Dec. 29, 1936. W. E. BOYLE ET AL 2,065,561

METHOD OF AND EQUIPMENT FOR PRODUCING ABRASION RESISTING COVERING FOR CONDUCTORS

Filed Jan. 19, 1934 2 Sheets-Sheet 1

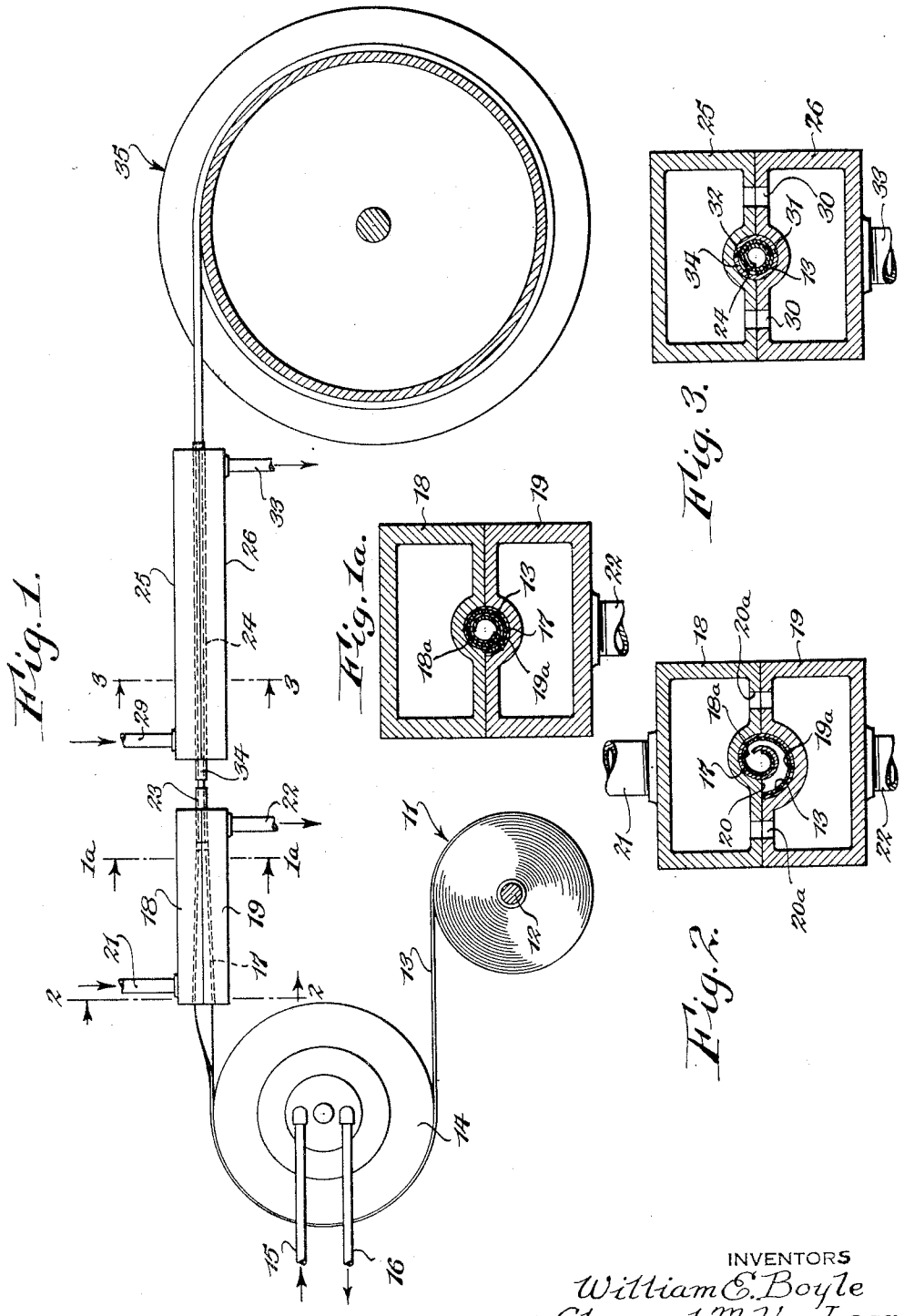


Fig. 1.

Fig. 3.

Fig. 1a.

Fig. 2.

INVENTORS
William E. Boyle
Glenwood M. VanLear
By Popp and Powers ATTORNEYS

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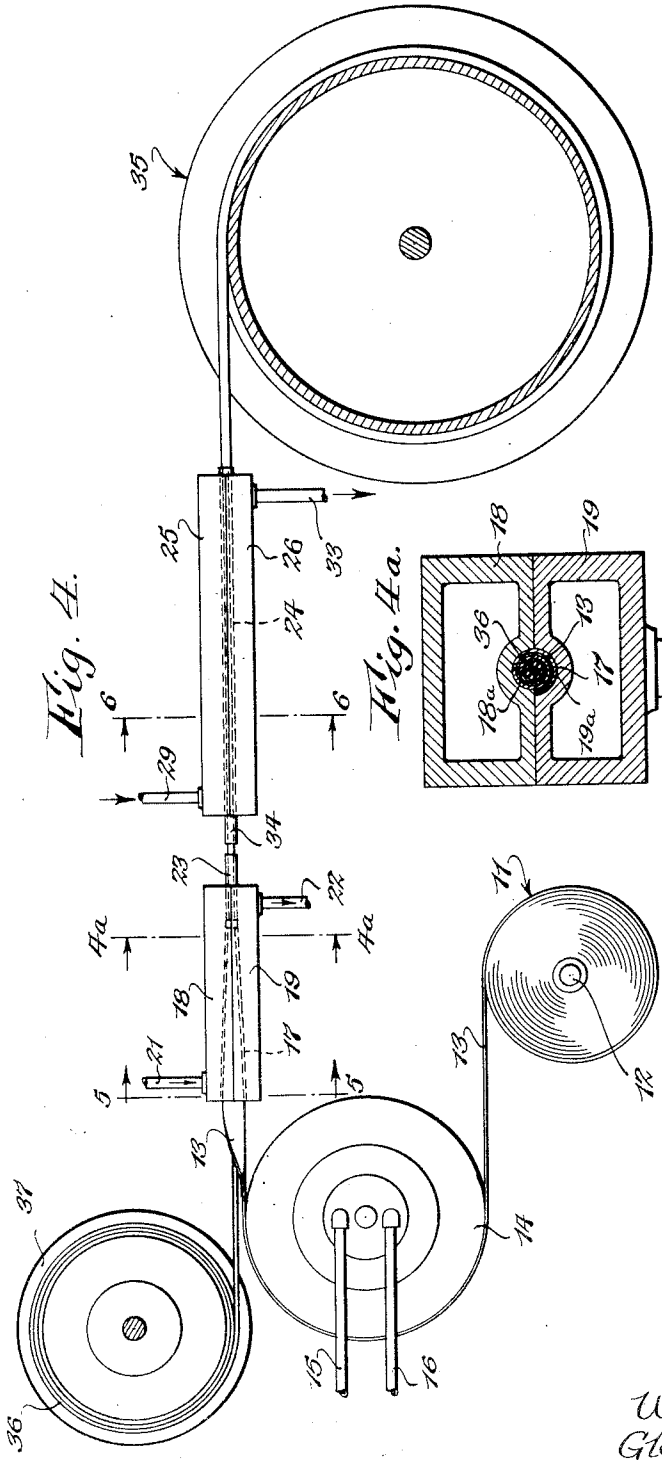


Fig. 4.

Fig. 4a.

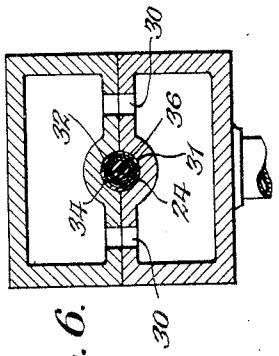


Fig. 6.

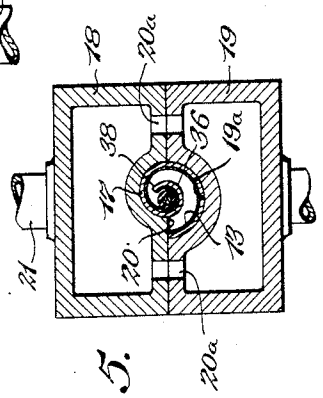


Fig. 5.

INVENTORS
William E. Boyle
Glenwood M. Van Lear
By Bopp and Bowers ATTORNEYS

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METHOD OF AND EQUIPMENT FOR PRODUCING ABRASION RESISTING COVERING FOR CONDUCTORS

William E. Boyle and Glenwood M. Van Lear, Madison, N. J., assignors to Spaulding Fibre Co. Inc., Tonawanda, N. Y., a corporation of New Hampshire

Application January 19, 1934, Serial No. 707,347

6 Claims. (Cl. 173—244)

This invention relates to protective shields of the kind covered by the copending application of William E. Boyle, Ser. No. 626,977, filed July 30, 1932 which has matured to Patent No. 1,979,444, dated Nov. 6, 1934. More particularly the invention is concerned with a novel method for the production of such shields and it involves novel equipment for practicing the method. The shield disclosed in the said application is suitable for a variety of purposes. It has, however, especial utility as an abrasion resisting covering for electrical conductors and the like; and for purposes of illustration it is described in connection with such use in both said copending application Ser. No. 626,977 and in the present application, it being understood that the invention contemplates the use of the shield in connection with either insulated or non-insulated conductors.

One object of the invention is a process which enables the production of a shield of the type generally described in any desired length or in multiples of such length.

A further object is a process which is available for the production of so-called "tree wire", this object contemplating the application of the shield directly to the conductor as an incident to the forming operation.

The invention is illustrated in the accompanying drawings in which:

Figure 1 is a view in elevation of equipment suitable for carrying out the process.

Figure 1*a* is an enlarged section taken along line 1ª—1ª of Figure 1.

Figure 2 is an enlarged section taken along line 2—2 of Figure 1.

Figure 3 is an enlarged section taken along line 3—3 of Figure 1.

Figure 4 is a view similar to Figure 1 illustrating modified equipment for applying the shield directly to the conductor as it is formed.

Figure 4*a* is an enlarged section taken along line 4ª—4ª of Figure 4.

Figure 5 is an enlarged section taken along line 5—5 of Figure 4.

Figure 6 is an enlarged section taken along line 6—6 of Figure 4.

In the practice of the process a continuous strip of stock is employed. The latter consists of a base material impregnated with a binder. The base material is preferably of a fibrous character and may, for example, be of duck, jute or paper. The binder with which the base material is impregnated is preferably a synthetic resin such as, for example, "Bakelite", or the like. It may contain a filler such as bituminous matter or a self-lubricant such as graphite. In the preparation of the strip of stock, assuming for purposes of illustration that the base material is duck and the binder a 40 to 50 per cent phenol-formaldehyde resin, the strip of duck is passed through a bath of the phenol-formaldehyde resin or is otherwise suitably coated with the resin. After the resin has been dried to the proper stage, the impregnated strip is subjected to heat and pressure to cure the resin to the extent desired, it being understood in this connection that the heating and pressing operations are so regulated as to only partially cure the binder in order that it may be again softened by heating. The strip is then permitted to cool. As it cools the binder hardens and sets. The strip thus provided may, for convenience, be formed into a roll.

A roll of stock prepared in the manner described is indicated at 11 in Figure 1, the said roll being suitably mounted upon a spindle 12 so that the stock may be unrolled to provide a continuous strip 13. The latter passes around a rotatable drum 14 which is preferably heated. To this end steam at a temperature, for example, of 350° F., is introduced into the drum through a supply pipe 15, the steam being discharged from the drum through an exhaust pipe 16. As the strip 13 passes around the drum 14 it is heated and the binder, which in the present instance is a phenol-formaldehyde condensation product, is softened and further cured.

The heated portion of the strip then passes through a forming member 17. The latter, as best shown in Figures 1*a* and 2 is in the form of a spiral and tapers from the end at which the strip enters it (the end shown in Figure 2) toward the end from which the strip emerges (the end shown in Figure 1*a*), whereby the distance between adjacent convolutions of the forming member decreases from the end at which the strip enters toward the end from which the strip emerges. As the strip passes through the forming member, therefore, it is formed into a spirally wound tube, the various convolutions thereof which are widely spaced at the entrance to the forming member being forced closer together as the strip passes through the forming member. As the binder with which the strip is impregnated is soft at this stage, the strip readily follows the guiding faces of the forming member. In order that the binder will be kept soft and, if desired, further cured during passage of the strip through the forming member, means is provided for further heating

the strip. The said means includes a pair of hollow cooperating sections 18 and 19. The abutting walls 18a and 19a of the said sections are shaped to fit conformably around the forming member, the wall 18a overlying the recess in the companion wall to provide a guiding surface 20. One edge of the strip moves along the said guiding surface, thereby causing the opposite edge of the strip to move around the inner face of the forming member as the strip passes through it. Thus, as the strip moves in the direction of its length it is rolled in a direction transverse to its length, whereby to form the strip into a continuous spirally wound tube. Steam is introduced into the sections 18 through an inlet pipe 21. It passes through registering openings 20a in the walls 18a and 19a into the section 19. The steam is discharged from the section 19 through an exhaust pipe 22.

It will be apparent that as the strip 13 passes through the forming member it is further heated. The binder, therefore, is kept in a soft condition while the forming member rolls the strip into its tubular shape, it being noted that the heating of the strip by the drum 14 and the sections 18 and 19 has the further advantage that the binder which at the outset is only partially cured is further cured. In the preparation of the strip 13 the binder may, if preferred, be cured to such an extent as to require no further curing. In this event the primary purpose of the drum 14 and heating sections 18 and 19 is to soften the binder. On the other hand the strip may be prepared in such a manner as to require further curing. In this case the heating of the strip by the drum 14 and sections 18 and 19 may be controlled so that the binder is cured to the extent desired, it being understood that the curing of the binder in the manner described may be effected in any desired number of stages.

Upon emerging from the forming member 17, the spirally wound strip enters a tube 23 (Figure 1). The tube is preferably of substantially the same diameter as the smaller end of the forming member. As the spirally wound strip passes through the tube 23 the outer convolution thereof is held against unrolling or expanding while the inner convolutions expand slightly to fill the spaces originally occupied by the various convolutions of the forming member. If desired the diameter of the tube 23 may be less than the diameter of the smaller end of the forming member. In this case the diameter of the various convolutions of the spirally wound strip is further reduced to take up the spaces originally occupied by the convolutions of the forming member. It will be apparent, therefore, that as the strip emerges from the tubes 23 its various convolutions are tightly rolled upon one another.

While the strip is held in this shape it is passed through a cooling chamber 24 (Figure 3) in order to harden and set the binder. The cooling chamber, as illustrated, is provided by a pair of hollow sections 25 and 26. A suitable refrigerating medium is introduced into the section 25 through an inlet pipe 29. It passes through registering openings 30 which are formed in the abutting walls 31 and 32 of the two sections into the section 26 and is discharged from the section 26 through an outlet pipe 33. A tube 34 fits conformably in the cooling chamber 24, the said tube being preferably of substantially the same diameter as the tube 23 and being in axial alignment therewith. Upon emerging from the tube 23 the spirally wound strip moves only a short distance before it enters the tube 34. As it passes through the latter it is subjected to the cooling action of the refrigerating medium which is circulated through the sections 25 and 26 whereby to harden and set the binder, the tube 34 serving to hold the strip in the shape in which it is formed by the forming member 17 until the binder has hardened and set so that it will retain such shape. As the strip 13 emerges from the tube 34 it is in the form of a spirally wound tube. It may be cut into straight sections of determined lengths or it may, as illustrated, be wound upon a drum 35, it being understood in this connection that although it is straight and resiliently resists bending, it can be readily wound upon a drum if the diameter of the latter is large enough so that the degree of bending is relatively small. The drum 35 may be driven in any suitable manner, whereby to feed the strip 13 through the various parts of the equipment.

The shield thus provided has the high dielectric properties characteristic of a phenol-formaldehyde condensation product and its hard smooth surface renders it highly resistant to abrasion. The various convolutions of the shield resiliently tend to retain their shape. Hence while it may be unrolled or opened to enable its application to a conductor it will, when released, automaticaly contract upon the conductor as it returns toward its original shape.

The shield may be divided into short sections similar to the section shown in the copending application above referred to. In this case the entire section may be unrolled or opened to enable its application to the desired part of the conductor. If a long section of the shield is employed it may be applied by progressively unrolling or opening succeeding parts to progressively encase succeeding parts of the conductor. In other words a part of the shield is unrolled or opened and arranged upon a part of the conductor. An adjacent part of the shield is then unrolled or opened and arranged upon the adjacent part of the conductor. This procedure is followed until the entire length of the shield is applied to the conductor.

In one aspect the invention contemplates forming the shield directly upon the conductor, whereby to produce a conductor commonly known as "tree wire." Equipment is illustrated in Figures 4 to 6 inclusive for producing a covered wire of this kind. It is similar to the equipment illustrated in Figure 1 except that it includes a coil of insulated wire 36, the said coil of wire being carried by a rotatable drum 37. The wire is fed from the drum into the forming member 17 with the strip 13, the drum being so located that the wire enters and moves substantially along the axis of the inner convolution 38 (Figure 5) of the said member. As the wire and strip pass through the forming member the strip is wound tightly around the wire, it being understood in this connection that the strip is preheated as it is fed over the drum 14 and then further heated as it passes through the forming member 17 as described in connection with the embodiment illustrated in Figure 1. Thereafter as the wire passes through the tube 34 the latter holds the strip 13 tightly wound around the wire. During this time the strip is subjected to the cooling action of the refrigerating medium which

is circulated through the cooling chamber provided by the sections **25** and **26**. The binder with which the strip is impregnated is thereby hardened and it sets to hold the strip tightly wound around the conductor. If desired the shield may be further secured by a conventional wrapping of tape or braid.

From the foregoing it will be apparent that the abrasion resisting covering may be produced independently as an accessory which is to be subsequently applied to the conductor or it may be applied directly to the conductor as an incident to the forming operation. In this connection it is to be understood that the shield is applicable, in either aspect, to conductors which are either insulated or bare.

We claim as our invention:

1. The method of producing an abrasion resisting covering for a conductor from a continuous strip of material which consists of a fibrous base impregnated with a binder consisting of a partially cured phenol-formaldehyde condensation product, which method consists of moving the strip in the direction of its length and during such movement heating the strip to soften and further cure the binder, rolling the strip in a direction transverse of its length to form a spirally wound tube, holding the tube thus formed against unrolling while permitting it to move lengthwise and cooling the tube while so held, whereby to harden and set the binder.

2. The method of producing an abrasion resisting covering for a conductor from a continuous strip of material which consists of a fibrous base impregnated with a binder consisting of a partially cured phenol-formaldehyde condensation product, which method consists of preliminarily heating the strip to soften the binder, moving the strip in the direction of its length and during such movement rolling it in a direction transverse of its length to form a tube, further heating the strip to keep the binder soft and further cure it during the last described operation, holding the tube against unrolling while permitting it to move lengthwise and cooling the tube while so held, whereby to harden and set the binder.

3. The method of covering a wire with a strip of material which consists of a fibrous base impregnated with a binder consisting of a partially cured phenol-formaldehyde condensation product, which process consists of heating the material to soften and further cure the binder, moving said strip in the direction of its length and during such movement feeding said wire alongside the strip, rolling the strip in a direction transverse to its length, whereby to form a spirally wound covering directly upon said wire and holding the covering against unrolling while the binder cools and hardens.

4. The method of covering a wire with a strip of material which consists of a fibrous base impregnated with a binder consisting of a partially cured phenol-formaldehyde condensation product, which process consists of heating the material to soften and further cure the binder, moving said strip in the direction of its length and during such movement feeding said wire alongside the strip, rolling the strip in a direction transverse to its length whereby to form a spirally wound covering directly upon said wire, holding the covering against unrolling while permitting it to move lengthwise with said wire and cooling said covering while it is so held, whereby to harden and set the binder.

5. The method of covering a wire with a strip of material which consists of a fibrous base impregnated with a binder consisting of a partially cured phenol-formaldehyde condensation product, which process consists of preliminarily heating the material, to soften the binder, moving the strip in the direction of its length and during such movement feeding said wire alongside the strip, rolling the strip in a direction transverse to its length whereby to form a spirally wound covering directly upon said wire, further heating said strip during said rolling operation to keep said binder soft and further cure it, holding the covering against unrolling while permitting it to move lengthwise with said wire and cooling said covering while it is so held, whereby to harden and set the binder.

6. The method of producing an abrasion resisting covering for a conductor from a continuous strip of material having a fibrous base, which method consists in impregnating the material with a binder comprising a phenol-formaldehyde resin, subjecting the impregnated strip to heat and pressure to convert the binder into a partially cured phenol-formaldehyde condensation product and permitting the binder to cool and harden, thereafter heating the strip to soften the binder, moving said strip in the direction of its length and during such movement rolling it in a direction transverse of its length into a tube and holding the tube against unrolling while the binder hardens.

WILLIAM E. BOYLE.
GLENWOOD M. VAN LEAR.