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METHOD OF MAKING INSULATED WIRE

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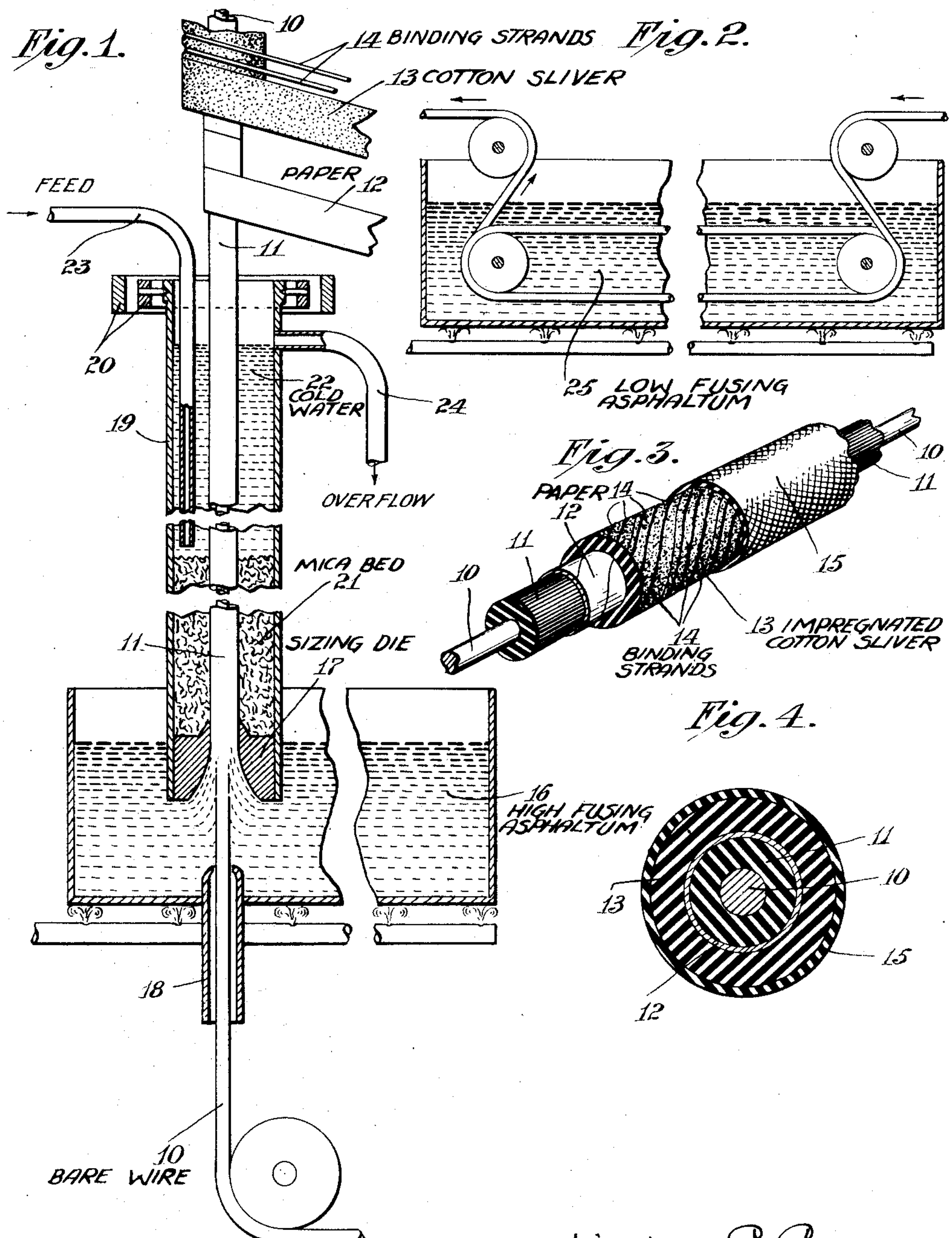

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METHOD OF MAKING INSULATED WIRE

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7 Claims. (Cl. 174—244)

The invention relates to a method of making insulated wire, and more particularly to a method of making an insulated wire adapted for use in the transmission of high voltage currents, by a procedure in producing such a wire which will ensure substantial uniformity in the effectiveness of the insulation throughout all parts of a length of the wire.

For many years there has been in successful use, an insulated wire in which the covering for the conductor wire consists of cotton sliver saturated or impregnated with an asphaltum compound, this covering sliver being confined by binder threads or binder braid. While such wires have been found to have extraordinarily long life, the insulation is not suitable for use in high voltage transmission lines now extensively used. This is due in part to the formation of air pockets in the fibrous covering matter, or to the difficulties of securing a thorough, uniform impregnation of the sliver with the asphaltum compound. The low melting point of this compound, from 150° to 200° F., when the wires are subjected to the heat of the summer sun, also causes a partial softening of the compound with a tendency to creepage toward the bottom of the wire with a resultant loss in the effectiveness of the insulation toward the top thereof which is subjected to greatest deterioration from exposure to the weather.

I have heretofore produced insulated wire having a solid stratum of the asphaltum compound in continuous contact with, and closely adherent to, the conductor wire, this stratum being inclosed by a covering cotton sliver saturated or impregnated with an asphaltum compound having a lower melting point than the stratum about the wire, the whole being confined by binding strands or by braid commonly used upon the outside of insulated wires. Actual tests have shown that such a wire is suitable for the transmission of high voltage currents, but that by reason of the structure of the wire and the method of producing same, there is likelihood of considerable variation in the resistance to the development of blow holes or punctures in the insulation in different parts of the completed wire.

With the above conditions in mind, I have produced an insulated wire embodying therein an inner stratum of asphaltum compound closely adherent to and enveloping the conductor wire, the insulation embodying therein what may be termed a "dam", which not only confines the inner stratum of the asphaltum but prevents any substantial variation in the thickness of different parts thereof, either during the production of the wire or while it is in use. This barrier or dam, resisting deformation of the inner asphaltum compound stratum, is positioned between this stratum and an outer layer of saturated or impregnated sliver, the sliver being held in position by confining strands or an outer braid imbedded in the sliver covering or anchored thereto in a manner well known in the production of sliver covered wires.

It is essential, in a wire constructed in accordance with the invention, that the dam or barrier shall be inherently non-deformable and impenetrable by the heavier constituents of the inner asphaltum compound stratum so as to avoid seepage of such constituents in the event of the softening of the material of either the inner stratum or of the asphaltum compound with which the sliver stratum is saturated or impregnated, whether this softening is due to heat to which the covered wire is subjected during the process of manufacture of the wire, or after the wire has been strung.

This barrier or dam itself has insulating properties, and the continuity and substantially uniform thickness of the same throughout, aids materially in preventing the development of voids in the covering for the wire, known generally as blow holes or punctures. Furthermore, in the process of manufacturing, particularly when coiling the wire after it leaves the asphaltum bath for saturating or impregnating the sliver, the presence of this barrier or dam prevents the displacement of the inner stratum of asphaltum compound with a resultant variation in the thickness of the inner stratum in different parts thereof.

In the production of wire embodying the invention, the inner stratum of asphaltum compound is accumulated upon the conductor wire; the dam or barrier strip, the sliver stratum and the binder threads are applied to the wire in rapid succession, and the wire thus covered is collected in a coil upon a drum prior to the impregnation or saturation of the sliver and the final finishing operations including sizing, waxing and polishing.

In thus building up the insulation upon the wire, the inner stratum of the asphaltum compound is subjected to compression from the dam or barrier strip, the sliver, the confining strands and the coiling operation. This compression may result in displacement of the inner stratum in a manner to vary the thickness of this inner stratum at different points in the length of the wire. Without the use of the dam or barrier strip this condition is much accentuated where the binder strand is applied to the sliver, since this strand is so tensioned as to be imbedded deeply in the sliver, and if the inner stratum of asphaltum compound is soft at the time of the application of the binder, it will be indented along the line of the binder strand, forming alternate high and low spots along the entire length of the said inner stratum.

With the above conditions in mind, I have developed a method of producing wire embodying the invention which will ensure sufficient superficial hardness of the inner stratum of the asphaltum compound to resist displacement, defor-mataion or distortion of the stratum in a manner to vary its thickness as a result of compressive strains of the character above referred to. By thus hardening the inner asphaltum stratum prior to the application of the dam or barrier strip thereto, preservation of substantially uniform thickness of this stratum throughout a length of wire is assured, and the dam or barrier strip may be drawn tightly upon said inner stratum which affords a non-deformable foundation for said strip.

The method also contemplates the cooling or chilling of the inner stratum of asphaltum compound in a manner which will not interfere with the distribution of the compound in a stratum of substantially uniform thickness throughout.

By constructing a wire in accordance with the hereinafter disclosed procedure, while the inner stratum of asphaltum compound is subjected to an elevated temperature during the impregnation or saturation of the covering sliver, this temperature is below the melting point of the compound of said inner stratum, and the interposition of the dam or barrier strip between the sliver and said inner stratum will tend to check the conduction of such heat to said inner stratum and thus aid in preventing the softening of the asphaltum compound of said stratum. Consequently, the method contemplates conditions in the production of the wire wherein the inner stratum of asphaltum compound, particularly toward the outer surface thereof, will be sufficiently cooled to hold the form of the stratum notwithstanding the pressure developed in applying the dam or barrier strip, the strip of covering sliver and the binding strands, and will be so protected from the heat developed during impregnation or saturation of the sliver as to avoid the softening of the compound of said inner stratum to an extent to permit creepage thereof in a manner to vary the original thickness thereof at any point because of such compression or heat. This condition and the presence of the dam or barrier strip material completely enveloping the inner stratum of compound, also prevents the distortion of the inner stratum while the wire is being wound upon a drum immediately following the impregnation or saturation stage.

The method also contemplates the application of the inner stratum of asphaltum compound under conditions which will ensure the application to the conductor wire of a substantially uniform thickness of said compound by the avoidance of a drag upon the compound upon the wire and of the tendency of hot asphaltum to creep by gravity along the wire.

The invention consists primarily in a method of making insulated wire embodying therein the steps of passing a wire vertically through a bath of an asphaltum compound having a high melting point, removing from the wire excess compound, immediately thereafter hardening or chilling the compound on the wire, applying a dam or barrier stratum of non-deformable material impenetrable by the heavier constituents of said compound, to said hardened or chilled inner stratum, laying an outer stratum of fibrous material upon said dam or barrier stratum, and saturating or impregnating said body of fibrous material with an asphaltum compound having a lower melting point than the compound in said inner stratum; and in such other novel steps and practices as are hereinafter set forth and described, and more particularly pointed out in the claims hereto appended.

Referring to the drawing,

Fig. 1 is a vertical section of a fragmentary portion of the agencies used in the steps of forming the inner stratum of the insulation upon a conductor wire, the hardening or chilling of said stratum, the application of the dam or barrier strip thereto, the laying of the strip of sliver upon the dam or barrier strip, and the application of binder strands to said sliver;

Fig. 2 is a more or less diagrammatic showing of the impregnation of the sliver following the steps shown in Fig. 1;

Fig. 3 is a perspective view upon an enlarged scale of the completed wire, broken away upon different planes; and

Fig. 4 is a cross sectional view of the wire upon a greatly enlarged scale.

Like numerals refer to like parts throughout the several views.

In the embodiment of the invention shown in the drawing, the insulated wire structure includes a conductor wire 10, which may be the ordinary drawn wire or a stranded cable now commonly used in high voltage transmission lines. Enveloping the conductor wire or cable, and in continuous contact with and closely adherent thereto, is an inner stratum of an asphaltum compound. This stratum is of substantially uniform thickness throughout an entire length of wire, but may vary in thickness according to the size or service required of the wire. Ordinarily, the stratum 11 will have a thickness of from one-sixty-fourth to one-eighth of an inch.

The asphaltum compound of the inner insulating stratum 11 has a high melting point, in a range of from 250° to 300° F.

Inclosing the inner stratum 11 is a barrier or dam 12 of non-deformable material such as a smooth hard paper. Various kinds and grades of paper may be used, such as kraft or Express paper, although the exact paper used is not material so long as it has little inherent characteristics permitting stretch of the paper circumferentially of the wire, and is impenetrable by the heavier constituents of the asphaltum compound stratum 11.

Inclosing and contacting with said dam or barrier is a body of fibrous material 13 such as cotton sliver, which is impregnated or saturated with an asphaltum compound having a lower melting point than the compound of the inner stratum 11. The melting point of the saturant for the sliver body is within a range of from 150° to 200° F. The body of sliver 13 is compacted as it is applied to the wire, either by being wound spirally thereon or applied lengthwise of the wire, and a binding strand or strands 14 is applied exteriorly of the body of sliver to hold it under compression. These strands are deeply imbedded in the sliver and are spaced apart sufficiently to allow the asphaltum compound to penetrate between the strands into the body of the sliver.

In applying the strands, they are so tensioned as to secure the above result, and the presence in the insulation of the dam or barrier 12 is in part for the purpose of preventing these strands from forming a sequence of depressions in the inner stratum of asphaltum compound 11 sufficiently deep to result in material variation in the thickness of this stratum.

As will appear more fully hereinafter, the method employed in covering the wire 10 is such as to impart to the inner stratum 11 sufficient hardness, compatible with the materials used, to avoid distortion thereof when applying the material of the dam or barrier.

The dam or barrier 12 is mainly for the purpose of holding the form of the inner stratum 11 during the production of the wire and while it is in use, of preventing the penetration of the material of the fibrous body into the inner stratum 11, and of preventing the formation of alternate dents and ridges in the outer surface of said body 11 by the forcing of the sliver by the binding strand or strands into the inner stratum 11. This dam or barrier also prevents the action of constituents of the compound with which the sliver body is impregnated, upon the compound of the inner stratum 11. It also acts as an additional insulating medium to prevent blow holes or punctures by reason of air pockets or imperfect impregnation or saturation of the sliver body.

In a wire embodying the invention, there is a strong bond between the material of the dam or barrier and the inner stratum, and a relatively weaker bond between the sliver body and said dam or barrier.

When stripping wire, the sliver body may be readily separated from the barrier or dam, and the inner stratum 11, while strongly adherent to the conductor wire, may be readily stripped from the wire.

While the binder strands and the sliver body may be used for giving an outside dress to a wire, ordinary outside braid, as shown at 15, may also be used for this purpose.

The above described wire is illustrated in Figs. 3 and 4 of the drawing. The method of making wire is illustrated in Figs. 1 and 2, the former showing the manner of applying the superimposed laminae of insulating material to the wire, and the latter showing the stage of impregnating or saturating the sliver body.

In the production of wire embodying the invention, the conductor wire is passed vertically through a bath 16 of an asphaltum compound having a melting point within a range of from 250° to 300° F. The wire with the compound accumulated thereon is passed through a sizing die 17 which is maintained at substantially the temperature of the bath by being submerged in the bath. The wire, when passing into the bath through a guide tube 18, is at normal factory temperatures, but its temperature is raised in passing through the guide tube 18. As the wire passes into the asphaltum bath, the compound is picked up or gathered by the wire, and being strongly adherent thereto, is drawn thereby through the die 17, the opening of which is downwardly flared as shown so as to ensure a free movement of the asphaltum through the die in sufficient volume to form an inner stratum 11 of the desired thickness about the wire. Excess compound is stripped from the wire.

One of the difficulties in producing a wire embodying the invention arises from the tendency of the wire to get out of straight at different points thereof.

To correct this condition, I freely suspend the die 17 so that the slightest pressure, even that of a soft asphaltum, will cause the die to move in any direction, according to the form of the wire. Hence the wire will always be centered accurately in relation to the opening of the die 17, or sufficiently accurately to cause the thickness of the asphaltum compound to be substantially uniform at all points about the wire.

Where I have referred to uniformity in thickness of the stratum 11, I do not intend to convey the idea that there is no variation in the thickness of the inner stratum 11, since in producing such wires mathematical accuracy is impossible, but the inner stratum 11 at every point of the wire will be approximately of the same thickness or of a thickness which will give the desired measure of insulating properties without danger of the formation of blow holes or punctures.

The free universal movement of the die results by reason of the fact that this die is supported at the lower end by a tube 19, which in turn is suspended adjacent the top thereof by means of a compass mount 20. A tube 19 is used to permit the hardening or chilling of the asphaltum compound in the inner stratum 11 immediately following its passage from the die and prior to the application of the dam or barrier strip 12 upon the inner stratum 11. This hardening or chilling of the asphaltum compound avoids any tendency toward the sagging or down flow of the compound by gravity in a manner to cause wide variance in the thickness of the inner stratum at different points of a length of wire.

The hardening or chilling of the compound in the inner stratum 11 is accomplished by passing the wire with the inner stratum of asphaltum compound 11 thereon, through a body of any suitable material such as flaked mica, immersed in water, and after leaving the flaked mica, through a bath of cold water. The mica bed is shown at 21 and the cold water is shown at 22. The bed 21 and the bath 22 are both within the pendulous tube 19. The tube 19 may be three feet or more in length, and it is necessary to maintain the bath 22 at a proper temperature to provide for a constant renewal of the supply of cold water within the tube and throughout the bed of mica. By reason of the high temperature of the asphaltum passing through the bed 21 and the bath 22, there is a tendency to rapidly heat the mica adjacent the die 17, and this portion of the bed will always be at a temperature approaching the boiling point of water. This is desirable, since it prevents the cooling of the die 17 which would interfere with a free run of the asphaltium of the stratum 11 through the die. Since the bath 22 is immediately above the bed 21 in the tube 19, it is obvious that water from the bath will seep through the mass of mica so as to keep it wet, and that the water will be at a progressively decreasing temperature toward the top of the bed.

A constant change of water in the tube 19 is secured by delivering water, which may be precooled, through a feed pipe 23 to adjacent the top of the bed 21 of mica and providing an overflow pipe at 24 adjacent the top of said tube. By first passing the wire covered with an asphaltum compound having a high melting point, through a bed of more or less granular material immersed in a cooling agent, and immediately thereafter passing it through a bath of a cooling liquid, the asphaltum is sufficiently solidified or hardened to give the asphaltum a form which cannot be changed, except as a result of the application thereto of heat at a temperature approximating the melting point of the compound.

After leaving the bath 22, I wrap a strip of smooth paper spirally about the asphaltum compound stratum, preferably lapping the edge of each convolution upon the edge of the preceding convolution so as to ensure continuity of the dam or barrier 12 afforded by this paper. The hardened asphaltum forms a firm base upon which the paper may be wrapped, and the asphaltum and the paper form a firm base upon which a strip of cotton sliver may be mounted, either by spirally winding or by other ways well known in the art.

In the drawing, I have shown a spiral winding of the sliver about the paper dam or barrier and a spiral winding of a binding strand or strands 14 about the sliver.

After the application of the binding strand or strands 14 to the sliver, the wire is passed through an impregnation or saturation bath shown at 25 where the cotton sliver body is impregnated or saturated with an asphaltum compound having a relatively lower melting point than the asphaltum compound in the bath 16. While the asphaltum compound in the bath 16 has a melting point within a range of from 250° to 300° F., that in the impregnation or saturation bath 25 has a melting point within a range of from 150° to 200° F.

An asphaltum compound having a melting point within the range stated has been found desirable, since when fused, it has a viscosity sufficiently low to ensure a fairly thorough impregnation or saturation of the cotton sliver of the body 12.

The lower melting point of the bath 25, notwithstanding that the covered wire is in this bath for a considerable period, has no tendency to soften the inner stratum 11 to an extent to permit it to be deformed as the wire is collected upon a drum. This is due largely to the fact that the barrier or dam 12 has heat insulating properties and is non-absorbent as to the lighter constituents of the compound in the bath 25. The barrier or dam may become sufficiently hot to ensure the making of an effective bond between it and the inner stratum 11, but this stratum as a whole remains sufficiently hard and firm, and is so confined by the dam or barrier, that when coiling the wire there is no tendency toward any substantial distortion of the inner stratum resulting in the forcing of the compound from one part of the wire toward another part thereof.

While I have referred herein to the chilling or hardening of the inner stratum 11, I have used such terms to indicate a condition in which the asphaltum compound is brought to its maximum hardness. These compounds never become really hard or brittle, but will remain, over a period of years, in a semi-plastic condition permitting the material to bend freely with the wire without likelihood of the cracking or breaking down of the insulation because of rupture of the covering compound. They are sufficiently hard to have no tendency to flow under temperatures to which they would normally be subjected while in use, although during production, when at a temperature approaching the melting point of the compounds, there is a tendency of the compound to flow, and it is to counteract this tendency that I pass the wire with the inner stratum adhering thereto, through the mica bed 21 admixed with water and the cold water bath 22 after leaving the mica bed. In passing the wire vertically through and from the bath 16 of asphaltum compound, the sagging or downward flow of the asphaltum compound is very much less than with a horizontal run of the wire, but by chilling or hardening the asphaltum compound immediately that the wire leaves the bath 16, such sagging or downward flowing is practically eliminated.

Since the bath 16 is well above the boiling point of water, and since the wire 10 passing through this bath travels at a rate of from thirty to forty feet per minute, it is obvious that the water in which the mica is immersed and the water of the bath 22 would be rapidly brought to the boiling point where the hardening action thereon is almost negligible, were not a circulation of cold water throughout the bath 22 maintained, and this cold water allowed to seep through the mica bed to replace the water driven off in the form of steam.

While the presence of the water in the bed 21 will tend to prevent mica adhering to the outer surface of the stratum 11, the presence of any such mica adherent thereto is not at all objectionable.

While I have described the use of mica in the bed 21, asbestos fibers might also be used, although I believe that mica will be found to be more effective in maintaining the desired temperatures adjacent the outlet of the die 17.

By using a tube 19 several feet in length, a sufficiently effective cooling or hardening of the asphaltum compound may be secured, although with such a tube, the asphaltum will be subjected to the cooling action of the mica bed and the water bath for only five or six seconds. If it be found that the asphaltum compound is not sufficiently hardened then, as stated, the water delivered through the feed tube 23 may be pre-cooled. A continuous circulation of water through the bath and throughout the bed 21 is highly desirable, since it permits a continuous production of insulated wire by the method of the invention and avoids frequent stoppages to renew the supply of water in the bath.

By delivering the water from the feed pipe adjacent the top of the mica bed, the asphaltum compound is subjected to a sudden chilling action after leaving the bed and the desired low temperature of the bath may be more readily maintained. While the temperature naturally increases toward the top of the bath, at no time will it be sufficiently high to interfere with the chilling or hardening action herein referred to.

When an outside braid is used, it is applied to the sliver stratum prior to passing the covered wire through the bath 25. Upon leaving the bath 25, the wire is collected upon a spool and subsequently is subjected to the final finishing operations of smoothing, waxing and polishing. No outer covering excepting the binder strands is used.

The term "non-deformable" applied to the dam or barrier strip, is used in the sense that the material of this strip has substantially no stretch. Hence the inner stratum 11, as to any part thereof, is not permitted to shift from one part of the wire to another part by the yielding of the material of said dam or barrier.

The dam or barrier 12 serves to prevent the penetration of the inner stratum 11 by the fibers of the sliver stratum 13, protects said inner stratum 11 from the constituents of low viscosity in the compound with which the sliver body is impregnated or saturated, and affords a firm, continuous backing closing any voids in the strata 11 and 13. During production, it also protects the stratum 11 from heat of the bath 25.

The legends upon the drawing are by way of explanation, since it is obvious it is not applicant's intention to limit his claims by the use of such legends.

A wire embodying the invention and made by the herein described method has been found to blow or puncture when subjected to voltages of twenty-five or thirty thousand.

It is not my intention to limit the invention to any particular type of paper in the dam or barrier 12, so long as such paper has the characteristics herein referred to.

While it is essential that there shall be a differential of melting temperatures of the compounds in the stratum 11 and the stratum 13, with the lower melting point in the latter stratum, the temperature ranges given are not critical.

Having described the invention, what I claim as new and desire to have protected by Letters Patent, is:

1. The herein described method of making insulated wire embodying therein the steps of passing a wire vertically through a bath of an asphaltum compound having a high melting point, removing from the wire excess compound, immediately thereafter hardening or chilling the compound on the wire, applying a dam or barrier stratum of non-deformable material impenetrable by the heavier constituents of said compound, to said hardened or chilled inner stratum, laying an outer stratum of fibrous material upon said dam or barrier stratum, and saturating or impregnating said body of fibrous material with an asphaltum compound having a lower melting point than the compound in said inner stratum.

2. The herein described method of making insulated wire embodying therein the steps of passing a wire vertically through a bath of an asphaltum compound having a high melting point, removing from the wire excess compound, immediately thereafter successively passing the wire with the stratum of asphaltum compound thereon through a wet bed of granular material and a bath of a cold fluid to harden or chill the compound, applying a dam or barrier stratum of non-deformable material impenetrable by the heavier constituents of said compound, to said hardened or chilled inner stratum, laying an outer stratum of fibrous material upon said dam or barrier stratum, and saturating or impregnating said body of fibrous material with an asphaltum compound having a lower melting point than the compound in said inner stratum.

3. The herein described method of making insulated wire embodying therein the steps of passing a wire vertically through a bath of an asphaltum compound having a high melting point, removing from the wire excess compound, immediately thereafter successively passing the wire with the stratum of asphaltum compound thereon through a wet bed of granular material and a bath of a cold fluid to harden or chill the compound while maintaining a circulation of said fluid in said bath, applying a dam or barrier stratum of non-deformable material impenetrable by the heavier constituents of said compound, to said hardened or chilled inner stratum, laying an outer stratum of fibrous material upon said dam or barrier stratum, and saturating or impregnating said body of fibrous material with an asphaltum compound having a lower melting point than the compound in said inner stratum.

4. The herein described method of making insulated wire embodying therein the steps of passing a wire vertically through a bath of an asphaltum compound having a high melting point, passing said wire through a die submerged in said bath for removing excess compound from the wire, immediately thereafter hardening or chilling the compound on the wire, applying a dam or barrier stratum of non-deformable material impenetrable by the heavier constituents of said compound, to said hardened or chilled inner stratum, laying an outer stratum of fibrous material upon said dam or barrier stratum, and saturating or impregnating said body of fibrous material with an asphaltum compound having a lower melting point than the compound in said inner stratum.

5. The herein described method of making insulated wire embodying therein the steps of passing a wire vertically through a bath of an asphaltum compound having a high melting point, passing said wire through a die submerged in said bath for removing excess compound from the wire, immediately thereafter successively passing the wire with the stratum of asphaltum compound thereon through a wet bed of granular material and a bath of a cold fluid to harden or chill the compound, applying a dam or barrier stratum of non-deformable material impenetrable by the heavier constituents of said compound, to said hardened or chilled inner stratum, laying an outer stratum of fibrous material upon said dam or barrier stratum, and saturating or impregnating said body of fibrous material with an asphaltum compound having a lower melting point than the compound in said inner stratum.

6. The herein described method of making insulated wire embodying therein the steps of passing a wire vertically through a bath of an asphaltum compound having a high melting point, passing said wire through a movable die submerged in said bath for removing from the wire excess compound, immediately thereafter successively passing the wire with the stratum of asphaltum compound thereon through a wet bed of granular material and a bath of a cold fluid to harden or chill the compound while maintaining a circulation of said fluid in said bath, applying a dam or barrier stratum of non-deformable material impenetrable by the heavier constituents of said compound, to said hardened or chilled inner stratum, laying an outer stratum of fibrous material upon said dam or barrier stratum, and saturating or impregnating said body of fibrous material with an asphaltum compound having a lower melting point than the compound in said inner stratum.

7. The herein described method of making insulated wire embodying therein the steps of passing a wire vertically through a bath of an asphaltum compound having a high melting point, passing said wire through a movable die submerged in said bath for removing from the wire excess compound, immediately thereafter successively passing the wire with the stratum of asphaltum compound thereon through a wet bed of flaked mica and a bath of a cold fluid to

harden or chill the compound while maintaining a circulation of said fluid in said bath, applying a dam or barrier stratum of non-deformable material impenetrable by the heavier constituents of said compound, to said hardened or chilled inner stratum, laying an outer stratum of fibrous material upon said dam or barrier stratum, spirally winding binding strands upon, and imbedding them in, said fibrous material, and saturating or impregnating said body of fibrous material with an asphaltum compound having a lower melting point than the compound in said inner stratum.

WILLIAM E. COOK.