No. 830,419. PATENTED SEPT. 4, 1906.

L. W. DOWNES.

FIELD COIL INSULATION AND PROCESS OF FORMING SAME.

APPLICATION FILED OCT. 22, 1904.

3 SHEETS—SHEET 1.

Fig. 1.

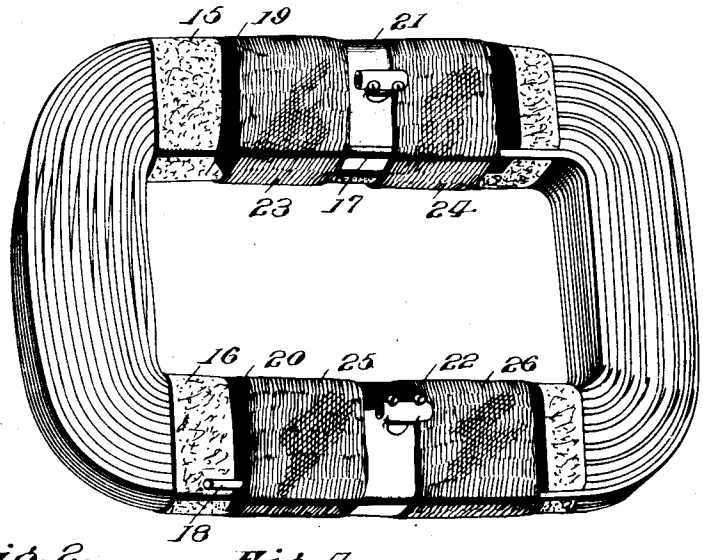


Fig. 2.

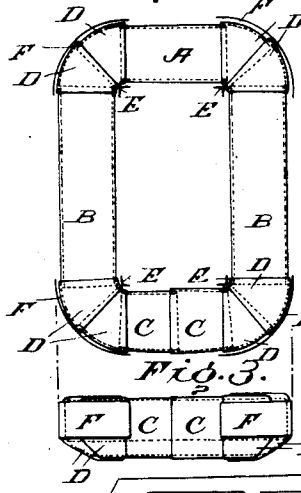


Fig. 4.

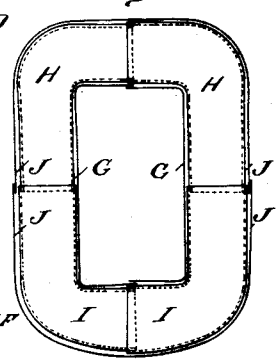
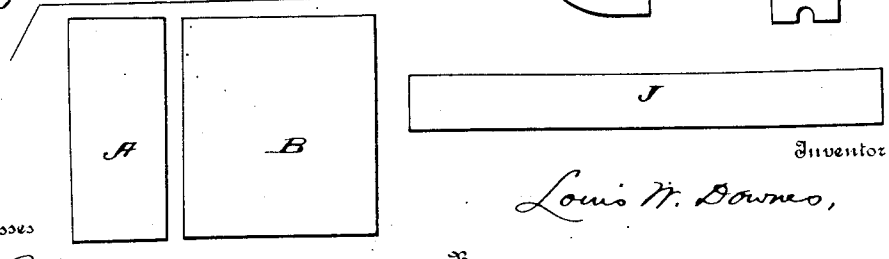


Fig. 3.

Fig. 5.



Witnesses

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3 SHEETS—SHEET 2.

Fig. 6.

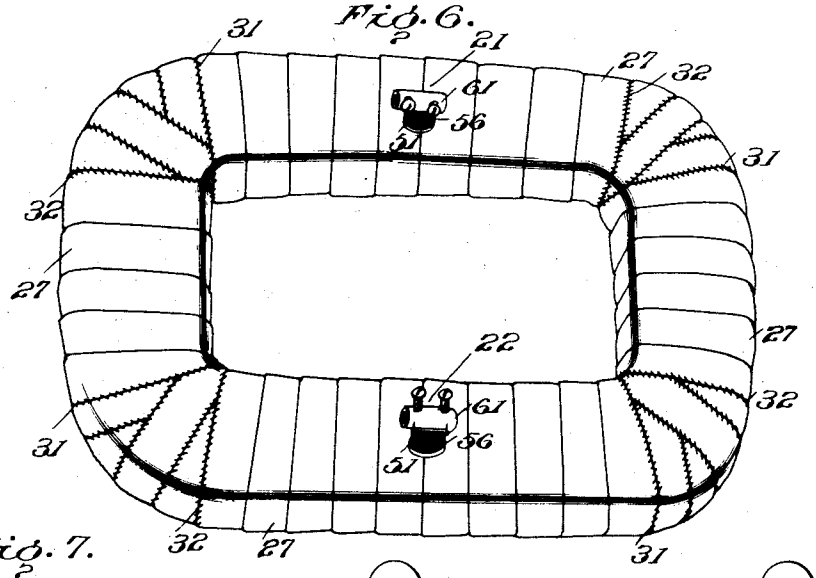


Fig. 7.

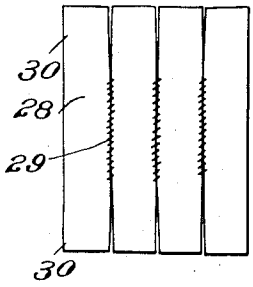


Fig. 8.

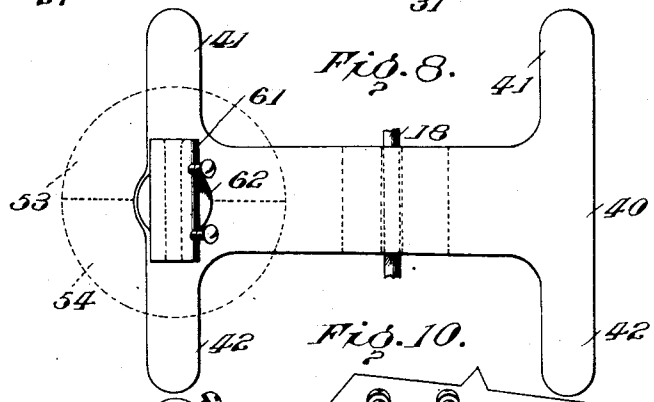


Fig. 10.

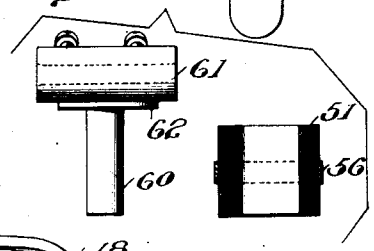


Fig. 11.

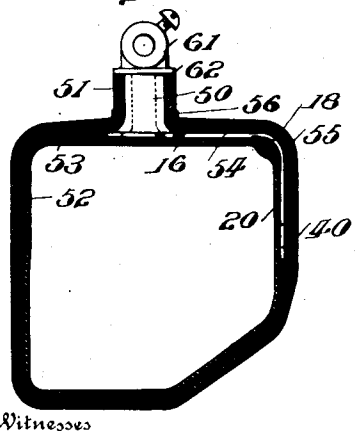
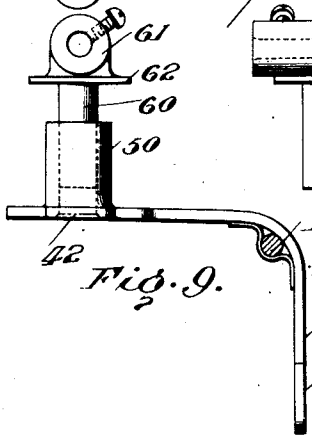


Fig. 9.



Witnesses

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3 SHEETS—SHEET 3.

Fig. 12.

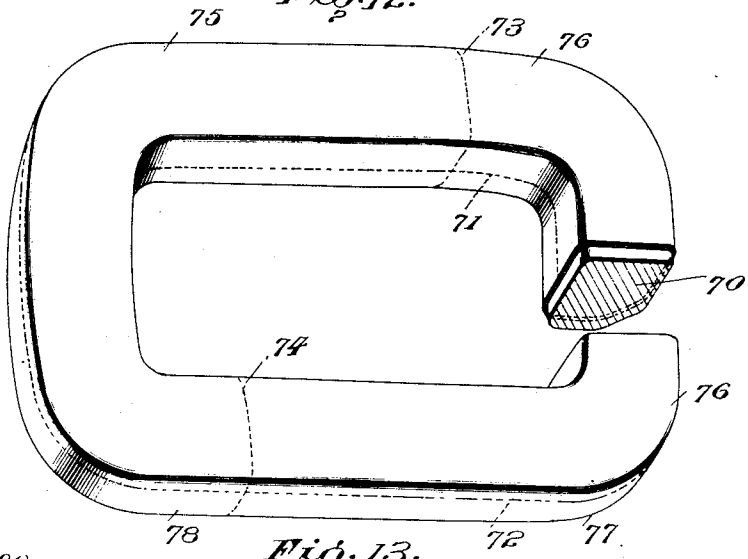


Fig. 13.

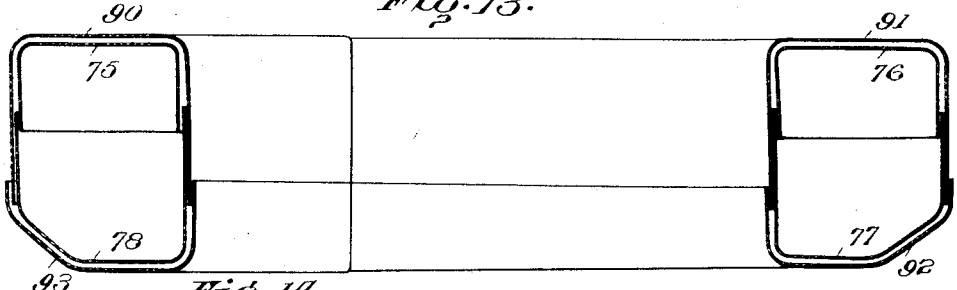
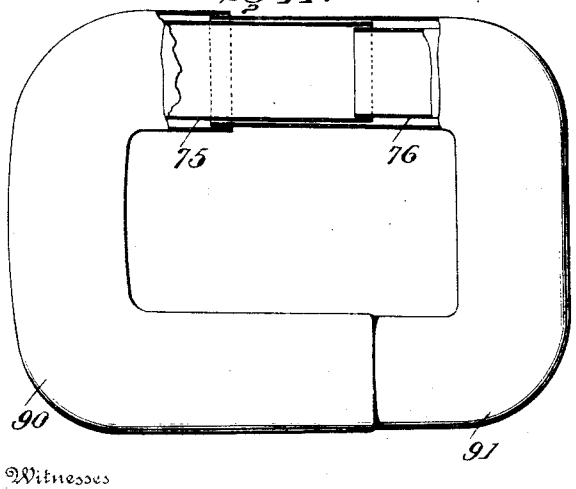


Fig. 14.



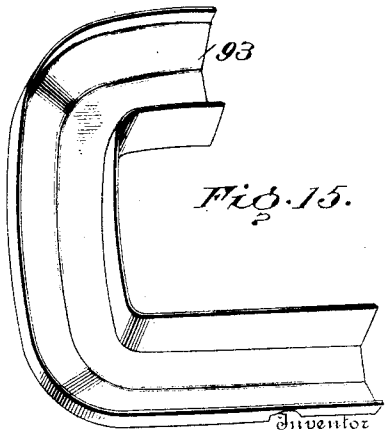


Fig. 15.

Witnesses

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UNITED STATES PATENT OFFICE.

LOUIS W. DOWNES, OF PROVIDENCE, RHODE ISLAND.

FIELD-COIL INSULATION AND PROCESS OF FORMING SAME.

No. 830,419. Specification of Letters Patent. Patented Sept. 4, 1906.

Application filed October 22, 1904. Serial No. 229,626.

To all whom it may concern:

Be it known that I, LOUIS W. DOWNES, a resident of Providence, Rhode Island, have invented a new and useful Improvement in Field-Coil Insulation and Processes of Forming the Same, which invention is fully set forth in the following specification.

This invention relates to the construction of electromagnetic coils for electric motors and dynamos, and particularly to the insulation thereof and the process of forming said insulation.

One of the most important desiderata in the use of any magnet-wire is to prevent contact of the convolutions with water or moisture. Railway field-coils, it is well known, are frequently subjected to partial immersion in water for quite lengthy periods, this undesirable condition being greatly aggravated by the frequent presence in the water of large percentages of salt or brine. As the water is quickly heated by the heat developed in the motor it results that the coil is sometimes subjected for many hours to the destructive action of a hot briny solution, one of the worst conditions that could be brought about. It will be readily appreciated that no matter how great the heat-resisting properties of the wire trouble will occur, due to the gradual carbonization of the materials ordinarily used in constructing the insulating wrapping or covering of the coils. This outer covering gradually hardens and becomes crisp and brittle by the action of the heat developed in the coil. Being at the same time subjected to severe vibrations and jars, cracks ultimately develop and admit water to contact with the convolutons, causing the coil to quickly break down.

My principal object is to prolong the life of electromagnetic coils, particularly field-coils used on electric cars or in other locations where they are of necessity exposed at times to water or moisture by the production of an insulation which will withstand unusual temperatures and not be readily affected by water or moisture. Practical use and extensive experiments have demonstrated that coverings of fabric made of cotton and similar vegetable fibers are not sufficiently heat-resistant and are quickly destroyed under the conditions referred to. The high heat-resisting properties of asbestos are very favorable to its use for the purpose. On the other hand, its hygroscopic properties are unfavorable. I propose, however, to employ as the principal part of my improved insulation asbestos so treated as to render it water-repellent. Extensive experiments have demonstrated that no varnish, oil, japan, or other water-proofing compound containing a vegetable or oxidizable oil can be used as to that portion of the insulation next to the convolutions of the coil, for the reason that such materials or oils readily decompose, producing active acids which invariably break down the insulation resistance by the formation of copper salts. So far as I am aware the only materials that can be safely used for waterproofing that portion of the asbestos covering which is directly over the convolutions of wire are those made from the paraffin compounds. There are a number of such compositions of excellent quality on the market under various trade names; but as drying oils and compositions having a drying-oil base, such as japans, possess very desirable properties and considerable resistance to heat when dry I find it very advantageous to use such water-proofing materials at an outer portion of the insulating-covering where they are effectively isolated from all possibility of contact with the copper. When so used, the drying oil or composition thereof prevents the paraffin compound within from escaping when melted by the heat of the coil and also prevents the admission of water or moisture from without. In the preferred form, therefore, my improved insulation comprises a first covering of asbestos applied over the convolutions of the coil and then saturated or impregnated with a non-oxidizable substance, preferably of the paraffin variety, and a second covering, preferably of asbestos, to which latter is applied a waterproofing composition capable of withstanding high temperature, such as a drying-oil or composition thereof. The insulating-casing and the completed coil also possess other important characteristics, and the invention also embraces improvements in the process of forming and applying the insulation, all of which will be fully understood by reference to the accompanying drawings, wherein the invention is illustrated with reference to a field-coil.

Figure 1 shows a coil of wire suitable for a field-coil with the terminals secured in place. Figs. 2 and 3 illustrate the preferred manner of applying a layer of asbestos formed of pieces of asbestos paper over the coil. Fig.

4 illustrates the preferred way of applying another layer of asbestos over the first layer. Fig. 5 illustrates the shape of the various pieces of asbestos paper employed in forming the coverings of Figs. 2, 3, and 4. Fig. 6 shows the coil after the outer winding of asbestos braid has been applied thereto. Fig. 7 shows pieces of asbestos braid sewed together so as to be suitable for use in covering of the corners of the coil. Fig. 8 is a plan view, and Fig. 9 a side view, of an improved form of terminal, and Fig. 10 comprises detail views of parts of the terminal. Fig. 11 is a transverse sectional view through the insulating-covering, showing the arrangement of the parts of the terminal with relation to said insulation. Fig. 12 is a perspective view of a form, partly broken away to show a covering applied thereto. Fig. 13 is a sectional view, and Fig. 14 a plan, partly in section, showing how the tray-like parts of the insulation fit together; and Fig. 15 is a perspective view of one of the tray-like parts.

In referring herein to the employment of "asbestos paper," I intend to embrace asbestos in any suitable sheet form, though I prefer to employ, on account of its cheapness and adaptibility to the purposes of this invention, what is commercially known as "asbestos paper." I may also employ an asbestos composition in plastic form, the same being spread out upon the coil or a form and allowed to set. In practice I have obtained the best results by employing in forming the coil wire insulated with asbestos in accordance with the inventions of my Patents No. 534,785, of February 26, 1895, and No. 709,001, of September 16, 1902, and commercially known as "deltabeston" wire.

The process of insulating a coil as illustrated in Figs. 1 to 11 is as follows: Wrappings of asbestos paper 15 and 16 are applied to opposite sides of the wire-coil beneath the bare ends 17 and 18 of the wire. Thin sheets of micanite 19 and 20 are applied over the wrappings of asbestos 15 and 16. The terminals 21 and 22 (of a preferred construction hereinafter described) are then applied over the micanite sheets, and the bare ends 17 and 18 of the wire are soldered to the terminals in the usual way. Wrappings of stout asbestos twine 23, 24, 25, and 26, extending over the wire ends 17 and 18, are next applied to securely bind the terminals to the coil. The coil is now ready for the formation thereabout of the first jacket, made up of pieces of asbestos paper, the latter being preferably dampened with a thin solution of flour paste or any good wall-paper paste, the dampening being sufficient to enable the paper to be readily shaped to the form of the coil. Care should be taken that the solution is not so strong as to glaze over the paper, and thereby prevent the latter from becoming saturated with the water-repellent compound applied later. To facilitate the application of the asbestos paper, we have found it expedient to cut it into various shapes, enabling it to be readily formed to the irregular surface and curved corners of the coil, the pieces being so disposed as to frequently break joints, thereby preventing openings or imperfections in the shell at points where the pieces of paper meet. In Fig. 5 I have illustrated pieces of asbestos paper cut to a form suitable for use in connection with a standard General Electric No. 52 motor field-coil. These pieces can be properly marked or identified, so that the workman will know exactly what piece is to be used in each position. As herein described, the first jacket is composed of four superposed layers of asbestos paper. A greater or less number of layers may be used. In fitting the different pieces to the coil I prefer to apply to the paper with a suitable brush an abundance of paste, preferably of an approximate density of five degrees as measured on an ammonia hydrometer. I preferably employ paper about one one-hundredth of an inch thick, and it is expedient to lay the paper flat on a board or in a shallow pan in applying the paste, so that the latter will thoroughly impregnate and wet the paper. In this condition the paper may be readily applied without the formation of creases. Referring to Fig. 2, the first layer of asbestos paper may be applied by wrapping the piece A about the end of the coil after being thoroughly saturated with the liquid paste, care being taken to stretch the paper tightly about the coil. Then pieces B B and C C are wrapped about the coil in the positions indicated, the lap of the two pieces C C being carefully pressed down to give a perfectly-tight joint. The four sides of the coil now being covered the corner-pieces D (sixteen in all, eight on the upper side of the coil and eight on the lower side thereof) are now applied and tightly pressed down by hand. Pieces D are slightly lapped at their edges, as clearly illustrated. The four inside end pieces E and the four outside end pieces F are now placed in position and tightly pressed down by hand. This completes the first layer, the pieces composing the same overlapping each other at the joints. While the first layer is still damp with the paste applied thereto in building it up from the different pieces of paper, I proceed to apply the second layer. (Illustrated in Fig. 4.) The two pieces G, Fig. 5, are first laid along the inside of the coil. The pieces H H (four in all) and the pieces I I (four in all) are next applied to opposite sides of the coil. Finally the two pieces J J are applied about the perimeter of the coil, care having been taken to press all of the pieces down by hand, so that they closely conform to the shape of the coil, and to lap the joints, so as to form a second continuous layer of asbestos paper. A third layer, simi-

lar to that of Fig. 2, and a fourth layer, similar to that of Fig. 4, are now preferably applied, the result being a jacket of four thicknesses of asbestos paper completely incasing the wire-coil and closely conforming to the shape thereof. In applying the pieces of asbestos paper openings or notches may be cut therein to closely fit about the stems of the projecting terminals. The coil is next thoroughly dried out, the drying being preferably slowly effected in air, so that the moisture from the inside may have ample opportunity to escape. After standing over night the coil will have the appearance of being quite dry; but I have discovered that it will still contain considerable moisture. To completely remove all moisture, it is desirable to place the coil in an oven and leave it there for a sufficient time—say for a period of two or three hours—to raise the temperature of the whole mass to about 300° Fahrenheit. Upon removing the coil from the oven and while it is still hot it is completely immersed in a paraffin insulating composition of the kind now generally used for this purpose and allowed to remain therein until the coil is thoroughly cooled. It is desirable to keep this paraffin composition fairly thin by the addition of naphtha from time to time, as the heat of the coil tends to volatilize the naphtha which is used as a solvent for the paraffin composition. When no bubbles appear at the surface of the paraffin composition and after the coil has become quite cool, the latter is removed from the bath and allowed to dry out. It will readily dry in a few hours. The process up to this point results in a coil completely and tightly incased in a covering or jacket 52, of asbestos paper rendered waterproof by impregnation with a non-oxidizable waterproofing material—a paraffin composition. A second jacket 55 is now applied over the first jacket, the same being composed principally of four layers of asbestos paper built up in the same manner as the layers of the first jacket. After being allowed to air-dry these layers will be ready to receive an outer wrapping, preferably of asbestos tape 27, Fig. 6, of a thickness of about three one-hundredths of an inch, which may be said to form part of the outer jacket. This asbestos tape can be procured on the market in suitable width, preferably about three-fourths of an inch. The coil should be tightly wrapped with a complete layer of asbestos tape, care being taken to wind the corners so as not to make them bulky. A preferred method of applying tape at the corners is illustrated in Figs. 6 and 7. Fig. 7 shows four pieces 28 of tape sewed together with asbestos twine 29, the sewing being of a length just sufficient to extend across the outer edge of the coil. In applying these pieces to the bend of the coil the loose ends 30 of the several pieces are caused to lap each other, as shown in Fig. 6, and are bound in place by the regular wrapping of the sides. After completing the wrapping the corner-pieces should be sewed to the side wrapping at the points 31 32, the result being an outer wrapping of tape strong, quite even, and free from bunches. The coil is now placed in an oven and rapidly raised to a temperature of about 300° Fahrenheit, which temperature is maintained for a period of one hour, and while still hot the coil is removed from the oven and immersed in a bath of good baking-japan or similar drying-oil composition or drying-oil alone, in which it is allowed to remain until the jacket 55 and its wrapping of tape are thoroughly saturated. Upon removal from the japan the coil is allowed to drain for an hour or two to remove excess of the composition and is then placed in a baking-oven and baked for a period of three or four hours until quite hard at a temperature of from 300° to 350° Fahrenheit. Upon removal from the oven and while still hot I preferably again place it in the japan-bath in order to complete the saturation, after which another draining and another baking at the temperature specified will complete the coil. It will be appreciated that the drying-oil composition or japan with which the outer jacket is impregnated is excluded from possible contact with the wire by the inner jacket.

It will be found that with very little experience coils can be insulated in the manner above described at comparatively low cost and that the insulation is practically indestructible by heat and moisture. Experience has demonstrated that field-coils so insulated may be kept in perfect condition by removal at the most, say, twice a year for a dipping in japan followed by baking.

One of the chief sources of trouble in the use of field-coils is due to the admission of water or moisture to the inside of the coil at the point where the terminals pass through the outer insulation, especially when one terminal is located at the bottom of the motor. To eliminate this source of trouble, I have designed an improved form of terminal having a water or moisture shield. Fig. 8 shows the terminal with the supporting-plate in the form which it assumes before being bent to conform to the coil. Figs. 9 and 11 show the plate 40, which is of pliable metal, bent to closely engage about a coil. Fig. 9 shows one end 18 of the wire of the coil soldered to plate 40 in the usual way. As shown in Fig. 11, the plate 40 bears against micanite-sheet 20, (heretofore mentioned,) being bound securely in place by asbestos wrappings 25 26 of Fig. 1, passing over extensions 41 42. A tubular socket 50 is cast on plate 40 and receives the stem 60 of a binding-post 61, having a flange 62, which prevents water from entering the socket. The inner end of the

stem is riveted in the socket, and together they constitute the shank of the binding-post. The socket is surrounded by a sleeve 51, of micanite or other insulating material, the lower end of which bears against the plate 40. After the first insulating-jacket 52 has been applied, so as to fit closely about the sleeve 51, a closely-fitting brass ring 56 is forced down about the sleeve to the position shown in Fig. 11. Two semicircular thin brass plates 53 and 54 (dotted lines in Fig. 8) are now placed over the first asbestos jacket about sleeve 51 and tightly soldered together and to the brass band or ring 56 along their inner semicircular edges, care being taken to force the brass shield tightly down upon the first jacket. The second jacket 55 is then applied over the brass shield, so as to fit closely about the parts of the terminal. Should water get past the outside jacket of the shield, the latter will deflect it onto the outer surface of the inner jacket away from the terminal, where it can do no damage.

Instead of forming the two jackets by building them up on the coil itself, they may be built up on forms and applied to the coil in sectional form. Such a method is illustrated in Figs. 12 to 15. Upon a form 70, Fig. 12, of appropriate dimensions, approximately those of the uncovered coil, I form a complete envelop or shell, preferably of a thickness of about four one-hundredths of an inch, by building up blanks of asbestos paper moistened with suitable paste in substantially the manner described with reference to Figs 2, 3, and 4. The lap-joints between the pieces of paper are preferably hammered down with welding effect, and thereby reduced to approximately the thickness of the jacket where there are no joints. After being allowed to dry thoroughly on the form the covering is detached by cutting around the outer and inner edges along the lines 71 and 72 and across the sides along lines 73 and 74, thereby separating the jacket into four trough-like sections 75, 76, 77, and 78, adapted to fit together about the wire and lap at their edges to form lap-joints. After scarfing the edges of the four trough-like sections down to a bevel, so that when lapped they will not give objectionable thickness, I dampen the sections and place them together over the coil in the manner shown in Fig. 13. Openings for the terminals are of course cut through the sections at appropriate positions. The overlapping edges of the sections are cemented together with a paste, such as before mentioned, and the shell allowed to thoroughly dry. The coil is then immersed in a non-oxidizable waterproofing composition, such as paraffin composition, with which the shell becomes thoroughly saturated. After removal and drying of the coil the exterior surface may be coated with one or more applications of the same waterproofing composition spread on with a brush. After a thorough drying the coil covered with its first asbestos insulating-jacket is ready to receive its second asbestos jacket. Four trough-like sections 90, 91, 92, and 93, constituting the second jacket, are constructed in substantially the same manner as the sections of the first jacket, except that the form used is slightly larger than that used for the first jacket, and the four sections are divided along different lines, so that the outer jacket will break joints with the inner jacket, as shown in Figs. 13 and 14. After the moisture in the second jacket has been allowed to thoroughly dry out the coil is immersed in a hot bath of baking-enamel, japan, or other drying oil or varnish. (Varnishes with a linseed-oil base have been found suitable for the purpose.) When thoroughly saturated, the coil is removed from the hot bath and is then wrapped with a covering of asbestos tape or braid, which forms part of the outer jacket, preferably in the manner heretofore described, to form a tough protective covering. The coil can then be redipped in the hot enamel-bath until the asbestos tape is thoroughly impregnated and rendered waterproof. The resulting coil-insulation will possess high heat-resisting properties, cannot be charred by temperatures developed in electric motors, which would injure or destroy the usual insulation in which cotton or linen fabrics are used, and is tough, durable, and waterproof.

An important characteristic of the improved insulation, which, it will be noted, is common to insulation resulting from both of the described methods, is the employment of two jackets, preferably essentially of asbestos, the inner jacket being impregnated with a waterproofing compound, such as those of the paraffin variety, incapable of in any way chemically reacting upon the copper to produce compounds which destroy or tend to destroy the insulation between the convolutions or layers of wire composing the coil proper, and the second jacket being impregnated or treated with a high heat-resisting waterproofing composition—such as an oil-base enamel, drying-oil, or japan—which sets to a tough horny structure and which could not safely be employed in waterproofing the first jacket.

Instead of employing asbestos in sheet form it may be applied in the form of plastic composition which will set when dry.

The invention may also be applied (in substantially the manner herein described with reference to field-coils) in insulating armature coils or sections thereof, as well as to other forms of electromagnetic coils.

It will of course be understood that the process and the resulting insulation may be varied within wide limits while still em-

ploying essential and distinctive features of the invention defined in the claims which follow.

More than two jackets may be employed. In referring in the claims to "asbestos" I intend to embrace materials or compositions having asbestos as their principal or essential ingredient.

What is claimed is—

1. The combination with an electromagnetic coil, of an insulating-covering therefor comprising inner and outer jackets of non-combustible insulating material, the material of the inner jacket being fibrous and water and moisture proofed with a non-oxidizable substance and the outer jacket being of asbestos.

2. The combination with an electromagnetic coil, of an insulating-covering therefor comprising an inner jacket of asbestos rendered water and moisture proof with a non-oxidizable substance, and an outer jacket of asbestos.

3. The combination with an electromagnetic coil, of an insulating-covering therefor comprising an inner jacket of asbestos rendered water and moisture proof with a paraffin substance, and an outer jacket of asbestos.

4. The combination with an electromagnetic coil, of an insulating-covering therefor comprising an inner jacket of insulating material rendered water and moisture proof with a non-oxidizable substance, and an outer jacket of insulating material rendered water and moisture proof with a high heat-resisting substance.

5. The combination with an electromagnetic coil, of an insulating-covering therefor comprising an inner jacket of insulating material rendered water or moisture proof with a non-oxidizable substance, and an outer jacket of asbestos rendered water and moisture proof with a high heat-resisting substance.

6. The combination with an electromagnetic coil, of an insulating-covering therefor comprising an inner jacket of insulating material rendered water or moisture proof with a non-oxidizable substance, and an outer jacket of asbestos rendered water and moisture proof with a drying oil or composition thereof.

7. The combination with an electromagnetic coil, of an insulating-covering therefor comprising an inner jacket of asbestos rendered water and moisture proof with a non-oxidizable substance, and an outer jacket of asbestos rendered water and moisture proof with a high heat-resisting substance.

8. The combination with an electromagnetic coil, of an insulating-covering therefor comprising an inner jacket of asbestos rendered water and moisture proof with a paraffin substance, and an outer jacket of asbestos rendered water and moisture proof with a drying oil or composition thereof.

9. The combination with an electromagnetic coil, of an insulating-covering or casing therefor comprising an inner jacket of asbestos rendered water and moisture proof with a non-oxidizable substance, an outer jacket of asbestos over the first jacket, and an outer wrapping of asbestos tape forming part of said outer jacket, said tape being rendered water and moisture proof by impregnation with a high heat-resisting substance.

10. The combination with an electromagnetic coil, of an insulating covering or casing therefor comprising an inner jacket of asbestos rendered water and moisture proof by impregnation with a paraffin composition, an outer jacket of asbestos, and a wrapping of asbestos tape forming part of said outer jacket, the latter being water and moisture proofed by impregnation with a drying oil or composition thereof.

11. The combination with an electromagnetic coil, of a terminal therefor comprising a plate by which the terminal is secured in place, a conducting-shank projecting from said plate, an inner insulating-jacket extending over the plate about the shank, a water-shield about the stem and over said jacket, and an outer insulating-jacket extending over said water-shield and about the shank.

12. The combination with an electromagnetic coil, of a terminal therefor comprising a plate by which the terminal is secured in place, a conducting-shank projecting from said plate, an inner insulating-jacket extending over said plate about the shank, a ring or band fitting tightly around the shank, a sheet or plate fitting closely around the stem and secured along its inner edge to the ring or band to constitute a water-shield, and an outer insulating-jacket over said water-shield and fitting closely about the stem.

13. The herein-described process of insulating electromagnetic coils consisting in applying thereover an inner jacket of fibrous insulating material, then water and moisture proofing said jacket by impregnation with a non-oxidizable substance, applying an outer jacket of fibrous insulating material, and then rendering said outer jacket water and moisture proof by impregnation with a high heat-resisting substance.

14. The herein-described process of insulating electromagnetic coils consisting in applying thereover an inner jacket of asbestos, then water and moisture proofing said jacket by impregnation with a non-oxidizable substance, applying an outer jacket of asbestos, and then water and moisture proofing said outer jacket by impregnation with a high heat-resisting substance.

15. The herein-described process of insulating electromagnetic coils consisting in applying thereover an inner jacket of asbestos,

then water and moisture proofing said jacket by impregnation with a paraffin composition, applying an outer jacket of asbestos, and then water and moisture proofing said outer jacket by impregnation with a drying oil or composition thereof.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

LOUIS W. DOWNES.

Witnesses:
REEVE LEWIS,
WILLARD S. SUSSAN.