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SEALING OF PAPER RIBBON PROJECTING EDGE PORTIONS ON WOODPULP INSULATED CONDUCTORS

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FIG. 1a.

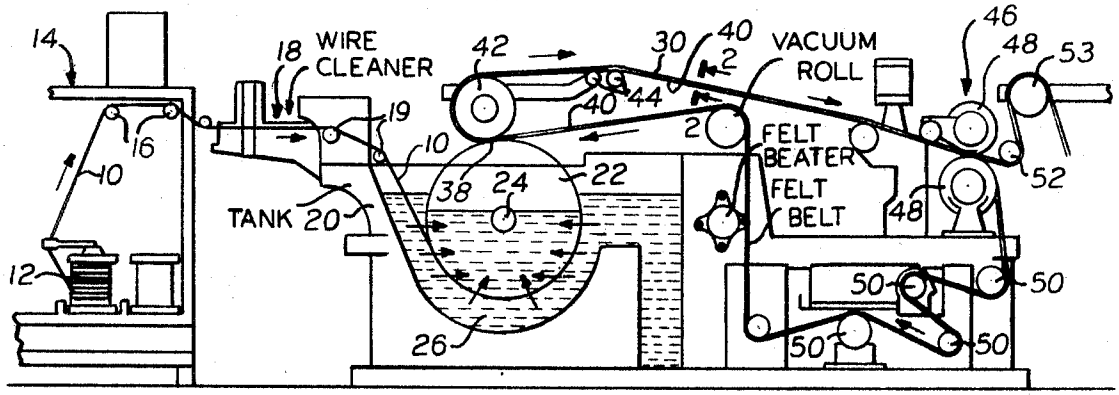


FIG. 1b.

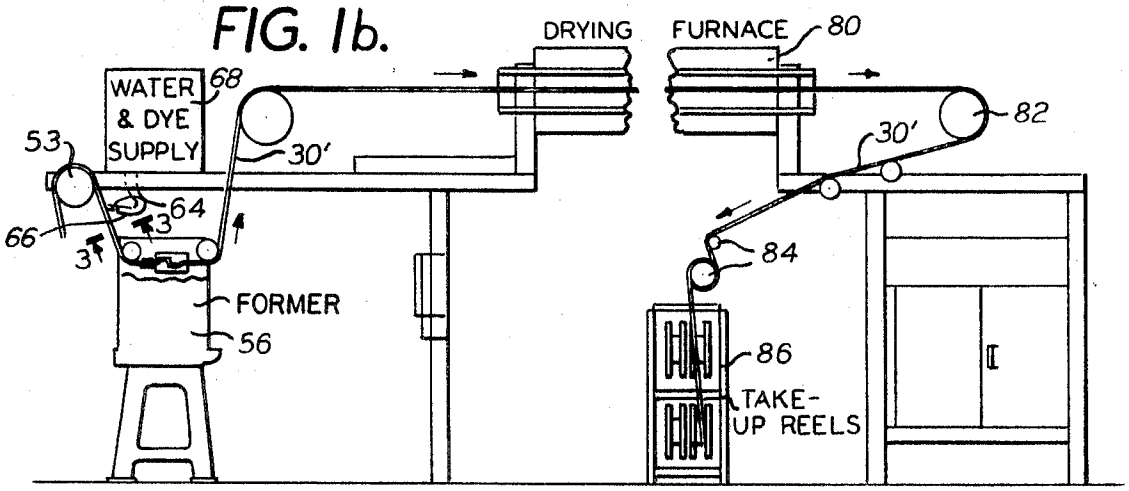


FIG. 2.

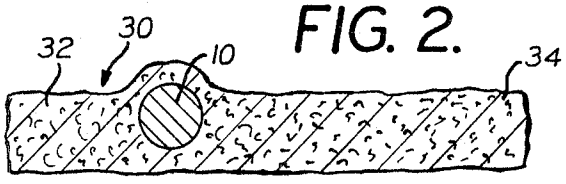


FIG. 3.

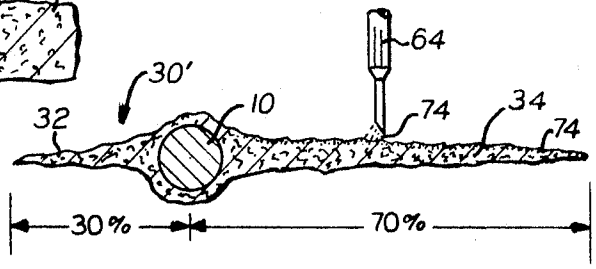


FIG. 4.

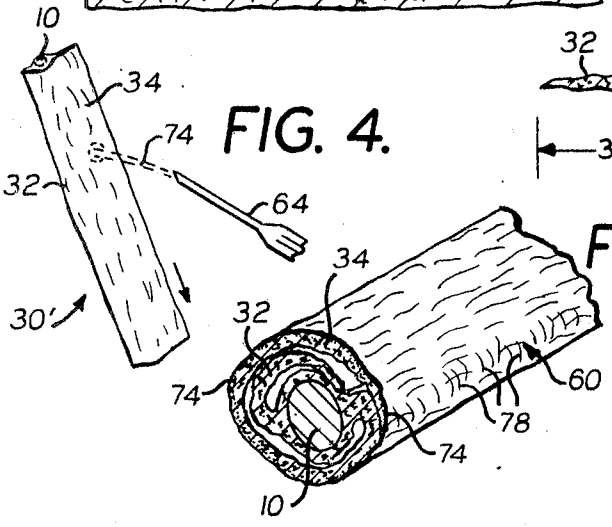


FIG. 5.

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SEALING OF PAPER RIBBON PROJECTING EDGE PORTIONS ON WOODPULP INSULATED CONDUCTORS

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ABSTRACT OF THE DISCLOSURE

Apparatus and process wherein an electrical conductor is passed through a cylindrical mold immersed in a tank of woodpulp, and the pulp is squeezed to remove excess water and to leave a ribbon of paper with the conductor imbedded therein. The conductor is located off center in the pulp mass so that a greater width of paper ribbon projects from one side of the conductor than from the other. Water is applied to one paper ribbon or projecting edge to refloat some of the surface fibers of the paper so that they are held against the seam of the paper ribbon with a helical conformation during the wrapping operation, thus providing means for holding the seam closed. The projecting edge portions are then wrapped circumferentially and the longer edge portion overlaps the shorter edge portion. The finished insulation, therefore, has only one seam.

BACKGROUND AND SUMMARY OF THE INVENTION

In the manufacture of paper-insulated electrical conductors by passing a conductor through a tank of woodpulp furnish and then squeezing the pulp to form a paper ribbon with the conductor imbedded therein, projecting edge portions of the ribbon opposite sides of the conductor are wrapped around the conductor to form a cylindrical tube of paper insulation. If the edge portions of the ribbon were permanently affixed to the balance of the paper in the wrapping, polishing, or forming operation, the insulation would be a continuous homogeneous tube. This does not occur, however, because wet paper ribbon does not bond to itself as woodpulp does. Use of glues, starches or other additives to secure the edge portions to the underlying paper in which the conductor is imbedded, is objectionable because it impairs the insulating qualities of the paper. It is necessary to squeeze the water out of the woodpulp and form a paper prior to the wrapping, polishing, or forming operation because otherwise the wire and woodpulp will fall apart when lifted from the felt belt on which draining of water takes place.

In subsequent operation of drying and wire handling, because the ribbon edge portions are not sealed to the underlying paper, the edge portions intermittently open up and in some instances the bare wire springs out of the paper in which it is imbedded. Since there has been no provision for sealing of the edge portions in a continuous and positive manner, the resulting product in the prior art, because of chance distribution and various degrees of edge portion adhesion, has been a non-uniform product.

In a strict sense the edge portions are ironed down in the forming and drying processes, but not sealed. In the presence of moisture during splicing of cables at high humidity and in handling of wire by a splicer, the edge portions tend to lift and open up. This becomes especially objectionable with automatic splicing machines. The sliding motion of the jaws gripping the wire tends to open the edge portions. The wire is bent at sharp angles and this also contributes to the opening of the edge portions.

This invention is based on the discovery that some of the woodpulp fibers forming the wet paper and predominantly aligned longitudinally parallel to the edges of the ribbon can be refloated from the surface of the wet paper and changed in alignment so as to act as a binder by wrapping them around the outer surface of the insulated conductor in a manner similar to serving a cotton yarn around a conductor, as is done on a magnet wire and the like.

In effect, the edge portion becomes as if stitched on the seam with the reoriented fibers occupying a helical conformation across the edge portion seam. In addition, once the edge portion becomes fastened as described above, and the wet wire with the fastened edge portion is subsequently passed through a drying oven, an additional benefit is realized. During the fast drying in the oven, the fibers of the edge portion and the fibers of underlying layers of wet paper are kept in close contact by the fastening of the edge portions. When the drying commences in the hot zone of the drying oven, the fiber of the edge portions and the fiber of the underlying paper layers remain in contact; and in the process of shrinking and curling (due to drying) the fibers of the edge portions mesh to some extent with the fibers of the underlying paper, resulting in a quasi-intermeshing of the paper which does not occur when wet edge portions are merely wrapped around the underlying paper and left free to shrink and lift slightly in the process of drying.

The liquid used for refloating of surface fibers can also be used as a vehicle for dye when it is desirable to color the outside of the insulation. Dye applied according to this invention is on the surface of the insulation and does not permeate all the way through. This maintains better insulating characteristics for the paper.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views:

FIGS. 1*a* and 1*b* are diagrammatic side elevations of apparatus for making pulp-insulated electrical conductors in accordance with this invention;

FIG. 2 is a greatly enlarged sectional view on the line 2—2 of FIG. 1*a*, illustrating the way in which the woodpulp is molded around the electrical conductor with edge portions extending from both sides of the conductor;

FIG. 3 is a greatly enlarged sectional view taken on the line 3—3 of FIG. 1*b* and showing the change in cross section of the edge portion after the woodpulp has been squeezed or pressed to remove excess water and to produce a paper insulation, and showing also the application of water to refloat surface fibers near the edge of the longer edge portion;

FIG. 4 is a diagrammatic view showing the application of the water stream to the paper insulation; and

FIG. 5 is a fragmentary isometric view of the insulated conductor after forming and showing the way in which the refloated fibers of the longer edge portion extend across the lap seam.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A bare wire electrical conductor **10** is withdrawn from a supply reel **12** at a conductor supply station **14**. The wire passes over guide rolls **16** and through a wire cleaner **18**, and then passes over other wire guides **19** and

into a tank **20** containing a cylinder **22** which rotates on an axle **24**. The apparatus actually has a large number of parallel conductors, but to simplify the illustration and description, the invention will be described with only one conductor.

The tank **20** contains woodpulp furnish **26** designated by stippling, and the conductor **10** passes around the underside of the cylinder **22** and becomes imbedded in a mass or ribbon of woodpulp **30** which surrounds the entire circumference of the conductor **10** and which is formed with projecting edge portions **32** and **34**. In accordance with one feature of the invention, the conductor **10** is located off center in the mass of woodpulp **30** so that the edge portion **34** is substantially longer than the edge portion **32**.

The cylinder **22** extends above the surface of the pulp furnish **26** in the tank and at a location **38** the woodpulp **30** with the conductor **10** imbedded therein, is removed from the cylinder to a conveyor which preferably comprises a felt belt **40**. This belt **40** passes around a guide roll **42** and across other guide rolls **44** to a squeeze station **46** where the woodpulp **30**, with the conductor **10** imbedded therein, is squeezed between pressure rolls **48** to remove excess water from the woodpulp so that the woodpulp is changed into a wet paper ribbon. The squeeze station **46** is at a substantial distance from the guide roll **42** so that a substantial amount of water can drain from the woodpulp before the woodpulp reaches the pressure rolls **48**.

At the discharge side of the pressure rolls **48**, the paper insulation **30'**, with the conductor **10** imbedded therein, is removed from the conveyor belt **40**, since the paper has sufficient strength to remain on the conductor after the excess water has been squeezed out by the pressure rolls **48**. The belt **40**, which is a continuous belt, passes around guide rolls **50** and back to the guide roll **42**.

The apparatus thus far described is illustrated diagrammatically and is described broadly since it is conventional except for the feature by which the last wire guide **19** locates the conductor **10** off center in the woodpulp mass **30**.

The paper insulation **30'**, with the conductor **10** imbedded therein, passes around guide rolls **52** and **53**, and then passes to a former **56** in which the projecting edge portions **32** and **34** are bent around the paper which covers the conductor **10**, and wrapped so as to give the assembly a substantially circular cross section, as shown in FIG. 4. A former for thus wrapping the projecting edge portions of a paper ribbon is well known and such a machine is disclosed in Pat. No. 1,615,416 issued Jan. 25, 1927. The construction of the former **56** of the present invention may be the same as that shown in FIGS. 3 and 4 of Pat. 1,615,416. When this invention is made with the off-center feature, the conductor **10** is preferably located so that at least 70% of the width of the paper strip or ribbon, in which the conductor is imbedded, is on the side of the edge portion **34** and not more than 30% of the width of the insulation strip is on the other side of the conductor, as shown in FIG. 3.

With this construction the edge portion **34** will wrap around substantially the entire circumference of the assembly, as shown in FIG. 5. This leaves the paper insulation tube with only one seam **60** on the outside. It will be evident that the actual length of the edge portion **34**, in order to obtain this result, depends upon the thickness of the edge portions, as well as upon their length, because the edge portion **34** has to cover the wrapped flap **32** and a greater length of the edge portion **34** is required if the edge portions **32** and **34** are thicker and the radius around which the edge portion **34** must wrap is thereby increased.

Referring again to FIG. 1*b*, a stream of water is supplied to the continuously moving insulation strip **30'** by a nozzle **64** at a location just ahead of the former **56**. This stream of water, which also contains dye, if the insulation

is to be colored, flows to the nozzle **64** through tubing **66** from a water and dye supply vessel **68**. The rate of flow is controlled by the hydrostatic pressure from stable level of liquid in the supply tank. The details of maintaining constant level are conventional and are not shown.

When dye is used, it is desirable to limit the dye in the insulation so as to preserve the electrical characteristics of the insulation by applying the dye only to one surface of the flap on which the surface fibers are refloated.

The nozzle **64** is located on one side of the long edge portion **34** and the stream of water is applied to the surface of the edge portion **34** which will be on the outside of the insulation after the forming operation. It is a feature of the invention that the water from the nozzle **64** is applied to the surface of the edge portion **34** immediately ahead (two or three feet upstream) of the location at which the former **56** contacts with the edge portions to bend them circumferentially around the conductor **10** and the paper insulation which coats the conductor itself. FIG. 3 indicates the water from the nozzle **64** by the reference character **74** and the water is applied to the surface of the paper insulation so close to the former **56** that the water **74** does not have time to soak into the wet paper before the former contacts with the surface fibers which are refloated by the stream of water **74**. These refloated fibers are thus reoriented from their longitudinally extending positions to a helical conformation which is a resultant of the longitudinal movement of the insulation **30'** and the conductor **10** through the former and the relative movement of the former circumferentially with respect to the surface of the paper insulation.

In practice, this refloating operation requires a correlation of the amount of water **74**, the distance from the nozzle **64** to the contact surfaces of the former, and the longitudinal speed of the conductor and insulation through the former.

Experience has shown that from two to five percent of the surface fibers can be refloated and dislodged from their predominantly longitudinal alignment (parallel to the conductor **10**) by polisher contact surfaces rotating at 6,000 revolutions per minute against paper insulation moving through the polishing machine at the rate of 130 to 150 feet per minute. These figures are given by way of illustration; but in the preferred construction the speed of the polisher head is at least 5,000 revolutions per minute and the progress of the conductor and insulation through the former is at least 100 feet per minute. The paper insulation, as it passes through the former **56**, has an approximate water content of 70% and a dry pulp content of 30%, neglecting the free floating water stream. Under such operating conditions, good results are obtained with the nozzle **64** two to three feet upstream (ahead of) the location where the former first contacts with the edge portions **32** and **34**, to fold them. These values are given by way of illustration.

The nozzle **64** may be a hypodermic needle of size No. 20 or 22 and the necessary stream of water from this nozzle can be obtained with a static pressure of water column of 26 inches. The water stream **74** is prevented from spreading to the edge portion **32** by the hump in the insulation over the conductor **10**. This hump serving as a barrier. When dye is included in the water **74**, the outside surface of the edge portion **30** is colored and this colors the entire outside surface of the finished conductor when the edge portion **34** is long enough to extend around the entire circumference of the assembly as shown in FIG. 5.

The refloated surface fibers, helically extending across the seam **60**, are indicated diagrammatically by the reference character **78**. These fibers hold the seam closed as it passes through a drying furnace **80** (FIG. 1*b*). By having the seam held closed there is an intermeshing of fibers of the interfaces of the edge portion **34** and the paper insulation over which it is wrapped, as previously explained.

The insulation produced by this invention is substantially stronger than that produced by methods of the prior art, which do not include the refloating step for reorienting fibers along the seam edge prior to forming. It has also further mechanical and electrical implications. In pairing, stranding and cabling, the insulation of conductors is held rigidly around the wires due to sealing of edge portions to a greater extent than in the prior art. This results in higher inductance of pairs and lower mutual capacitance for a given cable cross section.

Beyond the drying furnace **80**, the insulated conductor passes around a pulling capstan **82** and over guide rolls **84** to take-up reels **86** on which the wire is wrapped.

The preferred embodiments of the invention have been illustrated and described, but changes and modifications can be made and some features can be used in different combinations without departing from the invention as defined in the claims.

What is claimed is:

1. The method of making paper-insulated electrical conductors which comprises passing an electrical conductor through a mass of woodpulp to apply a coating of the pulp thereto, squeezing the pulp on the conductor to remove water therefrom and to form a wet paper insulation ribbon with the conductor imbedded in the ribbon and with an edge portion of the ribbon projecting from at least one side of the conductor, making said edge portion long enough to wrap around the entire circumference of the conductor and other insulation and to form a paper tube with a single lap seam, refloating some of the surface fibers on that surface of the edge portion which forms the outside of the paper tube by applying water to said surface after the squeezing operation and before wrapping the edge portion, and then wrapping the wet paper edge portion around the conductor and said other insulation to form the paper tube to insure that the refloated fibers are held against said lap seam during the wrapping to hold the seam closed.

2. The method described in claim **1** characterized by forming the paper ribbon with edge portions projecting from opposite sides of the conductor, and originally locating the conductor off center in the coating of woodpulp so that the paper ribbon forms with one edge portion substantially longer than the other, and wrapping the longer edge portion over the other edge portion.

3. The method described in claim **2** characterized by directing a stream of water against the longer edge portion progressively along the length of the insulation strip to refloat the surface fibers, and wrapping the paper edge portions about the conductor before the water has time to soak into the paper.

4. The method described in claim **2** characterized by dyeing the outer surface of the insulated conductor by including dye in the water which is applied to the surface of the edge portion to refloat the surface fibers.

5. The method described in claim **4** characterized by the dye being applied only to the outside surface of the longer edge portion and the other insulation on the conductor being left free of dye so as to maintain better electrical characteristics and to avoid impairing physical aging characteristics.

6. The method of making paper insulated electrical conductors which comprises passing an electrical conductor through a mass of woodpulp to apply a coating of the pulp thereto, squeezing the pulp to remove water therefrom and to form a wet paper insulation strip with the conductor imbedded in the strip and with an edge portion of the wet paper strip extending from at least one side of the conductor, wrapping the wet paper edge portion around the conductor and around the insulation immediately adjacent to the conductor to form a longitudinal lap seam along the length of the insulation and prior to said wrapping, refloating some of the outside surface fibers of the strip along the location where the seam is formed by the wrapping step, and orienting the refloated fibers transversely across the lap seam location to hold the seam closed, and then drying the insulation with the seam held closed.

7. The method described in claim **6** characterized by wrapping the edge portion by passing the conductor at a speed of at least 100 feet per minute progressively through a former that rotates at a speed of at least 5,000 revolutions per minute, refloating the surface fibers by applying water to said outside surface approximately two to three feet upstream from the location of contact of the former with the edge portion whereby the edge portion is wrapped before the applied water has time to soak into the paper, and reorienting the refloated fibers to a helical conformation across the seam location.

8. The method described in claim **6** characterized by refloating the surface fibers by applying water to said outside surface, and coloring at least a portion of the outside surface of the insulated conductor by including dye in the applied water.

9. The method described in claim **6** characterized by forming the paper insulation strip with edge portions projecting from opposite sides of the conductor, coloring at least a part of the outside surface of the insulation by applying dye to one of said edge portions, and limiting the dye in the insulation so as to preserve the electrical characteristics of the insulation by applying the dye only to said outside surface of an edge portion on which the surface fibers are refloated.

10. Apparatus for applying woodpulp paper insulation to an electrical conductor including, in combination, means for encasing a wire conductor in a ribbon of woodpulp with edge portions of the ribbon projecting in opposite directions from the conductor, a conveyor on which the woodpulp and the encased conductor are conveyed progressively from the means for applying the woodpulp, squeezing means along the path of travel of the conveyor for squeezing water from the pulp to form it into a paper ribbon encasing the conductor, a former downstream from the squeezing means and through which the paper ribbon and the encased conductor pass including means for wrapping the projecting edge portions closely around the conductor and the paper insulation immediately adjacent to the conductor, and a water applicator between the squeezing means and the former in position to apply water to a surface of one unwrapped edge portion, which surface will be an outside surface of the insulation after the forming for refloating some of the surface fibers of that edge portion ahead of the former.

11. The apparatus described in claim **10** characterized by the means for applying the woodpulp around the wire conductor, a wire guide immediately prior to the means for applying the woodpulp to the conductor, which wire guide locates the conductor in an off center position in the woodpulp to provide projecting edge portions of unequal length, the longer edge portion being of a length to extend around substantially the full circumference of the finished insulated conductor, the water applicator being also a dye applicator for coloring at least a portion of the outside surface of the finished insulation, and a furnace through which the paper insulation passes and in which it is rapidly dried at a location beyond the polishing head.

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156—53, 188; 162—120, 122, 138, 267, 285; 174—124