Aug. 24, 1937. E. H. BRANSON 2,091,234

INSULATED ELECTROMAGNET AND METHOD OF MAKING THE SAME

Filed Jan. 15, 1935

FIG. 1.

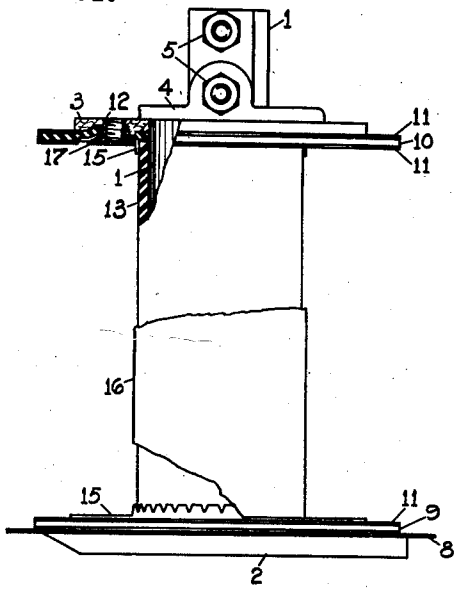


FIG. 3.

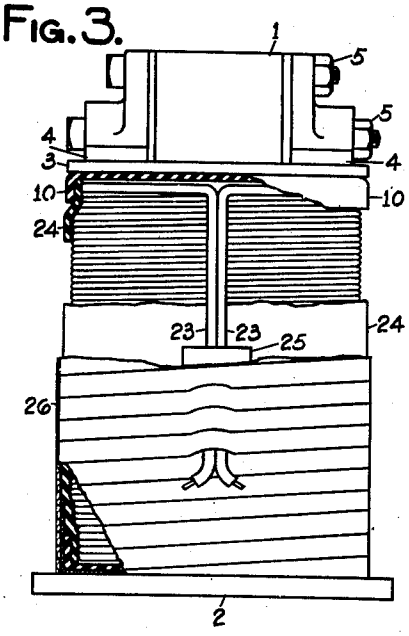


FIG. 4.

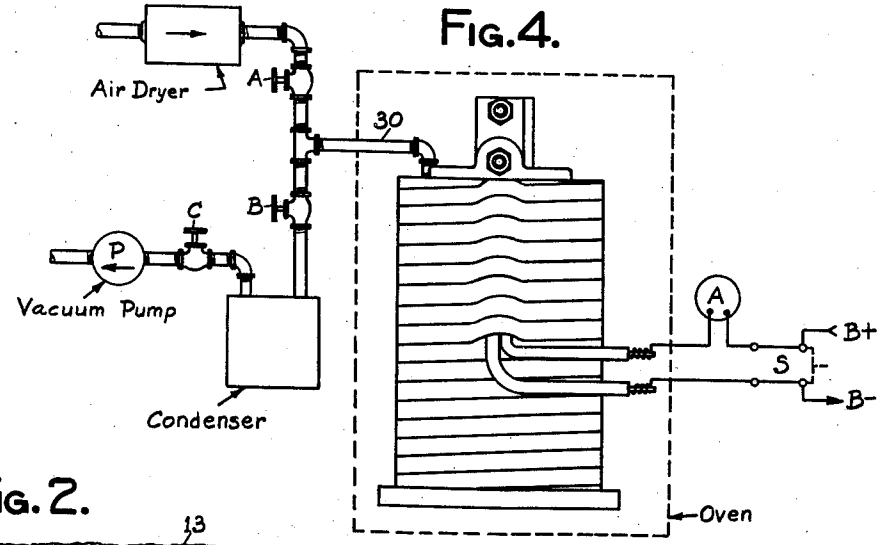


FIG. 2.

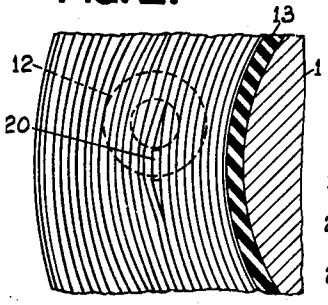
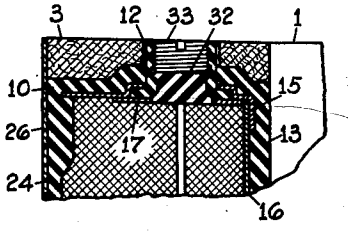


FIG. 5.



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INSULATED ELECTROMAGNET AND METHOD OF MAKING THE SAME

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Application January 15, 1935, Serial No. 1,924

8 Claims. (Cl. 175—21)

This invention relates to electro-magnets and the method and apparatus for making the same, and more particularly relates to the insulation and protection of the windings of electro-magnets.

In railway train control apparatus and the like, certain coils, such as the car-carried train control receiver coils, are subjected to severe shocks and vibrations and are exposed to moisture, acid, and other deteriorating foreign substances. It has consequently been found expedient to completely enclose such coils by a covering of resilient material, such as vulcanized rubber, which covering is in turn protected by a suitable coating which is resistant to acids and other deteriorating foreign substances.

It has been found however that the ordinary methods of vulcanizing the covering after being applied around such coils causes the rubber to blister and often forces the rubber out at the ends of the coils underneath the outer protecting layer of material, and during vulcanization of the enclosure for the coils, considerable solvent vapors and moisture develop which are trapped within the windings and later cause short-circuits and deterioration to the winding insulation. It has also been found that the covering around the coils is not uniformly vulcanized by the ordinary methods as considerable time is necessary for the heat to penetrate to the inner or core covering of the coils, which results in the outer covering being more thoroughly vulcanized than the inner.

In view of the above and other considerations, it is proposed in accordance with the present invention to provide an electro-magnet as well as the apparatus for and method of making the same which is substantially free from moisture, solvent vapors and other deteriorating substances, and which is also protected against subsequent entrance of such substances therein. It is further proposed to provide such apparatus for and method of vulcanizing the covering of electro-magnets whereby the resulting covering is uniformly vulcanized around both the inner and outer surfaces, and wherein the covering material is of uniform density and thickness as well as free from air pockets and blisters.

Other objects, purposes and characteristic features of the invention will appear as the description thereof progresses, during which, references will be made to the accompanying drawing which shows the invention in a manner to make it easily understood rather than with the view to showing the particular construction preferably employed in practice, and in which:—

Fig. 1 is an elevational view of a core with insulation applied thereto preparatory to the winding of the coil thereon with parts of such insulation broken away to more clearly show the arrangement thereof.

Fig. 2 is an enlarged sectional view showing a portion of a coil upon the core of Fig. 1.

Fig. 3 is an elevational view of the completely covered electro-magnet preparatory to vulcanization, with various parts thereof broken away to illustrate the arrangement thereof.

Fig. 4 is a diagrammatic and conventional view illustrating the apparatus employed in vulcanizing the covering around the coil of Fig. 3 in accordance with the present invention.

Fig. 5 is an enlarged sectional view of a portion of a completed electro-magnet constructed in accordance with the present invention.

Referring now to the drawing, a magnetic core 1 is shown with a pole piece 2 attached thereto, such as by welding, or of course these parts may be integral. This core 1 may be of various other shapes and of solid or laminated construction according to the requirement, and the top portion may be adapted to retain a suitable member for holding a coil upon the body of the core 1. The coil retaining means in the particular core construction chosen for the present disclosure includes an end washer 3 of suitable rigid insulating material, which in assembly, fits over the end of the body of core 1 and is retained by suitable brackets 4 clamped to the opposite sides of a reduced end of core 1 by bolts 5.

Before assembling the washers 3 and brackets 4 upon the core 1 however, the core 1, pole piece 2 and washer 3 are all sand blasted and thoroughly cleaned with benzine, or the like, after which the body surface of the core 1, inner surface of washer 3 and the inner surface of pole piece 2 are all coated with two coats of rubber priming cement, such as the type sold under the trade name of "Vulculock," which is followed by two coats of suitable rubber cement, with a drying time of approximately 15 minutes allowed between each of such coats.

A large bakelite-varnish impregnated cloth ring 8 is now placed over the core and pressed down tightly against the inner surface of the pole piece 2, as shown, and a smaller washer 9 of uncured rubber having an outside diameter slightly larger than the completed coil and an inside diameter approximately equal to the di-

ameter of core 1, is placed over the core 1 and pressed down and cemented tightly on the washer 8. The inside diameter of the ring 8 is sufficiently greater than the inside diameter of the washer 9 to allow an inner circular portion of washer 9 which is within the hole in ring 8 to cement to the pole piece 2. A second washer 10 of uncured rubber similar to the washer 9 is now pressed down and cemented tightly on the end washer 3, and the washer 3 together with washer 10 is now placed on the end of core 1 and the brackets 4 are assembled as shown in Fig. 1.

A sheet of uncured rubber 13 is now wrapped around the body of core 1, which sheet of rubber 13 is to be wide enough to abut the rubber washers 9 and 10 and long enough so that its ends slightly overlap. In wrapping the rubber sheet 13, the surface should be kept clean and should be carefully ironed in place with suitable tools to eliminate all air pockets and to fit tightly against the end washers 9 and 10. Strips of uncured rubber (not shown) may be applied around each end of the sheet 13 in a manner to re-enforce the joints between this sheet 13 and the rubber washers 9 and 10.

In order to protect the outer portion of the rubber washers 9 and 10 from dirt while winding the coil, narrow rings 11 of thin material such as linen are applied to each surface of the outer portions of these washers 9 and 10. Two varnished cambric washers 15 having inwardly extending flanges around their inside circumferences are placed over the core and pressed tightly against the inner surface of the rubber washers 9 and 10 respectively. In as much as it has been found expedient to assemble these washers 15 after the rubber washers 9 and 10 have been sealed to the core covering 13, it is necessary to cut one side of the washers 15 thereby allowing their installation by twisting in a manner to open this cut sufficiently to slide over the body of core 1.

A hole through a mid-portion of the end washer 3 is slightly counter-bored, and a hole of the same size in register therewith is cut through both the rubber washer 10 and washer 15 to receive a flanged bushing 12 constructed of insulated material. The outer surface of the bushing 12 is first thoroughly coated with both priming and rubber cement and a small varnished cambric washer 17 is cemented to the flanged end of bushing 12, after which the smaller end of bushing 12 is placed through the holes in washers 15, 10 and 3 so that its inner flange presses the surrounding portion of washers 10 and 15 into the counter-bored portion of washer 3 is shown in Fig. 1.

A sheet of varnish impregnated cloth 16 is now wrapped around the body of the core 1 over the rubber sleeve 13 so that its edges overlap the inner flanges of washers 15. The ends of the cloth 16 should overlap slightly and these overlapping end portions are cemented and temporarily bound with a few turns of tape until the coil is wound thereover.

In winding the coil a suitable machine of any well known type may be used and of course the size of wire and number of turns are to be chosen in accordance with the requirements of the particular application. The insulation on the wire used in the present coil should be impregnated with insulating varnish before winding. During the winding of the coil, vents or air passages are formed for conducting vapors from within the coil to the outlet provided by the bushing 12. These passages may be conveniently formed by inserting fibre strips 20 in intermediate portions of the coil during winding thereof, the strips 20 extending the full length of the coil and separating the layers of the winding in a manner to form voids or passages adjacent each edge thereof. One of the strips 20 is located as shown in Fig. 2 so that the void in the winding formed at an edge thereof aligns with the hole in the bushing 12 (represented by the dotted circles), and another strip 20 (not shown) may be similarly located in the windings at a position diametrically opposite.

In winding the outer layers of wire, an annular recess, or that is, a space having a lesser outside diameter than the center of the completed winding, is left at each end adjacent the washers 9 and 10 for a purpose which will later be obvious. The method of bringing out the coil ends or leads is not herein shown in detail, but it has been found expedient to cover the beginning of the coil or the first turn with varnished cambric tubing, and in bringing this lead to the outer surface, a radial slot (not shown) may be provided in the end washer 3 into which is pressed the rubber washer 10 to allow this bottom lead to be brought to the outer surface of the coil through this slot in order to prevent it from interfering with the other turns of the coil. The outer end is preferably terminated diametrically opposite the inner end, and flexible rubber covered lead wires 23 may be soldered to these coil ends, which lead wires 23 are brought around the outer top surface of the coil to a common point as shown in Fig. 3.

The lead wires 23 are cleaned thoroughly and wrapped with rubber tape, after which these leads 23 and the entire outer surface of the coil are coated with rubber priming cement and allowed to dry. A sheet of uncured rubber 24 similar to that applied to the core 1 is now tightly wrapped around the entire outer surface of the coil, beneath the extending portion of leads 23 as shown. The ends of the sheet 24 should overlap to form a tight joint, and should be carefully ironed down with suitable tools, making sure that all air pockets are removed. In ironing down the sheet 24, the edges are rolled down into the peripheral recesses left at the ends of the winding.

The linen protecting rings 11 are now removed from the rubber washers 9 and 10, and the extending portions of these washers are thoroughly cleaned and then folded inwardly over the portion of the rubber covering 24 which enters the peripheral recesses and ironed down tightly in order to knit thoroughly thereto, thus making the outer surface of the coil of substantially uniform diameter throughout, as shown in Fig. 3.

The leads 23 are now placed part-way down the sides of the coil covering 24, as shown, and rolls of uncured rubber are placed tightly around the sides of the leads 23, and the point at which the leads leave the coil is also carefully sealed and re-enforced by pieces of uncured rubber. A small square of uncured rubber 25 is placed over the leads 23 and rolled down tightly to the coil covering 24.

The entire outer surface of the coil may now be temporarily covered with water-soaked cotton tape (not shown) wound tightly thereon while wet and tied. The coil is then allowed to stand overnight, during which time the wet tape dries to apply pressure to the rubber cov-

ering with the result that the rubber covering is compressed evenly and to a predetermined dimension.

When the cotton tape has thus dried, it is removed from the coil and the extending portions of washer 8 are notched and folded inwardly over the rubber coil covering. The outer surface of the coil covering is now coated with a suitable rubber cement followed by a covering of rubberized tape 26 wound tightly over the rubber coil covering. In order to more thoroughly compress the coil covering, water-soaked cotton tape may again be temporarily applied in the same manner as before but over the rubberized tape 26, and the vulcanizing of the rubber covering should be started while this cotton tape is still wet in order to permit the shrinkage of the tape to compress the rubber covering against the windings during vulcanization.

The apparatus required for vulcanizing the rubber covering of the coil in accordance with the present invention includes an oven diagrammatically represented by the dotted rectangle enclosing the coil in Fig. 4, which oven should be thermostatically regulated and capable of maintaining a temperature of 275° Fahrenheit, with provisions included therein for conducting electrical energy from an external source into the interior thereof, and also with an external conduit 30 arranged for conveniently connecting to the threaded hole in the bushing 12 of the coil being vulcanized. Of course in practice an oven will be provided which will accommodate several coils at one time, and consequently a manifold within the oven will be provided and connected suitably to the conduit 30.

A vacuum pump P is also required and is connected to the conduit 30 through a suitable condenser as shown. The outlet 30 is arranged to be connected either to the vacuum pump P and condenser or to an air drier by valves A and B, which air drier may be of the calcium chloride type. The interior of the oven used in vulcanizing the present coils should be heated to a temperature of 275° Fahrenheit prior to placing the coils therein, and while the coils are being placed therein, the temperature should not drop below 200° Fahrenheit.

In arranging the coils in the oven, the leads 23 are connected such as by a suitable receptacle or plug connecting means to the external electrical circuit including an ammeter A and a switch S, whereby current of a predetermined value may pass through the windings of the coil from an energy source, conventionally indicated by the symbols B+ and B—. The conduit 30 within the oven is also connected to the threaded bushing 12, and it is necessary to make all of these connections as quickly as possible so that the temperature within the oven does not fall below 200°, otherwise the time required to again raise the temperature to 275° will be greatly increased.

When the coil is thus arranged in the oven, current is passed through the windings of a value which is found to heat the coil throughout in a period of one hour to a temperature of 275° Fahrenheit. The value of this current must of course be predetermined in accordance with the total resistance and the size of wire used in the coil.

With this current flowing in the windings of the coil, the valve A is closed, valve B is opened and a third valve C is opened sufficiently to allow the vacuum pump P to maintain a vacuum corresponding to an absolute pressure of about 380 millimeters of mercury in the interior of the coil, while the temperature of the coil is being raised to 275°. This condition is maintained for approximately one hour, after which time the electrical energy is removed from the windings of the coil by opening the switch S, and the valve C is fully opened to raise the vacuum within the coil to the maximum obtainable by the pump P.

The temperature within the oven is still maintained at 275° for a second period of 2½ hours with the electrical energy removed from the windings of the coil and under the maximum vacuum, after which time the oven heat is shut off and the valves B and C closed and valve A opened slowly to break the vacuum within the coil with dry air from the air drier. The oven door may now be opened and with the valve A still opened the coil is allowed to cool to room temperature.

When the coil has thus cooled to room temperature, the conduit 30 is disconnected from the bushing 12 and the electrical connections removed from the leads 23. The threaded opening in the bushing 12 must now be closed immediately, and if it is not found to be practical to permanently close this opening immediately, a temporary plug may be inserted. The method of permanently closing the opening in the bushing 12 is shown in the enlarged sectional view in Fig. 5, and consists in first thoroughly coating the entire inner surface of the threaded hole with one coat of rubber priming cement followed by one coat of suitable rubber cement, with a drying time of approximately 10 minutes left between these applications, after which, a disc of uncured rubber 32 is pressed into the hole in the bushing 12 and further forced down and retained by a threaded fibre plug 33. The temporary covering of cotton tape is now removed and the coil covering is finally completed by the application of two coats of suitable acid-proofing paint to the entire outer surface.

It will now be seen that the process thus outlined provides a method of completely enclosing a coil by a covering of uncured rubber with the exception of a small vent communicating with all parts of the interior of the coil by air passages formed during the winding thereof, thereby permitting moisture and solvent vapors to escape from the interior of the coil during vulcanization. The present invention also provides a novel arrangement of apparatus whereby vulcanization of the coil covering is greatly expedited by heating from within the coil by passing electrical current through its windings, and whereby the removal of all moisture is insured by evacuating the interior of the coil during vulcanization, and finally the pressure within the coil covering is raised to atmospheric by incoming air taken through an air drier.

The coil thus vulcanized is then completely sealed against the entrance of moisture or air by tightly and permanently plugging the vent so that the completed coil may then be maintained indefinitely in its moisture-free condition. The method and apparatus used in vulcanizing the covering of the present coil have the further advantage of creating a difference in air pressure between the outside and the inside of the coil covering which results in a denser and more uniform covering of rubber. In other words, the vacuum within the coil results in a compressive effect of the normal air pressure on the outer

surfaces, and of course, the possibilities of blistering of the coil covering due to the building up of pressure within the coil is entirely eliminated by the vacuum employed in the present process.

The above rather specific description of one form of the present invention is given solely by the way of example, and is not intended, in any manner whatsoever, in a limiting sense. It is also to be understood that various modifications, adaptations, and alterations may be applied to meet the requirements of practice, without in any manner, departing from the spirit or scope of the present invention, except as limited by the appended claims.

What I claim is:—

1. A method of making electro-magnets, comprising, applying an inner sleeve of uncured rubber to an iron core, applying end washers of uncured rubber to the inner sleeve, providing a vent in one of the end washers, winding a coil on the rubber spool thus formed leaving a longitudinal void in the coil aligning with the vent in the end washer, applying an outer sleeve of uncured rubber around the coil, folding the edges of the rubber washers over onto the outer sleeve, submitting the coil thus formed to a temperature of 275° Fahrenheit for 2½ hours or more to vulcanize the rubber parts into a unitary covering, and permanently sealing the vent in the end washer.

2. A method of making electro-magnets, comprising, applying an inner sleeve of uncured rubber to an iron core, applying end washers of uncured rubber to the inner sleeve, providing a vent in one of the end washers, winding a coil on the rubber spool thus formed leaving a longitudinal void in the coil aligning with the vent in the end washer, applying an outer sleeve of uncured rubber around the coil, folding the edges of the rubber washers over onto the outer sleeve, passing electrical current through the coil for one hour or more of a value effective to raise the temperature of the coil to 275° Fahrenheit, submitting the coil thus formed to a temperature of 275° Fahrenheit for 2½ hours or more to vulcanize the rubber parts into a unitary covering, and permanently sealing the vent in the end washer.

3. A method of making electro-magnets, comprising, forming a spool of uncured rubber, providing a vent in the spool, winding a coil on the spool, providing a longitudinal passage in the coil communicating with the vent, covering the outer surface of the coil with uncured rubber so as to unite with the edges of the spool, connecting the vent in the spool to an evacuating means, submitting the coil still connected to the evacuating means to a temperature of 275° Fahrenheit for 2½ hours or more, then breaking the vacuum within the coil by permitting the entrance of dry air, and sealing the vent in the spool.

4. A method of making electro-magnets, comprising, forming a spool of uncured rubber, providing a vent in the spool, winding a coil on the spool, providing a longitudinal passage in the coil communicating with the vent, covering the outer surface of the coil with uncured rubber so as to unite with the edges of the spool, connecting the vent in the spool to an evacuating means, passing a value of electrical current through the coil which raises the temperature throughout the interior thereof to approximately 275° Fahrenheit, then removing the electrical current and submitting the coil still connected to the evacuating means to a temperature of 275° Fahrenheit for 2½ hours or more, then breaking the vacuum within the coil by permitting the entrance of dry air, and sealing the vent in the spool.

5. A method of making an electro-magnet comprising, forming a spool of uncured rubber around an iron core, providing an outlet means in the spool communicating with the interior thereof, winding a coil on the spool, providing a passage extending longitudinally through the interior of the coil and communicating with the outlet means, applying a sleeve of uncured rubber to the spool in a manner to completely enclose the coil except for the outlet means, placing the coil thus covered in an oven previously heated to approximately 275° Fahrenheit, passing electrical current through the coil for one hour of a value which raises the temperature throughout the interior thereof to approximately 275° Fahrenheit, then disconnecting the electrical current and allowing the coil to remain in the oven at 275° Fahrenheit for approximately 2½ hours, and permanently sealing the outlet means when the coil has cooled.

6. A method of making an electro-magnet comprising, forming a spool of uncured rubber around an iron core, providing an outlet means in the spool, winding a coil on the spool, providing transverse voids in the interior of the windings of the coil communicating with the outlet means, applying a sleeve of uncured rubber around the outer surface of the coil, folding the outer edges of the rubber spool over onto the rubber sleeve in a manner to completely enclose the coil except for the outlet means, placing the coil thus covered in an oven previously heated to approximately 275° Fahrenheit, connecting a vacuum pump to the outlet means and effecting a vacuum of approximately 15 inches within the coil covering, passing current through the windings of the coil for one hour with the oven temperature at 275° Fahrenheit and with the vacuum of 15 inches maintained, the current being of a value effective to produce a temperature of 275° Fahrenheit throughout the interior of the coil within the one hour period, then interrupting the electrical current in the coil and increasing the vacuum therein to the maximum obtainable for a period of 2½ hours or more with the oven temperature maintained at about 275° Fahrenheit, then closing the connection from the vacuum pump to the coil outlet means and permitting only air passing through a drying means to enter the coil through the outlet means, and closing the outlet means against the further entrance of air or other substances.

7. The process of making a moisture-free enclosed coil, consisting in forming a spool of uncured rubber, winding a coil on the spool, covering the spool with uncured rubber so as to completely enclose the coil with the exception of a small vent, heating the coil thus formed in a manner to vulcanize all the rubber into a unitary covering, and completing the coil enclosure by sealing the vent.

8. The process of making a moisture-free enclosed coil, consisting in forming a spool of uncured rubber, winding a coil on the spool, covering the spool with uncured rubber so as to completely enclose the coil with the exception of a small vent, evacuating the interior of the coil thus covered through the vent, heating the coil while evacuated in a manner to vulcanize all the rubber into a unitary covering, and completing the coil enclosure by sealing the vent.

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