

July 18, 1933.

E. A. MAU ET AL

1,918,344

APPARATUS FOR INSULATING WIRE

Original Filed Nov. 29, 1922 3 Sheets-Sheet 1

Fig. 1.

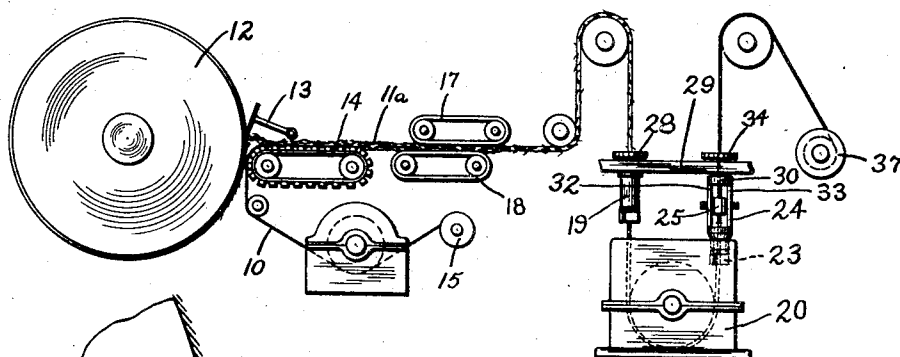
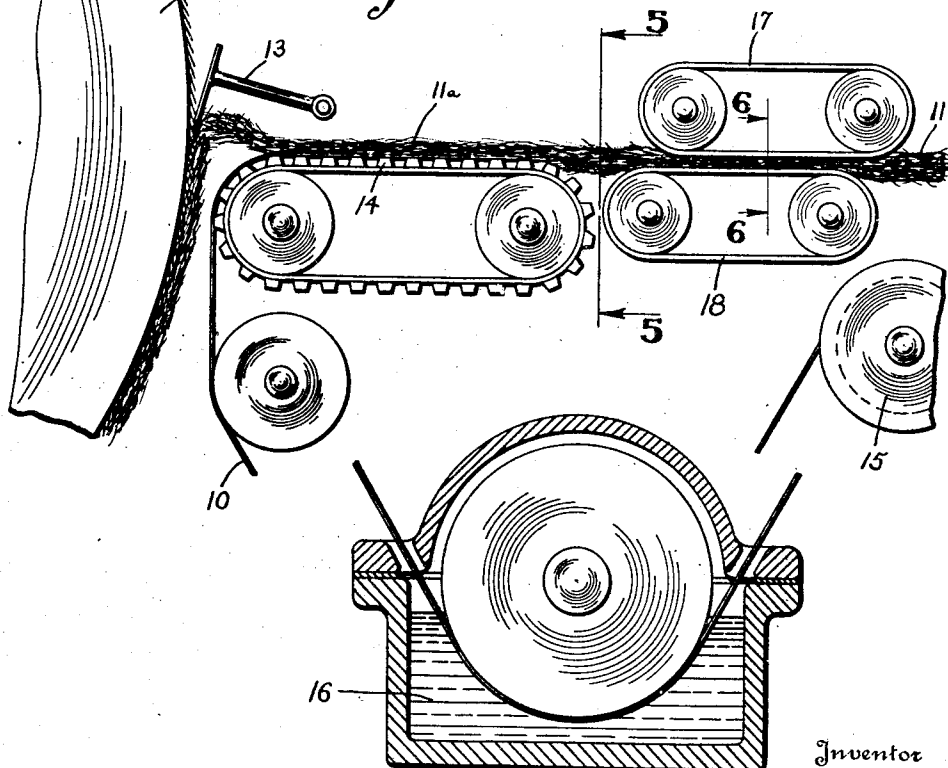


Fig. 2.



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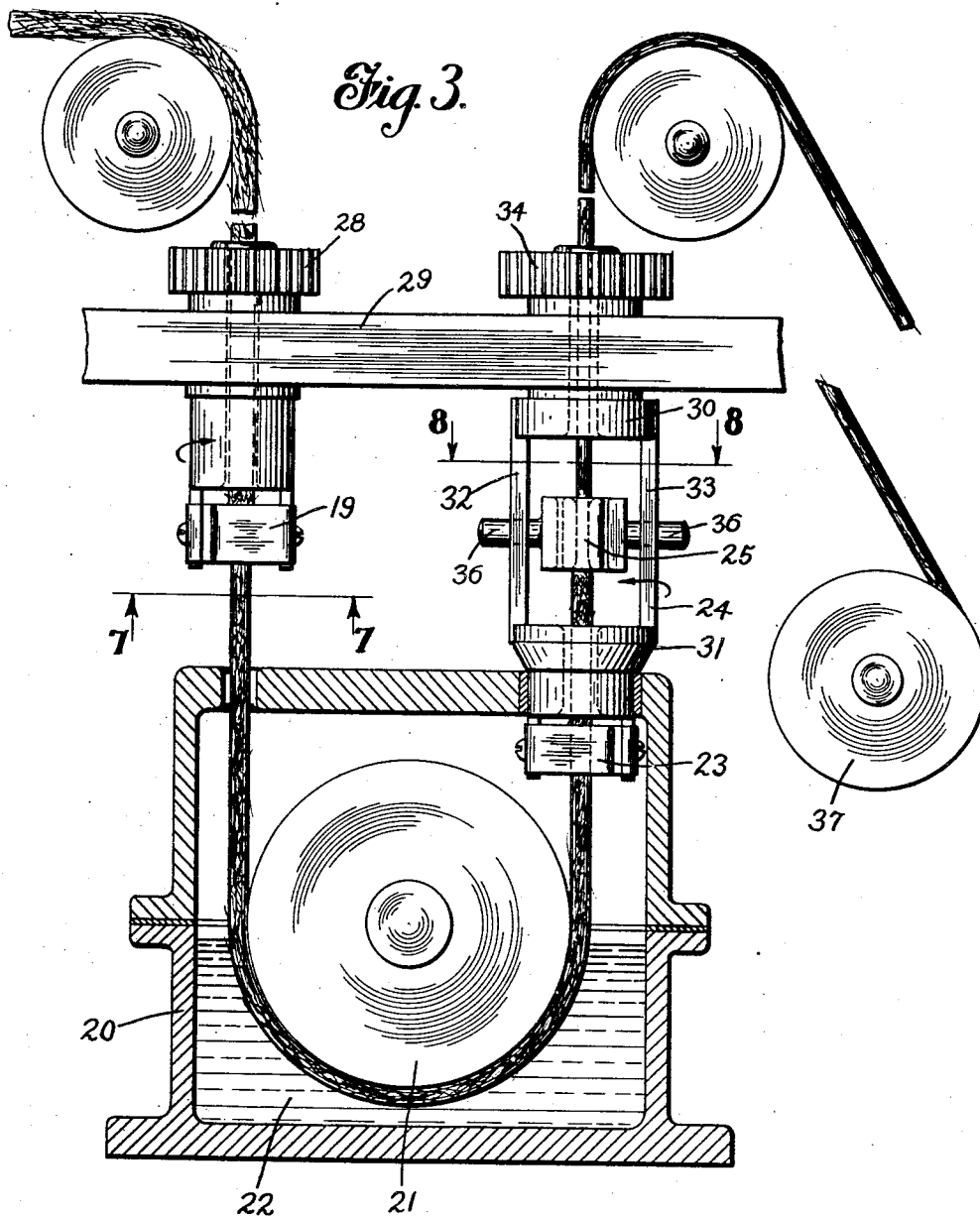
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Original Filed Nov. 29, 1922 3 Sheets-Sheet 2



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3 Sheets-Sheet 3

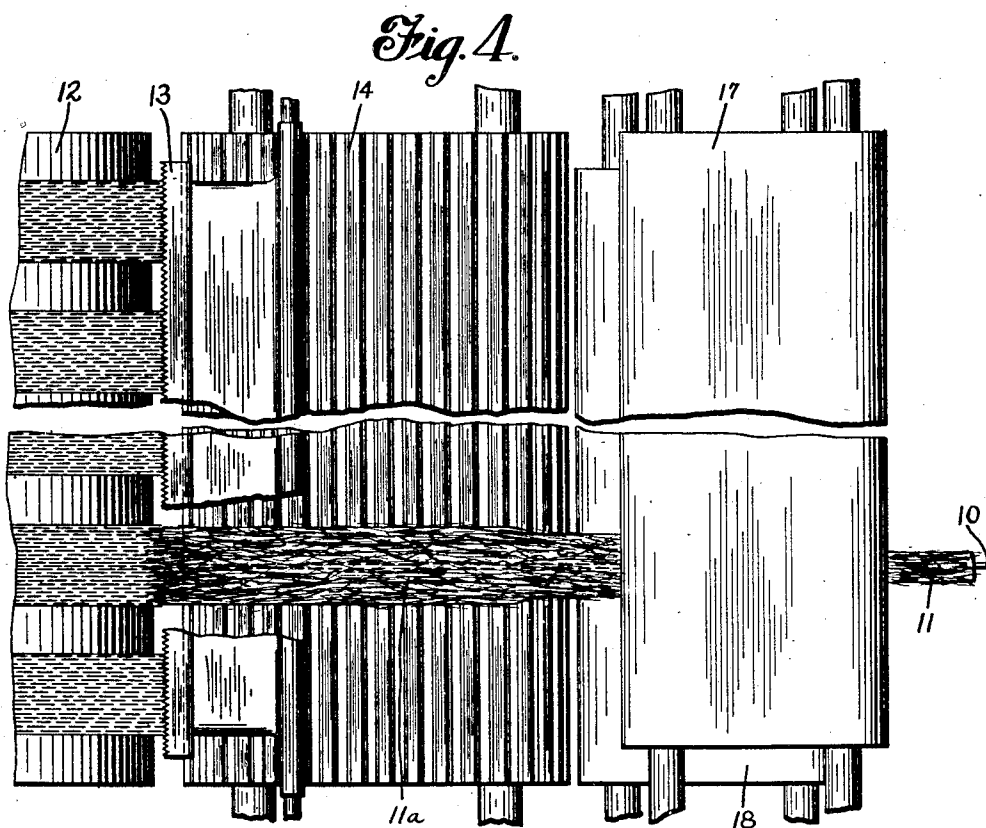


Fig. 5.

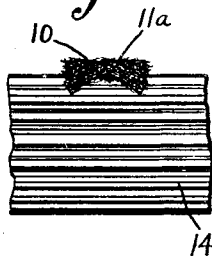


Fig. 7.

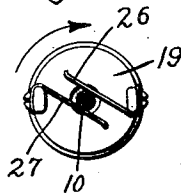


Fig. 8.

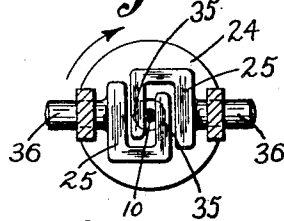


Fig. 6.



Fig. 9.



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UNITED STATES PATENT OFFICE

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APPARATUS FOR INSULATING WIRE

Original application filed November 29, 1922, Serial No. 604,022. Renewed October 21, 1927, now Patent No. 1,685,369, dated September 25, 1928. Divided and this application filed December 6, 1927. Serial No. 238,179.

This invention relates to insulated conductors, and more particularly to conductors which have insulated coverings of such small thickness as to fall within the class of magnet wires, such as described and claimed in our copending application, Serial No. 604,022, filed November 29, 1922, which has matured into Patent No. 1,685,369, issued Sept. 25, 1928, and of which this application is a division.

The invention is directed to apparatus for making an insulated conductor which is distinguished by the uniformity and reliability of the covering with respect to its electrical insulating properties, the thinness of the insulating covering which is a necessary attribute of magnet wire and the adaptability of the insulating covering to rapid manufacture of the wire at low cost, using inexpensive short fibres which are not suitable for general use. The apparatus of this invention is particularly useful in making an insulating sheath for a conductor according to the method of making the same, as described and claimed in our co-pending application, Serial No. 238,178, filed December 6, 1927 which has matured into Patent No. 1,893,590, issued January 10, 1933.

Magnet wire as commonly made heretofore has been of two types, that in which the insulating covering is a composition applied to the wire in a liquid or plastic state and hardened, and that in which the covering is made of fibrous material and is applied to the wire by wrapping it thereon. The object of this invention is to provide apparatus for making a magnet wire which is superior to these, superior to the film-coated wire with respect to reliability and uniformity of the covering as an electrical insulator and superior to the wrapped wire in that equally well insulated wire may be manufactured at much less cost. Magnet wire having the film or composition coating is deficient in the reliability of its electrical insulating properties for the reason that the coating lacks the necessary uniformity and is subject to cracking under flexure, peeling, pin-holes, protruding burrs, etc., so that the danger of exposure of the conductor or weakening of the insulation at one or more points is always present. With the wrapped fibre coating, on the other hand, while the desired uniformity and reliability of the coating as an insulation may be secured, the cost of production is relatively high as the manufacturing operation proceeds slowly and relatively expensive long-fibred staples must be employed in the production of the wrapping. The insulated conductor produced by the apparatus of the present invention, consists of a wire having thereon a coating of unspun fibres, preferably cotton fibres, intertangled and densely compacted and having ample flexibility and a smooth, hard, moisture-proof surface, the coating being very thin as is required of the insulating coating of magnet wire, but nevertheless of such thickness that at every point the wire is overlaid by a number of fibres. Such a coating may be made to adhere to the wire with great tenacity by the employment of a suitable adhesive in which the innermost fibres are embedded, and it is exceedingly tough and amply flexible. Because of these characteristics, there is no danger of the coating peeling from the wire or cracking as a result of repeated flexure of the wire. Also, in making such a coating, it is permissible to use short-fibre staple which is inexpensive because of its limited utility for other purposes. Furthermore, by the use of this apparatus it is possible to apply such a coating to a wire by a continuous and comparatively rapid process, much more rapid than any wrapping operation, with the result that the completed conductor may be produced at low manufacturing cost. The fibres may be applied to the wire in the form of a continuous sliver which is brought into contact with the wire after the latter has been coated with an adhesive; then the sliver may be subjected to a suitable rubbing motion whereby it is caused to enclose the wire and adhere to it; and then as the wire is fed along, it is subjected to rapidly rotating pressure devices which serve to compact the fibrous coating to a great density and give it a hard, glazed and preferably waterproofed surface while retaining its toughness and flexibility.

It has been proposed heretofore to insulate electrical conductors with an insulating coating of interentangled fibres, such for instance, as cotton or asbestos, but this has been done only in connection with the manufacture of so-called fixture wire in which the thickness of the insulating coating is a matter of little importance, mechanical strength to withstand blows and strains incident to the handling of the fixture being the important consideration. So far as we are aware, a magnet wire with a thin, dense, tough, flexible and uniform coating of unspun interentangled fibres has never been produced heretofore successfully.

In a conductor having an insulating coating of this nature, it is of the utmost importance to insure that the conductor shall be overlaid by a substantial number of fibres at every point, and this requisite must not be sacrificed to any appreciable extent in order to secure thinness of the coating, for thorough electrical insulation is a primary requisite. The attainment of this desirable characteristic is made more certain by so applying the fibres to the wire that they will be arranged more or less in accordance with a prescribed order. Very desirable results with respect to uniformity of the coating may be obtained by so applying the fibrous covering to the wire that the fibres close to the wire are arranged generally parallel to the length of the wire, whereas the fibres further from the wire are arranged in some other manner, as for instance, in a generally circumferential relation. This form of covering presents two important advantages, first, it results in the attainment of a greater degree of uniformity in the dielectric strength of the insulation, and second, it permits of the use of simple and inexpensive manufacturing expedients.

Another consideration of importance is that the electrical characteristics of the wire must not be deteriorated by the application of the covering to the wire. If the process employed be such that the wire is worked to any considerable extent it will become fatigued and its conductivity will be lowered. For instance, if the application of the fibrous covering to the wire be effected by the employment of a rub motion apparatus, this should not be so operated as to result in rolling of the wire back and forth upon itself as has been the case with apparatus of this character heretofore proposed. The best results are attained when the process and apparatus for applying the insulating covering are such that the wire passes through the apparatus with the minimum of bending and no movement about its axis, with the result that its electrical conductivity is not impaired at all.

The principal object of this invention is to provide an apparatus for making an in-

sulated conductor having the above characteristics, in an efficient manner.

Another object of this invention is to provide in apparatus for making an insulated conductor, a combination of mechanisms by which the insulated conductor may be inexpensively produced.

A further object of this invention is to provide in apparatus for such a purpose, a novel form of polishing mechanism, in combination with other mechanisms, whereby an insulation having the above characteristics will be efficiently produced by the combined action thereof.

A still further object of this invention is to provide in apparatus for such a purpose, a novel form of polishing mechanism for use during the final operation of polishing and smoothing the applied covering.

To these and other ends the invention consists in the novel features and combinations of parts to be hereinafter described and claimed.

In the accompanying drawings:

Fig. 1 is a somewhat diagrammatical side view of the apparatus embodying the features of this invention;

Fig. 2 is an enlarged side view of a portion of the apparatus, illustrating the mechanisms used during the first operations in the making of an insulated conductor;

Fig. 3 is an enlarged side view of a portion of the apparatus illustrating the mechanisms used during the last operations in making an insulated conductor, and is substantially a continuation of Fig. 2;

Fig. 4 is a plan view of the mechanisms shown in Fig. 2;

Fig. 5 is a section on line 5—5 of Fig. 2;

Fig. 6 is a section on line 6—6 of Fig. 2;

Fig. 7 is a section on line 7—7 of Fig. 3;

Fig. 8 is a section on line 8—8 of Fig. 3; and

Fig. 9 illustrates an insulated conductor having the characteristics desired, and which may be produced by the apparatus of this invention.

The wire or conductor to be insulated by the apparatus of this invention, is indicated at 10, and the covering or insulation at 11. As described in our co-pending application Serial No. 604,022, now Patent No. 1,685,369 above referred to, the fibres of the insulating covering for the core of wire are preferably arranged more or less in accordance with a prescribed order, whereby the fibres at the interior of the covering and adjacent the core are arranged generally parallel to the length of the core, and the fibres of the outer portion of the covering are arranged generally circumferentially of the same.

A suitable doffer roll 12, forming part of any well known type of fibre carding machine, in cooperation with a comb 13, supplies the

fibres in the form of a sliver 11^a, which is fed to a forwardly moving belt or conveyer 14, and disposed upon the upper surface thereof. The fibres of the sliver 11^a supplied from the doffer roll 12, are arranged generally parallel with the length of the sliver, which, in this instance, is in the form of a ribbon of fibres, the width of which is controlled by the transverse extent of the card on the doffer roll 12.

The conductor or core member 10 is supplied from a reel 15 and passes through a tank containing an adhesive compound 16. The adhesive or cement 16 consists of a suitable gum dissolved in a solvent, the arrangement being such that by the time the conductor 10 reaches the belt 14, the solvent will have evaporated to a considerable extent, and the residue upon the wire will be so sticky that the fibres will become embedded in the adhesive and will adhere to the wire but the adhesive will not penetrate the fibres to any substantial extent. The conductor 10 after passing through and being covered by the adhesive 16, is fed upwardly and over on to the upper surface of the belt or conveyer 14, and disposed beneath the sliver 11^a. The belt 14 movably supports the conductor 10 and the sliver 11^a during their forward movement toward a pair of rub motion belts 17 and 18. The rub motion belts 17 and 18 are given a longitudinally progressing and laterally reciprocating motion by suitable driving means (not shown), and the sliver 11^a and the conductor 10 pass together at the same speed between these belts. The action of the belts 17 and 18 is such that the sliver 11^a is wrapped about the core or conductor 10, the fibres adjacent the core being embedded in the adhesive thereon, while all of the fibres of the sliver are interentangled. The tension between the belts 17 and 18 is such that the fibres are slightly compressed, but is not great enough to roll or twist the core or conductor transversely of its length. The longitudinally progressing movement of these belts is such as to not interfere with the forward movement of the sliver and conductor.

The fibre enclosed core is then fed through a lick or wiping device 19, which may consist of a pair of flat spring members 26 and 27 disposed to engage opposite points about the core. The lick 19 is rapidly rotated by suitable driving means (not shown), or it may be provided with a driving gear to mesh with a gear 28, secured to the wiping device 19, which, in this instance, is journaled in a suitable supporting frame 29. The rotation of the wiper 19 causes the spring members 26 and 27 to engage against the product passing therethrough, to condense the body of fibres upon the core, to form them into a covering thereabout, which will conform to the shape of the core or wire and be substantially concentric with the periphery thereof. The

action of these spring members reduces the covering to approximately the required gauge and further disposes the fibres at the outer portion of the covering generally circumferentially thereabout.

The covered core is then carried through a moisture proofing medium 22, which is contained in a tank 20, upon a pulley shaped member 21, about which the conductor passes. A compound of nitro cellulose is well adapted for use as a moisture proofing medium, inasmuch as a coating of that substance not only protects the insulating covering from moisture, but also serves to cement down the fibres of the insulating body and hold them permanently in close contact. The conductor is passed through this compound at a rate of speed sufficient to permit a thorough impregnation of the covering thereof thereby.

From the receptacle 20 the conductor passes through a wiper 23, which is of the same general structure as the lick 19. This wiper serves to remove excess compound from the covering and is preferably disposed within the receptacle 20, being in this instance, journaled to the cover thereof, and secured to the lower end of a polishing device.

The polishing device comprises a framework or spindle 24, having upper and lower end members 30 and 31, respectively, end member 31, in this instance, forming a lower bearing which is journaled in the cover of the receptacle 20, and end member 30 forming an upper bearing, which is journaled in the frame 29. Extending between the end members 30 and 31 is a pair of diametrically opposed side bars 32 and 33. A pinion 34 is secured to the upper end member 30, and the device may be rapidly rotated by meshing a driving gear (not shown) with pinion 34.

A pair of polishing blocks 25 is disposed intermediate the end members 30 and 31, and between the side bars 32 and 33. The blocks 25 are each provided with a polishing finger 35, secured to which is a stem 36. The stem 36 extends outwardly at substantially right angles to the face of the finger 35 and also at substantially right angles to the conductor. The fingers 35 oppose each other and are disposed one on either side of the conductor, being adapted to engage the same when they are moved toward each other. Each of the stems 36 extends through an opening provided in the adjacent side bars 32 and 33, and is freely slidable therein. The arrangement is such that movement of the stem 36 outwardly will cause the fingers 35 to tend to move toward each other and engage and press upon the conductor, whereby the fibres of the covering thereof will be condensed and the outer surface thereof smoothed and polished. A rapid rotation of the frame or carrier will urge the members 36 outwardly, due to centrifugal force acting thereupon, whereby the fingers fixed to and forming portions of the

respective members will move inwardly and tightly press against opposite sides of the covered conductor as it passes longitudinally through the device.

After being smoothed and polished, the covered conductor is directed toward a power driven reel 37, upon which it is wound. The tension exerted by the reel 37 upon the conductor serves to continuously draw the same through the various mechanisms above described. Suitable provision may be made to vary the speed of movement of the conductor by providing any well known type of change speed mechanism, in cooperation with the driven reel 37.

It will be obvious from the above description, that the apparatus of this invention is adapted to form an insulating sheath about a conductor or core member 10, and having the characteristics desired. The fibres of the sliver 11^a are arranged in contact with an adhesive covered conductor, by feeding the conductor 10 upwardly and disposing it underneath the sliver 11^a. By means of the supporting conveyer belt 14, the conductor 10 and the sliver 11^a are movably supported during their forward movement toward the rub motion belts 17 and 18. The belts 17 and 18, by their longitudinal progressive movement, permit the sliver 11^a and conductor 10, to pass therebetween without interruption and by their lateral reciprocating movements interentangle the fibres of the sliver while wrapping the same about the conductor. During these operations, the fibres of the sliver adjacent the conductor, are embedded in the adhesive and secured to the conductor, being generally disposed parallel to the length of the conductor and to the direction of the forward movement thereof, they not having been substantially disturbed from this position after leaving the doffer roll 12. The remaining fibres are interentangled and slightly condensed without, in any degree, twisting or rolling the conductor by the transverse or lateral reciprocating action of the rub motion belts 17 and 18, due to the tension provided therebetween.

The covered conductor is then acted upon by a pair of opposed spring fingers 26 and 27 of the licker 19, which condenses the fibres and disposes the outer fibres generally circumferentially about the conductor. The entire fibrous covering is then thoroughly impregnated with a fibre binding compound, the surplus of which is removed by the rotating wiping means 23. The rapidly rotated centrifugally operated fingers 35 of the polishing means 24, press against opposite sides of the covered conductor and condense the fibres thereof into a dense, compact flexible covering or sheath for the conductor, as well as smoothing and polishing the outer surface thereof.

It will, of course, be understood that the

fibres from a carding machine are arranged in the form of a ribbon in which they are promiscuously entangled while being disposed generally parallel to each other and to the length of the ribbon. We have also shown means comprising a set of rub-motion belts 17 and 18 between which the ribbon-like sliver of fibres and the conductor to which this sliver of fibres has been applied, are drawn, while these belts wrap the ribbon-like sliver about the conductor by the laterally reciprocating motion thereof, and, due to a predetermined amount of pressure between the belts, slightly condenses the body of fibres. As brought out above, these rub-motion belts, owing to the lateral reciprocating motion thereof, entangle the fibres without substantially disturbing the generally parallel disposition of the fibres that have become embedded in the adhesive. It will be obvious, however, that other mechanism might be employed whereby these results could be obtained. Changes may also be made in respect to the licker 19 that further condenses the body of fibres while disposing the outer ones generally circumferentially about the conductor, the compound applicator 20, and the surface polishing device 24.

While we have shown and described a preferred embodiment of our invention, it is to be understood that it is not to be limited thereto in all of its details, as the same is capable of modification and variation which will lie within the spirit of the invention and the scope of the appended claims.

What we claim is:

1. In apparatus for making insulated electrical conductors, means to provide a body of entangled and generally parallel fibres, means to feed the body of fibres adjacent to a conductor, means to apply an adhesive to the conductor, opposed members to pressingly apply the fibres to and about the conductor without disturbing the parallel disposition of the fibres adjacent the conductor, and means including a rotatable wiper having members adapted to pressingly engage the outer fibres of the body of fibres to arrange them generally circumferentially about the conductor.

2. In apparatus for making insulated electrical conductors, means to provide a body of entangled and generally parallel fibres, means to feed the body of fibres adjacent to an adhesive covered conductor, means to apply an adhesive to the conductor, cooperating mechanism including opposed members movable relatively to the conductor to pressingly apply the fibres to and about the conductor to embed them in the adhesive thereon without disturbing the parallel disposition of the fibres adjacent the conductor and to arrange the outer fibres of the body of fibres generally circumferentially about the conductor.

3. Apparatus for making an insulating sheath for an electrical conductor, comprising means to apply a densely compacted body of entangled fibres to a core member with the fibres thereof disposed generally parallel to said core member, opposed members engaging the body of fibres to wrap the same about the core member while permitting a part of the fibres of said body to remain generally parallel to said core member, members engaging different sides of said covered core member to turn the fibres of another part of the body of fibres into a position wherein they are directed generally circumferentially about the core member, and mechanism rotatable about said core member and engaging the covering thereon to compress all of the fibres against the core member and to smooth the outer surface of said sheath.

4. Apparatus for forming an insulating sheath for an electrical conductor, comprising means to feed a body of fibres to a core member with the fibres thereof disposed generally parallel to said core member, cooperating elements to engage the body of fibres and to apply it to the core member and to condense the body of fibres without disturbing the parallel disposition of the fibres adjacent the core member but with incidental turning of another portion of said fibres of said body generally circumferentially about the core member, mechanism adapted to impregnate the fibres with a fibre binding compound, and cooperating members resiliently engaging the covered core member to further condense the fibres into a compact and dense mass while smoothing the outer surface of the sheath.

5. In apparatus for forming an insulating sheath for an electrical conductor, means for applying a body of generally parallelly disposed entangled fibres upon a longitudinally movable core member generally in parallel therewith, cooperating mechanism including opposed members in engagement with the fibres about the core member to wrap and condense the body of fibres transversely about the member without twisting the core member and with the fibres adjacent the core member remaining directed generally parallel therewith, and to direct the fibres of an outer portion of the body of fibres generally circumferentially about the core member, and means to draw the core member through said apparatus.

6. In apparatus for forming an insulating sheath for an electrical conductor, means to apply an adhesive to a core member, means to feed a body of entangled fibres upon the adhesive coated core member with the fibres of said body disposed generally parallel to said core member, cooperating mechanism including opposed members movable relatively to the conductor to wrap and condense the body of fibres about the core

member without twisting the core member, with the fibres adjacent the core member remaining directed generally parallel therewith, and to direct the fibres of the remaining portion of the body of fibres generally circumferentially about the core member, means to impregnate the body of fibres with a fibre binding compound, and means to condense the body of fibres into a compact and dense mass while smoothing the outer surface of the sheath.

7. In a wire insulating machine, a rotary frame through which the wire is passed, and a pressure element associated with said frame having a portion which moves outwardly by centrifugal action on rotation of said frame, and another portion fixed to the first and in alignment therewith radially with respect to said frame which moves inwardly toward the wire.

8. Apparatus for insulating an electrical conductor comprising an adhesive applying mechanism to coat the conductor with an adhesive compound, a member adapted to receive a body of entangled and generally parallel fibres of an insulating material thereon, means to direct the body of fibres from said member into engagement with the adhesive covered conductor, opposed members disposed one on either side of the conductor, to wrap and compact the body of fibres about the conductor while preserving the generally parallel disposition of the fibres adjacent the conductor, opposed members disposed one on either side of the conductor to engage and further compact the body of fibres of the outer portion thereof into a generally circumferential direction and to bind the fibres therebeneath closely to said conductor, a fibre binding compound applicator adapted to receive the covered conductor, and opposed members disposed one on either side of the conductor to engage and further compress the body of fibres and to smooth the outer surface thereof.

9. Apparatus for insulating an electrical conductor comprising an adhesive applying mechanism to coat the conductor with an adhesive compound, a member adapted to receive a body of entangled and generally parallel fibres of an insulating material thereon, means to direct the body of fibres from said member into engagement with the adhesive covered conductor, opposed members engaging the body of fibres and cooperating to compact and wrap the same about the conductor and to entangle the fibres thereof while preserving the generally parallel disposition of the fibres adjacent the conductor, and rotating members engaging the outer surface of the covered conductor and cooperating to further compact the body of fibres and to direct the fibres engaged thereby into a generally circumferential direction with respect to said conductor.

10. Apparatus for insulating an electrical conductor comprising an adhesive applying mechanism to coat the conductor with an adhesive compound, a member adapted to receive a body of entangled and generally parallel fibres of an insulating material thereon, means to direct the body of fibres from said member into engagement with the adhesive covered conductor, opposed members engaging the body of fibres and cooperating to compact and wrap the same about the conductor and to entangle the fibres thereof while preserving the generally parallel disposition of the fibres adjacent the conductor, and rotating members engaging the outer surface of the covered conductor and cooperating to further compact the body of fibres, and to direct the fibres engaged thereby into a generally circumferential direction with respect to said conductor, a fibre binding compound applicator adapted to receive the covered conductor and opposed cooperating members adapted to engage the outer surface of the covering to further compress said body of fibres and to smooth the outer surface thereof.

11. Apparatus for insulating an electrical conductor comprising an adhesive applying mechanism to coat the conductor with an adhesive compound, a member adapted to receive a body of entangled and generally parallel fibres of an insulating material thereon, means to direct the body of fibres from said member into engagement with the adhesive covered conductor, opposed members engaging opposite sides of the body of fibres and cooperating to compact and wrap the same about the conductor and to entangle the fibres thereof while preserving the generally parallel disposition of the fibres adjacent the conductor, and rotating members engaging opposite sides of the outer surface of the covered conductor and cooperating to further compact the body of fibres and to direct the fibres engaged thereby into a generally circumferential direction with respect to said conductor, a fibre binding compound applicator adapted to receive the covered conductor, and rotating members disposed to engage opposite sides of the surface of the conductor covering and cooperating to apply equal pressure thereupon to further compress said body of fibres and to smooth the outer surface thereof.

12. In a surface polishing device, a rotatable support having a plurality of members slidably mounted thereon for radially directed movement by centrifugal force when the support is rotated, a portion of each member being adapted to move toward the corresponding portion of the other member and toward the axis of said support, and another portion on each member adapted to move away from the corresponding portion of the

other member, the portions of each member being fixedly secured together.

13. In a surface polishing device, a rotatable support and a polishing element slidably mounted upon said support for movement relative thereto during the rotation of said support to press against the surface of an article to polish the same, said element being disposed at one side of the axis of said support, and a member disposed at the other side of the axis of said support and adapted to be acted upon by centrifugal force to operate said polishing element.

14. In a surface polishing device, a rotatable support adapted to permit an article to pass longitudinally therethrough, a polishing element slidably mounted upon said support for radial movement relative thereto and disposed at one side of the axis of said support, and a member disposed at another side of the axis of said support and radially slidable with respect thereto by centrifugal force during the rotation of said support to press said polishing element against the surface of an article passing longitudinally through said support to polish the same.

15. In apparatus for covering a conductor with fibrous material, means to direct in one direction a conductor and the fibrous material with the fibres thereof generally parallel to the conductor, a rotary device to receive the conductor and the fibrous material and acting thereon to locate the outer fibres generally circumferentially about the conductor without disturbing the parallel arrangement of the fibres adjacent the conductor, a compound applicator to receive the covered conductor from said rotary device and means forming part of said compound applicator to direct the received conductor in a direction substantially opposite to the first named direction, and a rotary insulation surface smoothing device to receive the covered conductor from the compound applicator to compress the fibrous material about the conductor and smooth the outer surface thereof.

16. In apparatus for covering a conductor with fibrous material, means to direct downwardly a conductor and the fibrous material with the fibres thereof generally parallel to the conductor, a rotary device to receive the conductor and the fibrous material and acting thereon to dispose the outer fibres generally circumferentially about the conductor without disturbing the parallel arrangement of the fibres adjacent the conductor, a compound applicator to receive the covered conductor from said rotary device and means forming part of said compound applicator to direct the received conductor upwardly, and a rotary insulation surface smoothing device to receive the covered conductor from the compound applicator to compress the fibrous material about the conductor and smooth the

outer surface thereof, said rotary devices being rotated in the same direction about said conductor to prevent disarrangement of the circumferentially disposed outer fibres.

17. In apparatus for covering a conductor with fibrous material, means to direct downwardly a conductor and the fibrous material with the fibres thereof generally parallel to the conductor, a rotary device to receive the conductor and the fibrous material and acting thereon to dispose the outer fibres generally circumferentially about the conductor without disturbing the parallel arrangement of the fibres adjacent the conductor, a compound applicator to receive the covered conductor from said rotary device, and means forming part of said compound applicator to direct the received conductor upwardly, and a rotary insulation surface smoothing device to receive the covered conductor from the compound applicator to compress the fibrous material about the conductor and smooth the outer surface thereof, the axes of said rotary devices being parallel to each other, said rotary devices being rotated in the same direction about said conductor to prevent disarrangement of the circumferentially disposed outer fibres.

18. In apparatus for covering a conductor with fibrous material, means to direct in one direction a conductor and the fibrous material with the fibres thereof generally parallel to the conductor downwardly, a rotary device to receive the conductor and the fibrous material and acting thereon to dispose the outer fibres generally circumferentially about the conductor without disturbing the parallel arrangement of the fibres adjacent the conductor, a compound applicator to receive the covered conductor from said rotary device in one direction and means forming part of said compound applicator to direct the covered conductor in another than the first named direction, and a rotary insulation surface smoothing device to receive the covered conductor from the compound applicator to compress the fibrous material about the conductor and smooth the outer surface thereof, and a rotary device associated with said compound applicator and rotatable with said second mentioned rotary device to engage the covered conductor before it enters said second mentioned rotary device to remove surplus compound therefrom.

19. In apparatus for insulating a conductor with fibrous material, a rotary device for compressing the insulation about the conductor, a rotary insulation smoothing device having its axis parallel to the axis of the first mentioned rotary device, and a compound applicator, including means to receive the insulation covered conductor axially from one of said rotary devices and to direct it axially into the other of said devices while

directing it through said compound applicator.

20. In apparatus for insulating a conductor with fibrous material, a pair of rotary spindles mounted with their axes in parallel, each being adapted to permit the conductor to pass axially therethrough, and means to receive the conductor as it passes in one direction from one of said spindles and to direct it in the opposite direction toward the other of said spindles.

21. In apparatus for insulating a conductor with fibrous material, an insulation compressing device, a compound applicator, and an insulation smoothing device, said devices and said applicator being so arranged in respect to each other that the conductor with the adhering fibrous material as it emerges from the first mentioned device feeds in one direction through said compound applicator and then in the opposite direction toward and into the other device.

22. In apparatus for insulating a conductor with fibrous material, an insulation compressing device, a compound applicator, and an insulation smoothing device, said devices and said applicator being so arranged in respect to each other that the conductor with the adhering fibrous material as it emerges from the first mentioned device feeds downwardly through said compound applicator and then upwardly toward and into the other device, describing a U-shape in its travel.

23. In apparatus for making insulated electrical conductors, means providing a supply of entangled and generally parallel fibres in the form of a flat ribbon-like strip, means to feed the strip of fibres lengthwise along and adjacent to the conductor, means to apply an adhesive to the conductor, opposed members one on either side of the conductor to engage and transversely wrap the strip of fibres about the conductor, to press the fibres adjacent the conductor into tight engagement therewith, and to arrange the outer fibres generally circumferentially about the conductor, and means to impregnate the fibrous covering.

24. In apparatus for making insulated electrical conductors, means providing a supply of entangled and generally parallel fibres in the form of a flat ribbon-like strip, means providing a supply of an adhesive covered conductor, means to feed the strip of fibres lengthwise along and adjacent to the conductor, opposed members one on either side of the conductor to engage and transversely wrap the strip of fibres about the conductor without twisting the conductor and to pressingly engage the fibrous strip to embed the fibres adjacent the conductor into the adhesive thereon without disturbing the parallel disposition of the fibres but with incidental turning of the outer fibres generally circumferentially of the conductor,

means to impregnate the fibrous covering, and members resiliently engaging the covered conductor to further condense the covering and to polish the same.

25. In apparatus for insulating electrical conductors, means providing a supply of entangled fibres in the form of a flat ribbon-like strip, means to feed the strip of fibres lengthwise along and adjacent to a conductor, means to transversely wrap the strip of fibres about the conductor and to press the fibres adjacent the conductor into tight engagement therewith, means to receive the conductor so covered, said last-named means containing compound for impregnating the fibrous covering and including means to direct the conductor out of said receiving means in a direction reverse to that by which it entered, and a rotatable member to engage the outer surface of the covered conductor as it emerges from said receiving means and to compress the fibrous covering thereof, said conductor directing means acting to guide the conductor through said receiving means and to direct it into said rotating member axially with respect thereto.

26. In apparatus for insulating electrical conductors, means providing a supply of en-

tangled and generally parallel fibres in the form of a flat ribbon-like strip, means to feed the strip of fibres lengthwise along and adjacent to an adhesive covered conductor, means to transversely wrap the strip of fibres about the conductor without twisting the conductor and to press the fibres adjacent the conductor into tight engagement therewith to embed them in the adhesive thereon and without affecting the parallel disposition of the fibres adjacent the conductor, means to receive the conductor so covered, said last-named means containing compound for impregnating the fibrous covering and including means to direct the conductor out of said receiving means in a direction reverse to that by which it entered, and a rotatable member to engage the outer surface of the covered conductor as it emerges from said receiving means and to compress the fibrous covering thereof, said conductor directing means acting to guide the conductor through said receiving means and to direct it into said rotating member axially with respect thereto.

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