washer 18 under the edge 51 and by pressing on the end 13 removing the washer, then by holding under the edge 52 of washer 16 again pressing on the end 13 and removing the stud 11. The ring 36 is now removed after which the sleeving covered terminal 29 is raised out of the groove 24 in washer 17 whereupon washer 17 is readily removed. The completed coil now appears as at 53, Fig. 9 where terminal wires 29 and 32 emerge from a fabric reenforced insulation covered coil through the sleeving 27 and 33 respectively.

It will be seen that both my coil and the method in which it is made differs radically from the conventional methods. Coils made by conventional methods are wound on a mandrel from which they must be removed in order to impregnate them, either by dipping them in liquid insulation or by enclosing a number of them in a pressure-tight tank of the liquid and forcing the liquid into the wound coils. When these conventional methods are employed the coils may not be thoroughly impregnated unless they were removed from the mandrel and when so removed before impregnation the several turns must be tied or taped together to keep the coils from coming apart while they are being impregnated and baked. Further a coil and its mandrel could not well be dipped together into a body of liquid insulation because of the quantity of the liquid which would completely cover the mandrel and be baked upon it, such covering requiring much time to remove, and because the terminal ends of the coils would be cemented so thoroughly to the mandrel as to defy removal of the terminal ends.

Coils made by conventional methods then must be removed from the mandrel before impregnation, they must be tied or taped, they do not have the conductive portion of their several turns spaced apart by a great enough amount of the liquid insulation and they lose a considerable part of that which is gotten between the conductive portion of their turns when the coils are baked, they do not hold a definite size or shape, and they do not have adequate protection on the outside against entry of foreign matter or against physical abuse.

The coil herein shown and described has a greater amount of the insulation mass separating the conductive portion of the several turns and an impervious covering of fabric reenforced insulation entirely surrounding the turns, it is extremely accurate as to size and shape, it is wound on and completed on the same winding spool without loss of material and without getting any appreciable quantity of the cementitious insulation on the winding spool itself, and no taping or tying operation is required in the process of making.

Believing that these advantages are both new and useful,

I claim,

1. An electrical coil comprising a single continuous mass of impervious cementitious insulation, reenforcing washers of non-metallic fabric imbedded in and secured to said coil by said mass at the ends, a coil of insulatedly spaced apart turns of conductive wire imbedded in the same mass between said reenforcing washers, and sleeving of non-metallic fabric, also imbedded in and secured by said mass, surrounding the turns of wire comprising the entire first layer and the turns of wire comprising the entire last layer of said coil, ends of said wire surrounded by ends of said sleeving extending from said mass.

2. The method of making an electrical coil comprising a plurality of insulatedly spaced apart turns of conductive wire with end washers of porous non-metallic fabric, all imbedded in a single continuous mass of impervious cementitious insulation, which consists of coating the wire and impregnating the washers with the insulation in liquid form, drying the insulation until it becomes a yielding fusible solid, winding a coil of the wire between the washers, heating the coil and washers until the insulation between the turns of the wire and in the pores of the washers fuses into a single continuous mass, and maintaining the heat until the insulation mass is converted into a single infusible body.

3. The method of making an electrical coil comprising a plurality of insulatedly spaced

apart turns of conductive wire with reenforcing end washers of porous non-metallic fabric, all imbedded in and solely supported by a single continuous mass of impervious cementitious insulation, which consists of coating the wire and impregnating the washers with the insulation in liquid form, drying the insulation until it becomes a yielding fusible solid, winding a coil of the wire between the washers, forcing the washers into more intimate contact with the coil by pressure, heating the coil and washers while the pressure between them is maintained until the insulation between the turns of the wire and in the pores of the washers fuses into a single continuous mass, and maintaining the pressure and heat until the insulation mass is converted into a single infusible body.

4. The method of making an electrical coil comprising a plurality of insulatedly spaced apart turns of conductive wire with reenforcing end washers of porous non-metallic fabric and with the inner and outer layer of the coil covered with non-metallic fabric sleeving, all imbedded in and solely supported by a single continuous mass of impervious cementitious insulation, which consists of coating the wire and impregnating the end washers and sleeving with the insulation in liquid form, drying the insulation until it becomes a yielding fusible solid, placing a length of sleeving over the end of the wire comprising the turns of the inner layer of the coil, winding the coil between two of the reenforcing end washers with the exception of the outer layer, placing a length of sleeving over the wire comprising the turns of the outer layer, winding the outer layer, forcing the washers and the sleeving into more intimate contact with the coil by pressure, heating the structure while the pressure is maintained until the insulation therein fuses into a single continuous mass, and maintaining the pressure and heat until the insulation mass is converted into a single infusible body.

5. The method of making an electrical coil comprising a plurality of insulatedly spaced apart turns of wire having a fibrous covering with reenforcing end washers of porous non-metallic fabric and with the inner and outer layer of the coil covered with non-metallic fabric sleeving, all imbedded in and solely supported by a single continuous mass of impervious cementitious insulation which consists of impregnating and coating the fibrous covering on the wire, the fabric end washers and the sleeving with the insulation while in a liquid state, drying the insulation until it becomes a yielding fusible solid, placing a length of sleeving over the end of the wire comprising the turns of the inner layer of the coil, winding the coil between two of the reenforcing end washers with the exception of the outer layer, turning the outer edges of the end washers toward each other over the coil, placing a length of sleeving over the wire comprising the turns of the outer layer, winding the outer layer over the inturned edges of the end washers, forcing the washers and the sleeving into more intimate contact with the coil by pressure, heating the structure while the pressure is maintained until the insulation therein fuses into a single continuous mass, and maintaining the pressure and heat until the insulation mass is converted into a single infusible body.

6. An electric coil comprising a plurality of insulatedly spaced apart convolutions of electrically conductive material wound in layers, porous non-conductive material in the spaces between said convolutions, coverings of porous non-conductive material compressed tightly to the inside, outside and ends of the coil, said inside and outside coverings being composed of porous sleeving surrounding the individual turns of the entire inside and outside layers of the coil, and a single smoothly compressed mass of hardened impervious insulating cement extending through and filling the pores of the non-conductive material between adjacent convolutions and extending through and containing the non-conductive coverings.

In testimony whereof I affix my signature.

VINCENT G. APPLE.