July 7, 1942. C. S. FULLER 2,288,695

ELECTRICAL INSULATED CONDUCTOR

Filed July 26, 1939

CELLULOSE FIBERS TREATED WITH A RESIN FORMING COMPOUND CONTAINING A METHYLOL RADICAL

FIG. 1

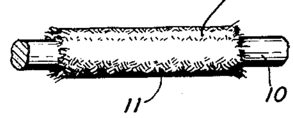


FIG. 2

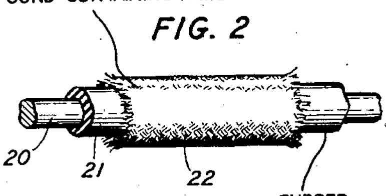


FIG. 3

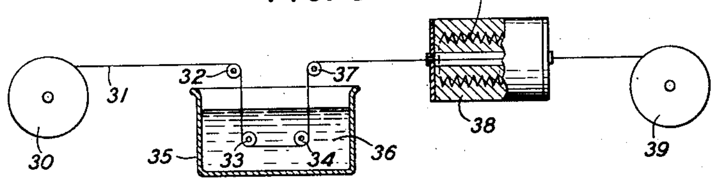


FIG. 4

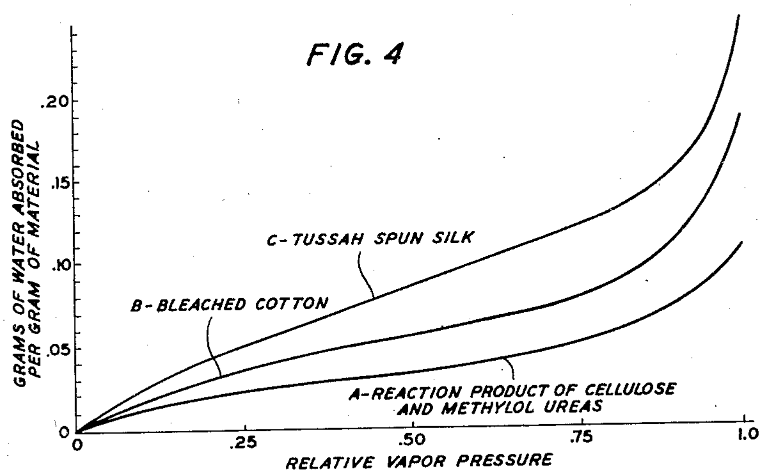


FIG. 6

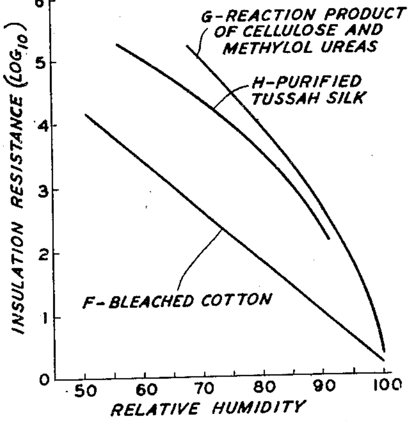
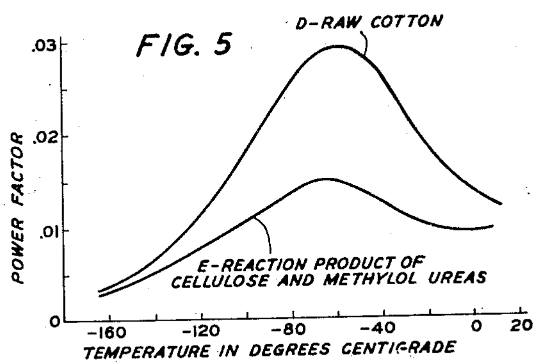


FIG. 5



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ELECTRICAL INSULATED CONDUCTOR

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11 Claims. (Cl. 174—121)

This invention relates to electrical structures and more particularly to electrical insulated conductors.

Textile served conductors have long been employed in electrical systems. A textile serving of cellulose possesses many mechanical and electrical properties which are particularly adapted for use as insulation on conductors. However, when subjected to a humid atmosphere it absorbs appreciable quantities of water to decrease markedly its insulation resistance. Materials employed as impregnating media for these textiles do not prevent this water absorption. For example, it has been heretofore proposed that the textile served on conductors be impregnated with a synthetic resin dissolved in an organic solvent. The resin while providing a filling between the interstices of the fibers and an over-all cover for the textile does not ultimately improve the resistive characteristics of the insulation on the conductors.

An object of this invention is to insulate a conductor with a material which markedly improves its insulation resistance in humid atmospheres.

A more particular object of this invention is to insulate conductors with textiles which are flame-proof and resistant to light.

In accordance with this invention, a conductor is insulated with a material derived from a cellulosic substance which is markedly improved in electrical characteristics from the substance from which it was derived. The insulation resistance of this material is considerably greater under humid conditions than cellulosic substances whether impregnated or unimpregnated. Further, the materials employed for insulation in accordance with this invention possess flameproofing properties and are resistant to the detrimental effects of light. For example, such materials have insulation resistance approximating that of tussah silk, and water-resistant characteristics and a power factor considerably superior to those of the cellulosic substances from which they are derived. The materials may be produced by the interaction of cellulose with a water-soluble resin-forming compound comprising a methylol radical. The materials are prepared preferably by the interaction of cellulose with a water solution of methylol urea. Preferably the insulated conductor is produced by serving a conducting core with a cellulosic substance, such as cotton textiles. The served conductor is then passed through a water solution of a derivative of urea such as dimethylol urea. The textile is then subjected to heat. The urea derivatives combine with the cellulosic substances to produce a composition which has markedly greater insulation resistance and superior water-resisting characteristics than the cellulosic substances from which it was derived.

A more comprehensive understanding of this invention is obtained by reference to the accompanying drawing in which,

Figs. 1 and 2 are perspective views partly broken away of conductors constructed in accordance with this invention;

Fig. 3 is a view of the apparatus employed in the impregnation of conductors shown in Figs. 1 and 2;

Fig. 4 is a graphic representation of a comparison of the moisture absorption characteristics of the insulation employed for conductors in accordance with this invention with other insulating materials;

Fig. 5 shows graphically the power factor of the insulation employed for conductors in accordance with this invention and raw cotton insulation; and

Fig. 6 is another graphic representation which demonstrates the superior insulation resistance of the material employed for the insulation of conductors in accordance with this invention and other substances used for like purposes.

In Fig. 1 a conductor **10**, preferably comprising round flexible copper, is served with a cellulosic insulation **11**, impregnated with a water solution of a resin-forming material comprising a methylol radical. Subsequently the impregnated insulation is subjected to heat to form a reaction product of the cellulose with the resin-forming material.

In Fig. 2 a flexible conductor **20** is covered with rubber **21** in a manner well known in the art. The rubber insulation **21** is served with cellulosic textiles **22** which are treated with a water solution of resin-forming material comprising a methylol radical, similar to the insulation **11** shown in Fig. 1.

Typical apparatus for the impregnation of the textile served conductors is shown in Fig. 3.

Cellulosic textile served wire **31** passes from a drum **30** over a guide roll **32**, thence over guide rolls **33** and **34**, both of which are situated in a tank **35**. The tank **35** contains a water solution **36** of a resin-forming material comprising a methylol radical. From the tank **35** the textile served wire passes over a guide roll **37**, through an oven **38** to a receiving drum **39**. An electrical resistance element **40** in the oven **38** supplied by a source of current, not shown, provides the necessary heat energy.

While any water solution of a resin-forming compound comprising a methylol radical, such as a phenol or urea derivative of formaldehyde, or a mixture of such derivatives may be used to effect the formation of the reaction product with cellulose, it is preferred that a mixture of mono and dimethylol ureas be employed.

If it is desired to produce a wire such as that shown in Fig. 1, in which the impregnating media is an aqueous solution of mono and dimethylol ureas, the following procedure may be practised.

Two servings of alkali cooked and bleached cotton washed to neutrality or between pH 6.5 and pH 7.5 are placed on the conductor. Subsequently an additional serving of alkali cooked and bleached cotton similar to the initial serving is wound thereon. The covered wire is then passed through a solution of mono and dimethylol ureas contained in the tank **35**. The solution is prepared by dissolving one mol of urea in 1.2 mols of neutralized formaldehyde in a 40 per cent aqueous solution. The solution is adjusted to a pH value between 8 and 9 with a base such as sodium hydroxide and brought to a temperature of 65° C., for a period of about two hours. The solution is then diluted with water in a ratio of one part of solution with one-quarter part of water and held in this form until used. This solution is suitable for use for a period of approximately two weeks. Immediately prior to use a catalyst such as diethanol amine hydrochloride is added to the solution in a ratio of .3 to .6 cc. of a 15 per cent solution in water to 25 cc. of the urea derivative solution diluted as noted. The amount of catalyst represents 0.18 to 0.36 per cent by weight of the total solution. After the insulated wire is passed through the tank **35** it is heated in the oven **38** at a temperature between 150° to 200° C. The resulting insulation of the wire comprises a reaction product of cellulose and mono and dimethylol ureas.

A typical example of a preferred method of preparing cotton for the production of the methylol reaction products is as follows:

234 grams of cotton are subjected to a 1.5 per cent sodium hydroxide solution at 50 pounds steam pressure for three hours with circulation. ¼ gram of Igepon is added to facilitate wetting out. The cotton is washed with water until alkali-free and bleached for two hours at 25° C. in 5 liters of water containing 4.6 grams calcium hypochlorite. The bleached cotton is washed with water, treated for one hour in 4 liters of water containing 1 gram of sodium bisulfite ($NaHSO_3$) washed well with water and dried rapidly at 80° C.

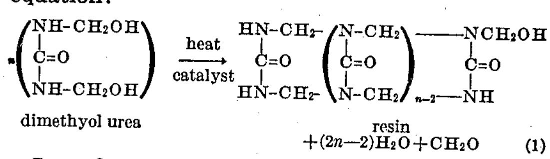
An alternative method of preparing a cellulose derivative containing a methylol linkage for electrical conductors is as follows:

Alkali cooked and bleached 60/1 cotton is subjected in skein form to impregnation with a water solution containing 40 grams of mixed mono-methylol and dimethylol ureas in 100 cc. of solution in the presence of 0.1 gram of diethanolamine sulphate. The wet skeins are centrifuged to below fiber saturation, dried at 50° C., and subjected to 150° C. for fifteen minutes. This product is then served on a electrical conductor as an insulating covering.

Alternatively, the skeins after drying at 50° C. are served directly on the conductor and subsequently cured in place by passing the served conductor in a continuous manner through a heated chamber (180° C.) at a speed of 56 feet per minute or the reaction product is formed by heating the served wire after drying at 50° C. in the form of an open coil in an oven at 150° C. for one-half hour.

For certain purposes, it is desirable to insulate a conductor with a cellulosic substance and treat the material with a water-soluble resin-forming compound comprising a methylol radical such as a water solution of a methylol urea or a methylol phenol or a mixture of a methylol urea and a methylol phenol so that not only does the compound react with the cellulosic substance but in addition the resin substantially fills the pores and interstices of the substance. For accomplishing this result, the cellulosic substances may be impregnated in a water solution of the resin-forming compound and the amount of compound which is normally removed by dies may be regulated so that an appreciable amount will remain within the pores and interstices of the substance. Subsequently the conductor may be heat treated to form the reaction product of cellulose and the methylol compound and to cure the surplus resin in the pores and interstices of the substance. For example, a copper conducting core may first be served with cotton textiles and the serving impregnated with a methylol derivative of urea. After subjection to heat, a second serving of cotton textiles may be applied to the insulated conductor. The served conductor may be impregnated in the water solution of the methylol derivative of urea and subsequently subjected to heat treatment. The amount of compound remaining on the cellulosic substance after each impregnation in the compound but before heat treatment may be regulated by adjustment of the wiping dies so that in addition to effecting the formation of the reaction product of cellulose and the water-soluble resin, the pores of the textile are substantially filled by the cured form of the compound.

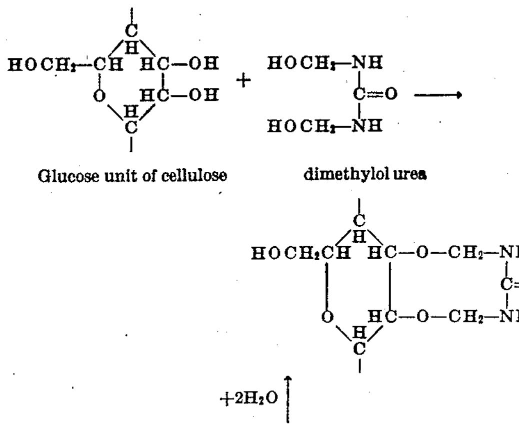
When a cellulosic material is treated with a water-soluble urea derivative, a reaction product is formed which is markedly different from that of the cellulosic material from which it was derived. For example, on heating demethylol urea with cellulose, the dimethylol urea melts both in the pores and on the surface of the fibers, and several reactions occur. In the first place, the dimethylol urea can condense with itself to form a resinous compound with the splitting off of water and formaldehyde. One course of such a reaction is illustrated in the following equation:



(1)

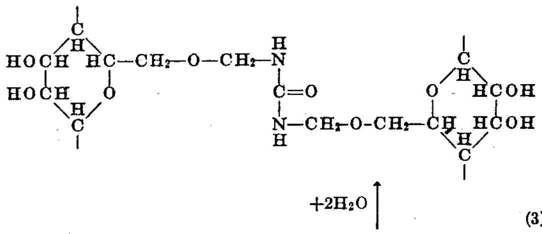
In so far as this reaction alone occurs, no compound formation with cellulose takes place.

Simultaneous with this reaction, however, the following ones involving cellulose occur:



(2)

or with two glucose units

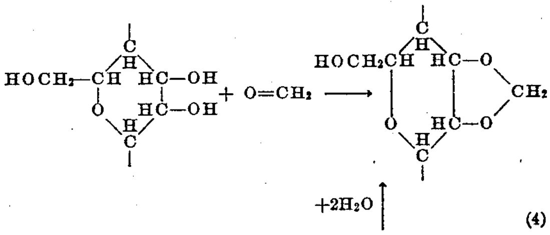


(3)

In reaction (2) for convenience only one glucose unit of the cellulose has been represented. A combination between two cellulose hydroxyls with dimethylol urea through an acetal type reaction is postulated. In this case the reaction is pictured as intramolecular and a cyclic structure results. Instead of bridging the 2, 3 hydroxyl groups of glucose, the dimethylol urea may bridge the hydroxyls of the 2,5 or the 3,5 positions. Also it is possible that hydroxyl groups of adjacent glucose units in the same cellulose chain may be bridged. It is realized, of course, that in place of dimethylol urea higher methylol compounds, like the products in (1), may react similarly.

In reaction (3) the same type of combination is shown as occurring intermolecularly instead of within the same molecule. In this case, as in the previous one, the final result is to reduce the total number of OH groups present in the final compounds.

A further reaction which may occur to some extent is one between formaldehyde given off in (1) and the cellulose hydroxyls with the production of a formal as shown in (4). Here again other pairs of the cellulose hydroxyls may be involved. The extent of this reaction, however, is no doubt rather small.



(4)

Fig. 4 shows graphically the water absorption of the reaction products of dimethylol urea and cellulose, tussah spun silk and bleached cotton. Curve A indicates the water absorption characteristics of the reaction product of dimethylol urea and alkali cooked and bleached cotton textiles; curve B the same characteristics of bleached cotton; while curve C shows the properties of tussah silk. It is observed that the reaction product absorbs materially less water at all humidities than either tussah silk or the bleached cotton from which the reaction product is derived.

Fig. 5 shows the correlation of power factor and temperature of raw cotton and the reaction product of methylol urea and cotton. Curve D represents graphically the power factor at various temperatures of raw cotton and curve E shows the same characteristics of reaction product of cellulose and methylol ureas. The reaction product has a considerably lower power factor than that of the cotton from which it is derived. The following table shows the values of the power factor maxima for these two materials at various frequencies in the dry condition:

Power factor maxima

	1 kc.	10 kc.	100 kc.
Washed cotton	.0255	.0304	.0327
Reaction product of cotton and a mixture of methylol urea and dimethylol urea	.0130	.0152	.0178

In Fig. 6 the insulation resistance of cotton, tussah silk and the reaction product under various conditions of humidity is shown. The insulation resistance of bleached cotton indicated by curve F is plotted on a logarithmic scale against relative humidity. The insulation resistance of the reaction product to the humid conditions appears as curve G, while that of tussah silk is shown by curve H. These curves indicate clearly the superior nature of the insulation comprising the reaction product over raw cotton and tussah silk.

The effect of concentration of the resins employed for impregnating the textiles on the nature of the reaction product as revealed by the insulation resistance of the product resulting from the interaction of resin and cotton yarn on cotton served wire is demonstrated by an examination of the following table. The cotton served wires were impregnated as heretofore described. The original solution employed for this impregnation contained 60 per cent of methylol ureas by weight.

Pts. of water by volume to one pt. of solution	Insulation resistance 38° C., 85% relative humidity	
	Kilomegohms per ¾″ length bleached 60/1 cotton	Megohms, 2–60/1, 1–40/2 bleached cotton-served #22 AWG wire
0.00	340,000	
0.16	223,000–340,000	
0.25	210,000–340,000	378–1174
0.33	120,000–223,000	
0.50	71,000–120,000	350–765
0.66	34,000–103,000	
0.75	22,000–58,000	
1.00	18,000–38,000	193–397
2.00		35.3–93.6
5.00		5.40–11.7
Washed cotton	100–300	
Tussah silk	2,500–16,000	
2–60/1, 1–40/2 alkali cooked bleached cotton on #22 AWG wire		0.40–1.00
2–62/1 tussah silk and 1–40/2 washed cotton on #22 AWG wire		2.00–3.00

In the first column of the table the parts of water by volume added to one part of the original solution containing 60 per cent by weight of methylol ureas are noted. The insulation resistance of the bleached cotton per three-quarter inch length of a No. 60 single thread which is impregnated with the solution and heat treated as heretofore described for the various solutions is tabulated in the second column, while that of conductors served with cotton and treated with the solutions appear in the third column. It is observed that as the concentration of resin is decreased there is a definite drop in the insulation resistance. A 60 per cent water solution of methylol ureas appears to be the most desirable for the impregnation of the textile served conductors. The optimum for a particular purpose can be ascertained empirically.

An interesting experiment illustrates the differences between the sunlight resisting characteristics of cotton and the reaction products. Two samples of wire served with the same cotton textile, one of which was treated with a mixture of monomethylol and dimethylol ureas, to form the reaction product in accordance with this invention and the other of which was untreated, were subjected to identical weathering tests for a period of over a year. At the end of this time both were examined for deterioration. The cotton on the untreated sample was badly tendered and readily crumbled on slight abrasion, whereas that of the reaction product had retained practically its original tensile strength and abrasive qualities. The insulated conductors in accordance with this invention are, therefore, admirably adapted for use on wires exposed to the elements.

The reaction product for the insulation of conductors is formed by the interaction of all types of water-soluble urea resins containing a methylol linkage. For example, water-soluble thio urea resins having methylol linkages likewise react with the cellulose insulation under the conditions outlined to produce a reaction product superior from an insulation resistance, water resistance and abrasive resistance standpoint to the original cellulosic material from which it was derived. Then, too, other types of cellulosic materials than cotton textiles may be used, such as paper pulp. Preferably, however, the cellulosic material is first placed on the wire before the reaction product is formed.

A typical example of the preparation of other methylol derivatives of cellulose, such as the reaction product of cellulose and methylol phenols, which may be employed for the insulation of conductors is as follows:

188 grams of phenol is reacted at 100° C. with 200 cc. of 40 per cent formalin in the presence of 4 cc. concentrated ammonia water for one and a half hours. The resulting solution comprising mono and dimethylol phenols is employed to react with purified cotton. An electrical conductor containing one serving of 40/2 cotton, and two outer servings of 60/1 cotton previously purified is drawn continuously through the solution and the excess removed by wiping with rubber or felt. The wire is then passed through a hot air chamber where it is dried and heated to cause resin formation and compound formation with the cellulose. A temperature of 180° C. and a speed of 56 feet per minute is preferably employed.

That the cellulose has been altered in properties by combination with the methylol phenol compounds is shown by the following electrical results:

Insulation resistance, 85— R. H., 38° C.	Megohms per 19½ in. length
Triple Served #22 AWG wire—no treatment	0.15
Triple Served #22 AWG wire—treated	13.00

Another example of a reaction product of cellulose and a resin-forming compound having a methylol linkage is as follows: 282 grams of phenol and 180 grams of urea are reacted with 540 cc. of formalin (40 per cent) in the presence of 30 cc. of N/5 sodium hydroxide for two hours at 65° C. The resulting solution is diluted with 240 cc. of water and employed for treating cotton served wire as described in the previous example. The mixed methylol ureas and methylol phenols combine with the cellulose. The insulation resistance of insulated wire before and after treatment at 38° C. and 85 per cent relative humidity is:

	Megohms per 19½ in. length
Triple cotton served #22 AWG wire—no treatment	0.15
Triple cotton served #22 AWG wire—treated	510.00

Alternatively, both the methylol phenols and the mixed methylol ureas and phenols can, of course, be applied directly to the cotton cellulose and then served on wire, curing being accomplished either before or after serving.

The stability of the resin cellulose compounds of this invention is best demonstrated by an examination of the results of tests conducted on an insulated wire prepared by employing mixed methylol ureas and methylol phenols as heretofore described. One sample was placed in an atmosphere of 95 per cent relative humidity for one week, then dried over $CaCl_2$ one week, then placed in an atmosphere of 75 per cent relative humidity for one week, then dried one week. This sequence was repeated for one year. At the end of this time the insulation resistance of the wire at 38° C., 85 per cent relative humidity was still 220 megohms, i. e., 1500 times that of the original untreated wire. A second sample was placed on the roof exposed to sunlight. At the end of one year and four months the insulation resistance of this wire was still over 80 times that of the original untreated sample.

This invention embraces within its scope the insulation of conductors with any reaction product of cellulose and a resin-forming material comprising a methylol radical. For example, cellulosic materials for the insulation of wire may be treated with water-soluble amino compounds other than urea, such as water-soluble methylol derivatives of dicyandiamide with a potentially acid-forming catalyst such as ammonium chloride. Or water-soluble methylol derivatives of melamine (2,4,6-triamino-s-triazine), of guanidine or guanidine carbonate may be used in a manner similar to that heretofore described. Likewise, other phenolic types of compounds may be employed such as water-soluble methylol derivatives of resorcinol, pyrocatechol, phloro glucinol, pyrogallol and the like. Among other examples are the methylol derivatives of ketones. Thus, four parts of acetone may be mixed with two parts of water and three parts of formalin (40 per cent) by volume. Five cc. of 10 per cent sodium hydroxide is added as a catalyst. After about twenty-five minutes, a skein of 60/1 purified cotton is added to the solution and immersed for two minutes. It is removed, centrifuged to remove excess solution, dried one hour at 105° C., and heated for four hours at 120° C. to produce the reaction product. After washing, the tests of insulation resistance at 38° C., and 85 per cent relative humidity are as follows:

	Kilo megohms per ¾″ length
Untreated	90
Treated	1700

Obviously the methylol derivatives of other ketones than acetone may also be employed, such as β-methyl-Γ-keto butonol or β-methyl β-hydroxy methy Γ-keto butonol derived from the reaction of formalin and methyl ethyl ketone.

Preferably acid catalysts are employed in the curing reaction except in the case of methylol phenols and methylol acetone. For the formation of the reaction product of cellulosic material and these latter substances, alkaline catalysts may be used.

This invention also includes within its scope the multiple treatments on the same cellulosic base material with the same or different water-soluble resin-forming compounds comprising a methylol radical. Successive treatments and cures may be made by employing the same methylol derivative or different methylol derivatives may be applied successively as well as simultaneously. For example, a water-soluble methylol urea may be applied to an electrical conductor having a cellulosic material thereon. After heating to effect the formation of a reaction product of the cellulose and methylol urea, a water-soluble methylol phenol is applied and heated in a manner similar to that heretofore described to produce a reaction product of cellulose and the methylol phenol. In certain cases, particularly when alkaline catalysts are employed, it may be desirable to wash the final product and to dry after the washing.

While preferred embodiments of this invention have been illustrated and described, various modifications may be made therein without departing from the scope of the appended claims.

What is claimed is:

1. An insulated electric conductor comprising a conducting wire covered with a layer of insulation comprising a fibrous reaction product of cellulose and a water-soluble resin-forming compound containing a methylol radical, made by partially reacting fibrous cellulose material, by impregnation and heating, with an aqueous solution of a water-soluble resin-forming compound containing a methylol radical so that the identity of the fibers of the original cellulose material is retained and the fibrous reaction product is a cellulose derivative which is predominantly cellulosic in nature, but which has flame resistance, abrasion resistance, moisture resistance, light resistance, and power factor characteristics greatly superior to those of the original cellulose material, and electrical resistivities at high and low humidities greatly superior to those of the original cellulosic material and approximating those of silk.

2. An insulated electric conductor comprising a conducting wire covered with a layer of insulation comprising a fibrous reaction product of cellulose and a water-soluble resin-forming compound containing a methylol radical, made by partially reacting fibrous cellulose material, by impregnation and heating, with an aqueous solution of a water-soluble resin-forming compound containing a methylol radical so that the identity of the fibers of the original cellulose material is retained and the fibrous reaction product is a cellulose derivative which is predominantly cellulosic in nature, but which has flame resistance, abrasion resistance, moisture resistance, light resistance, and power factor characteristics greatly superior to those of the original cellulose material, and electrical resistivities at high and low humidities greatly superior to those of the original cellulose material and approximating those of silk, the pores of said fibrous reaction product and the interstices between the fibers thereof being substantially completely filled with a resin produced by curing a water-soluble resin-forming compound containing a methylol radical.

3. The method of manufacturing an electrical conductor comprising applying a fibrous cellulosic material to a conducting core, passing said core through a water solution including a potentially acid substance and a water-soluble methylol derivative of urea, removing the excess of said solution, drying said conductor and heating said conductor between 150° C. to 200° C.

4. An insulated electrical conductor comprising a conducting wire covered with a layer of insulation comprising a fibrous reaction product of cellulose and a water-soluble mixture of monomethylol urea and dimethylol urea, made by partially reacting fibrous cellulose material, by impregnation and heating, with an aqueous solution of a mixture of monomethylol urea and dimethylol urea so that the identity of the fibers of the original cellulose material is retained and the fibrous reaction product is a cellulose derivative which is predominantly cellulosic in nature, but which has flame resistance, abrasion resistance, moisture resistance, light resistance, and power factor characteristics greatly superior to those of the original cellulose material, and electrical resistivities at high and low humidities greatly superior to those of the original cellulosic material and approximating those of silk.

5. An insulated electrical conductor comprising a conducting wire covered with a layer of insulation comprising a fibrous cellulosic reaction product of fibrous cotton and a product obtained by heating urea and formaldehyde in the presence of water, said cellulosic reaction product being formed by partially reacting fibrous cotton, by impregnation and heating, with an aqueous solution of said urea-formaldehyde product so that the identity of the fibers of the cotton is retained and the fibrous cellulosic reaction product is a cellulose derivative which is predominantly cellulosic in nature, but which has flame resistance, abrasion resistance, moisture resistance, light resistance, and power factor characteristics greatly superior to those of the original cotton, and electrical resistivities at high and low humidities greatly superior to those of cotton and approximating those of silk.

6. An electrical conductor comprising a conducting member covered with a layer of cellulosic fibrous material in which the cellulose has been partially chemically transformed by impregnation with an aqueous solution of a water-soluble resin-forming compound containing a methylol derivative of urea and by subsequent heating to cause a partial chemical combination of the cellulose fibers with the impregnant as evidenced by increased electrical resistivity of the fibers at high humidity.

7. The method of treating an electrical conducting wire covered with a layer of fibrous cellulose material comprising impregnating said fibrous cellulose material with an aqueous solution of a water-soluble resin-forming compound containing a methylol radical and heating said impregnated cellulose material so that said resin-forming compound partially reacts with said cellulose material, without destroying the identity of the fibers of said cellulose material, to form a fibrous reaction product which is a predominantly cellulosic cellulose derivative but which has flame resistance, abrasion resistance, moisture resistance, light resistance, and power factor characteristics greatly superior to those of the original cellulose material, and electrical resistivities at high and low humidities greatly superior to those of the original cellulose material and approximating those of silk.

8. An electrical conductor comprising a conducting member covered with a layer of cellulosic fibrous material in which the cellulose has been partially chemically transformed by impregnation with an aqueous solution of a water-soluble resin-forming compound containing a methylol derivative of phenol and by subsequent heating to cause a partial chemical combination of the cellulose fibers with the impregnant as evidenced by increased electrical resistivity of the fibers at high humidity.

9. An electrical conductor comprising a conducting member covered with a layer of cellulosic fibrous material in which the cellulose has been partially chemically transformed by impregnation with an aqueous solution of a water-soluble resin-forming compound containing a mixture of a methylol derivative of urea and a methylol derivative of phenol and by subsequent heating to cause a partial chemical combination of the cellulose fibers with the impregnant as evidenced by increased electrical resistivity of the fibers at high humidity.

10. An electrical conductor comprising a conducting member covered with a layer of cellulosic fibrous material in which the cellulose has been partially chemically transformed by impregnation with an aqueous solution of a methylol derivative of a ketone and by subsequent heating to cause a partial chemical combination of the cellulose fibers with the impregnant as evidenced by increased electrical resistivity of the fibers at high humidity.

11. An electrical conductor comprising a conducting member covered with a layer of material comprising cellulose textile fibers which have been partially chemically reacted with an aqueous solution of a methylol derivative of urea as evidenced by increased electrical resistivity at high humidity and by greater resistance to disintegration upon exposure to the atmosphere, the pores of said fibers and the interstices between said fibers being substantially completely filled with a resin produced by curing a methylol derivative of urea.

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