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PATENT SPECIFICATION

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Specification Accepted: Jan. 31, 1939.

PROVISIONAL SPECIFICATION.

No. 28546 A.D. 1937

Improvements in or relating to Insulated Electric Conductors.

We, W. T. HENLEY'S TELEGRAPH WORKS COMPANY LIMITED, a British Company, of 11, Holborn Viaduct, London, E.C.1, WILLIAM CYRIL BARRY, of "Balmuir", Parrock Avenue, Gravesend, Kent, and BENJAMIN BEARDMORE EVANS, of "Sunny Bank", Singlewell Road, Gravesend, Kent, both British Subjects, do hereby declare the nature of this invention to be as follows:—

This invention relates to insulated electric conductors, for instance, wires or cables, having a flexible and substantially non-hygroscopic dielectric. The dielectric material most generally employed for such purposes is a vulcanised india-rubber compound having good insulating properties. Such a material has the disadvantage that it is not fire resistant; when ignited it will continue to burn. On the other hand rubber-like compounds derived from polymerised chloro 2-substituted butadiene are well known to possess flame resistant properties. We have found however that this material known in the trade as "neoprene" cannot be used as a dielectric in place of insulating rubber compounds owing to its low specific insulation resistance. As a result of our researches we have ascertained that a composite body comprising a layer or layers of insulating rubber and a layer of the aforesaid rubber-like compound will have good insulating properties if the proportion by volume of the rubber-like compound does not exceed 75% of the whole and will be self-extinguishing, that is to say, it will not continue to burn, when the igniting flame or other source of ignition is withdrawn therefrom, providing the proportion by volume of the rubber-like compound does not fall below 25% of the whole.

By the present invention we provide a conductor insulated with a composite dielectric comprising an inner layer or layers consisting of insulating vulcanised india-rubber compound and an outer layer of a flame resistant compound derived from and containing not less than 20% by weight of polymerised chloro 2-substituted butadiene, the relative thicknesses of the layers being such that the proportion of flame resistant compound is from 25%—75% by volume of the whole.

The two component layers of the composite dielectric are preferably applied in an unvulcanised condition to the conductor and vulcanised together on the conductor, whereby the two layers become physically united to form a single body of dielectric.

In the preceding statements the expression "dielectric" means that part of the cable which is relied upon to insulate the conductor. It does not include a covering or sheath which, although it may possess a certain degree of insulation resistance, is applied primarily for the purpose of affording mechanical or chemical protection to the dielectric. For instance, it does not include a protective sheath consisting of tough rubber or a compounded covering of tape or braid or a jute serving.

Any natural rubber compound of the kind usually employed for cable insulation may be used to form the inner part of the composite dielectric. An example of such a compound is as follows:—

	Parts by weight.
Rubber (1st grade plantation)	50.0
Softener	2.0
Zinc oxide	15.0
Sulphur	2.0
Accelerator	0.5
Anti-oxidant	0.5
French chalk	30.0

The compound derived from polymerised chloro 2-substituted butadiene (hereinafter referred to as neoprene compound) may comprise neoprene admixed with the usual vulcanisation accessories, softeners and fillers. An example of a satisfactory neoprene compound is as follows:—

[*Price* 1/-]

	Parts by weight.
Neoprene	33.0
Factice	1.5
Light calcined magnesia	3.3
Cotton seed oil	6.0
Rosin	1.5
Anti-oxidant	0.75
Zinc oxide	3.3
Light magnesium carbonate	16.5
French chalk	34.15

For cable conductors having a small radial thickness of dielectric we prefer to use a composite layer comprising a fairly low proportion of neoprene compound by volume of the whole and to increase this proportion as the thickness of the dielectric increases. For instance, for a conductor having a radial thickness of dielectric of 0.036 inches, the percentage of the neoprene compound is preferably about 40% and for a conductor having a radial thickness of dielectric of 0.056 inches the percentage may be increased to about 60—65%.

In some cases especially where the thickness of the dielectric is relatively high, it is advisable for economic reasons to avoid increasing the proportion of the neoprene compound as indicated in the preceding paragraph. Instead of effecting such an increase, the natural rubber compound portion of the composite dielectric can itself be comprised of two parts, an inner one consisting of ordinary insulating rubber compound and an outer one consisting of an insulating rubber compound possessing a resistance to combustion, which though considerable, is by no means equal to that possessed by the neoprene compound forming the outer part of the composite dielectric. The rubber compound employed for the outer portion of the inner layer of the dielectric may be a selenium rubber compound, that is, a natural rubber compound generally containing about 10% of selenium. In this case a composite dielectric having a radial thickness of 0.056 inches may, for example, comprise an innermost layer of ordinary good insulating rubber compound having a radial thickness of .022 inches, an intermediate layer of selenium rubber having a radial thickness of .012 inches and an outer layer of .022 inches radial thickness of the example of neoprene compound given above, all of these layers preferably being applied in the unvulcanised state and vulcanised together.

The improved construction of insulated conductors also has the important advantage that the dielectric is more resistant to oils and greases than is the dielectric of the ordinary V.I.R. insulated cables at present in general use.

Dated this 20th day of October, 1937.

R. L. CLEAVER,
Agent for the Applicants,
Cable Research House,
Silver Street, W.C.1,

PROVISIONAL SPECIFICATION.
No. 7733 A.D. 1938

Improvements in or relating to Insulated Electric Conductors.

We, W. T. HENLEY'S TELEGRAPH WORKS COMPANY LIMITED, a British Company, of 11. Holborn Viaduct, London, E.C.1, WILLIAM CYRIL BARRY, of "Balmuir", Parrock Avenue, Gravesend, Kent, and BENJAMIN BEARDMORE EVANS, of "Sunny Bank", Singlewell Road, Gravesend, Kent, both British Subjects, do hereby declare the nature of this invention to be as follows:—

This invention relates to insulated electric conductors, for instance, wires or cables, having a flexible and substantially non-hygroscopic dielectric. The dielectric material most generally employed for such purposes is a vulcanised india-rubber compound having good insulating properties. Such a material has the disadvantage that it is not fire resistant; when ignited it will continue to burn. On the other hand rubber-like compounds derived from polymerised chloro 2-substituted butadiene, known in the trade as "neoprene", are well known to possess flame resistant properties and have high electrical breakdown strength but the insulation resistance is very much lower than that of the vulcanised india-rubber compounds generally used for insulating purposes.

By the present invention we provide a conductor insulated with a composite dielectric comprising an inner layer (or layers) consisting of insulating vulcanised india-rubber compound and an outer layer (or layers) of a flame resistant compound containing not less than 20% by weight of polymerised chloro 2-substituted butadiene, hereinafter referred to as neoprene compound, the thickness of the layer of neoprene compound being from about 33% to about 75% of the whole. The relation between

the proportions by thickness and the proportions by volume of the neoprene compound to that of the whole dielectric will depend upon the size of the conductor but the thickness range of 33%—75% may be taken to be approximately equivalent to a range of 35%—85% by volume. We have found that a composite conductor dielectric, consisting of vulcanised india-rubber compound and neoprene compound in the proportions aforesaid has good insulating properties and is self-extinguishing, that is to say, when subjected to an external source of ignition it will not transmit flame beyond the portion of dielectric under the influence of the source of ignition.

The two component layers of the composite dielectric are preferably applied in an unvulcanised condition to the conductor and vulcanised together on the conductor, whereby the two layers become physically united to form a single body of dielectric.

In the preceding statements the expression "dielectric" means that part of the cable which is relied upon to insulate the conductor. It does not include a covering or sheath which, although it may possess a certain measure of insulating properties is applied primarily for the purpose of affording mechanical protection to the dielectric. For instance, it does not include a protective sheath consisting of tough rubber or a compounded covering of tape or braid or a jute serving.

Any natural rubber compound of the kind usually employed for cable insulation may be used to form the inner part of the composite dielectric. An example of such a compound is as follows:—

	Parts by weight.
Rubber (1st grade plantation)	50.0
Softener	2.0
Zinc oxide	15.0
Sulphur	2.0
Accelerator	0.5
Anti-oxidant	0.5
French chalk	30.0

The neoprene compound may comprise neoprene admixed with the usual vulcanisation accessories, softeners and fillers. An example of a satisfactory neoprene compound is as follows:—

	Parts by weight.
Neoprene	33.0
Softener	6.7
Pigment	1.5
Light calcined magnesia	3.3
Zinc oxide	3.3
Rosin	1.0
Sulphur	0.3
Accelerator	0.3
Anti-oxidant	0.75
French chalk to complete	
	100 parts by weight.

Where fire resistant properties are of primary importance the proportion of neoprene compound used will be greater than in cases where high insulation resistance is of primary importance, and the thickness of the neoprene compound layer will lie in the region of the upper limit of the specified range and may be, say, from 70%—75% of the whole. For instance, a conductor may be insulated by a dielectric comprising three superimposed layers vulcanised together, the first being a layer of ordinary insulating rubber compound of 0.010 inches radial thickness, the second a layer of neoprene compound of 0.012 inches thickness, and the third a layer of neoprene compound of 0.016 inches thickness.

Where the thickness of the dielectric is relatively high, it may be desirable for economic reasons to use a lower proportion of neoprene compound than that indicated in the preceding paragraph. In such cases, the natural rubber compound portion of the composite dielectric can itself be comprised of two parts, an inner one consisting of ordinary insulating rubber compound and an outer one consisting of an insulating rubber compound possessing a resistance to combustion, which though considerable, is by no means equal to that possessed by the neoprene compound forming the outer part of the composite dielectric. The rubber compound employed for the outer portion of the inner layer of the dielectric may be a selenium rubber compound, that is, a natural rubber compound generally containing from about 3% to 10% of selenium. In this case a composite dielectric having a radial thickness of 0.057 inches may, for example, comprise an innermost layer of ordinary good insulating rubber compound having a radial thickness of 0.015 inches, an intermediate

layer of selenium rubber having a radial thickness of 0.019 inches and an outer layer of 0.023 inches radial thickness of the example of neoprene compound given above, all of these layers preferably being applied in the unvulcanised state and vulcanised together.

The improved construction of insulated conductors also has the important advantage that the dielectric is more resistant to oils and greases than is the dielectric of the ordinary V.I.R. insulated cables at present in general use.

Dated this 12th day of March, 1938.

R. L. CLEAVER,
Agent for the Applicants,
Cable Research House,
Silver Street, W.C.1.

COMPLETE SPECIFICATION.

Improvements in or relating to Insulated Electric Conductors.

We, W. T. HENLEY'S TELEGRAPH WORKS COMPANY LIMITED, a British Company, of 11, Holborn Viaduct, London, E.C.1, WILLIAM CYRIL BARRY, of "Balmuir", Parrock Avenue, Gravesend, Kent, and BENJAMIN BEARDMORE EVANS, of "Sunny Bank", Singlewell Road, Gravesend, Kent, both British Subjects, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to insulated electric conductors, for instance, wires or cables, having a flexible and substantially non-hygroscopic dielectric. The dielectric material most generally employed for such purposes is a vulcanised india-rubber compound having good insulating properties. Such a material has the disadvantage that it is not fire resistant; when ignited it will continue to burn. On the other hand rubber-like compounds derived from polymerised chloro 2-substituted butadiene, known in the trade as "neoprene", are well known to possess flame resistant properties and have high electrical breakdown strength, but the insulation resistance is very much lower than that of the vulcanised india-rubber compounds generally used for insulating purposes.

By the present invention we provide a conductor insulated with a composite dielectric comprising an inner layer (or layers) consisting of insulating vulcanised india-rubber compound and an outer layer (or layers) of a flame resistant rubber-like compound containing not less than 20% by weight of polymerised chloro 2-substitute Butadiene, hereinafter referred to as neoprene compound, the thickness of the layer of neoprene compound being from 33% to 75% of the whole. The relation between the proportions by thickness and the proportions by volume of the neoprene compound to that of the whole dielectric will depend upon the size of the conductor but the thickness range of 33%—75% may be taken to be approximately equivalent to a range of 35%—85% by volume. We have found that a composite conductor dielectric, consisting of vulcanised india-rubber compound and neoprene compound in the proportions aforesaid has good insulating properties and is self-extinguishing, that is to say, when subjected to an external source of ignition it will not transmit flame beyond the portion of dielectric under the influence of the source of ignition.

The component layers of the composite dielectric are preferably applied in an unvulcanised condition to the conductor and vulcanised together on the conductor, whereby the layers become physically united to form a single body of dielectric.

In the preceding statements the expression "dielectric" means that part of the cable which is relied upon to insulate the conductor. It does not include a covering or sheath which, although it may possess a certain measure of insulating properties, is applied primarily for the purpose of affording mechanical protection to the dielectric. For instance, it does not include a protective sheath consisting of tough rubber or a compounded covering of tape or braid or a jute serving.

Any natural rubber compound of the kind usually employed for cable insulation may be used to form the inner part of the composite dielectric. An example of such a compound is as follows:—

	Parts by weight.
Rubber (1st grade plantation)	50.0
Softener	2.0
Zinc oxide	15.0
Sulphur	2.0
Accelerator	0.5
Anti-oxidant	0.5
French chalk	30.0

The neoprene compound may comprise

neoprene admixed with the usual vulcanisation accessories, softeners and fillers. An example of a satisfactory neoprene compound is as follows:—

	Parts by weight.
Neoprene	33.0
Softener	6.7
Pigment	1.5
Light calcined magnesia	3.3
Zinc oxide	3.3
Rosin	1.0
Sulphur	0.3
Accelerator	0.3
Anti-oxidant	0.75
French chalk to complete 100 parts by weight.	

Where fire resistant properties are of primary importance the proportion of neoprene compound used will be greater than in cases where high insulation resistance is of primary importance, and the thickness of the neoprene compound layer will lie in the region of the upper limit of the specified range and may be, say, from 70%—75% of the whole. For instance, a conductor may be insulated by a dielectric comprising three superposed layers vulcanised together, the first being a layer of ordinary insulating rubber compound of 0.010 inches radial thickness, the second a layer of neoprene compound of 0.012 inches thickness, and the third a layer of neoprene compound of 0.016 inches thickness.

Where the thickness of the dielectric is relatively high, it may be desirable for economic reasons to use a lower proportion of neoprene compound than that indicated in the preceding paragraph. In such cases the proportion of neoprene is preferably reduced to a value of from 33%—45% of the total thickness of the dielectric and the natural rubber compound portion of the composite dielectric is comprised of two parts, an inner one consisting of ordinary insulating rubber compound and an outer one consisting of an insulating rubber compound possessing a resistance to combustion, which though considerable, is by no means equal to that possessed by the neoprene compound forming the outer part of the composite dielectric. The rubber compound employed for the outer portion of the inner layer of the dielectric may be a selenium rubber compound, that is, a natural rubber compound generally containing from, say, 3% to 10% of selenium.

An example of a satisfactory selenium rubber compound is:—

	Parts by weight.
Rubber	25.0
Light basic magnesium carbonate (known in the rubber industry as "light magnesia carbonate")	12.0
Zinc oxide	20.0
Selenium	5.0
Sulphur	0.15
Anti-oxidant	1.0
Accelerator	0.2
Softener	2.0
Inert filler	34.65

Where the natural rubber compound portion of the composite dielectric comprises an outer part of selenium rubber compound the dielectric, which may, for example, have a total radial thickness of 0.057 inches, may comprise an innermost layer of ordinary good insulating rubber compound having a radial thickness of 0.015 inches, an intermediate layer of selenium rubber having a radial thickness of 0.019 inches and an outer layer of 0.023 inches radial thickness of the example of neoprene compound given above, all of these layers preferably being applied in the unvulcanised state and vulcanised together.

That the improved conductor dielectric has satisfactory insulation resistance is indicated by the following table showing the insulation resistance of the dielectric of two common sizes of conductor provided with a composite dielectric according to the invention. In one case (specimens 1—4 inclusive) the conductors have a dielectric comprising an inner layer of the specified example of insulating natural rubber compound and two layers of the specified example of neoprene compound; in the other case (specimens 5—8 inclusive) the conductors have a dielectric comprising an inner layer of the aforesaid example of insulating rubber compound, an intermediate layer of the specified example of selenium rubber compound, and an outer layer of the specified example of neoprene compound.

Specimen No.	Size of Conductor	Total thickness of Dielectric	Thickness of Neoprene layer as % of total thickness	Thickness of selenium rubber as % of total thickness	Insulation resistance in megohms/1000 yds.
1.	3/.036″	0.038″	73	—	1050
2.	7/.036″	0.041″	73	—	800
3.	3/.036″	0.057″	73	—	3000
4.	7/.036″	0.059″	73	—	1500
5.	3/.036″	0.038″	40	33	4300
6.	7/.036″	0.041″	40	33	1830
7.	3/.036″	0.057″	40	33	3000
8.	7/.036″	0.059″	40	33	2900

From tests undertaken on specimens 1 and 5 (3/.036″ conductor designed for 250 V working and having a total radial thickness of dielectric of 0.038″) it was ascertained that the asymptotic values of curves obtained by plotting the time taken for the dielectric to break down against the voltage at which breakdown took place were approximately 10 K.V. in both cases. This is very considerably higher than the asymptotic value (6.5 K.V.) of the curve for a corresponding conductor with a dielectric consisting entirely of natural insulating rubber similar to that used for the innermost layer of specimens 1 and 5.

An indication of the fire-resisting properties of the improved dielectric was obtained by subjecting samples of the specimens of insulated conductor referred to in the preceding table to the flame of a No. 20 Barthel burner of the type described in B.S.S. No. 738—1937 for a period of 60 seconds, the sample being held in a vertical position. The following results were obtained.

Specimen No.	Burning time in seconds after removal of flame	Total length affected in inches
1.	0	3.5
2.	10	3.75
3.	22	4.5
4.	0	3.0
5.	3	3.5
6.	15	3.25
7.	10	4.25
8.	13	3.0

In the case of conductors of which the dielectric consisted wholly of ordinary insulating rubber, the dielectric continued to burn furiously after the removal of the flame, even where the period of application of the flame was less than 60 seconds.

The improved conductor dielectric possesses very satisfactory mechanical properties. Tests carried out on tubes of the improved dielectric obtained by withdrawing the conductor from the insulated wire or cable gave the following results:—

Normal tensile strength in lbs/□″ of rubber/neoprene and of rubber/selenium rubber/neoprene dielectric - - = 1100—1300

Percentage elongation at breaking load of each of above dielectrics - - = 450— 500

The improved construction of insulated conductors also has the important advantage that the dielectric is more resistant to oils and greases than is the dielectric of the ordinary V.I.R. insulated cables at present in general use.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. An electric conductor having a composite dielectric comprising an inner

Specimen No.	Size of Conductor	Total thickness of Dielectric	Thickness of Neoprene layer as % of total thickness	Thickness of selenium rubber as % of total thickness	Insulation resistance in megohms/1000 yds.
1.	3/.036"	0.038"	73	—	1050
2.	7/.036"	0.041"	73	—	800
3.	3/.036"	0.057"	73	—	3000
4.	7/.036"	0.059"	73	—	1500
5.	3/.036"	0.038"	40	33	4300
6.	7/.036"	0.041"	40	33	1830
7.	3/.036"	0.057"	40	33	3000
8.	7/.036"	0.059"	40	33	2900

From tests undertaken on specimens 1 and 5 (3/.036" conductor designed for 250 V working and having a total radial thickness of dielectric of 0.038") it was ascertained that the asymptotic values of curves obtained by plotting the time taken for the dielectric to break down against the voltage at which breakdown took place were approximately 10 K.V. in both cases. This is very considerably higher than the asymptotic value (6.5 K.V.) of the curve for a corresponding conductor with a dielectric consisting entirely of natural insulating rubber similar to that used for the innermost layer of specimens 1 and 5.

An indication of the fire-resisting properties of the improved dielectric was obtained by subjecting samples of the specimens of insulated conductor referred to in the preceding table to the flame of a No. 20 Barthel burner of the type described in B.S.S. No. 738—1937 for a period of 60 seconds, the sample being held in a vertical position. The following results were obtained.

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2.	10	3.75
3.	22	4.5
4.	0	3.0
5.	3	3.5
6.	15	3.25
7.	10	4.25
8.	13	3.0

In the case of conductors of which the dielectric consisted wholly of ordinary insulating rubber, the dielectric continued to burn furiously after the removal of the flame, even where the period of application of the flame was less than 60 seconds.

The improved conductor dielectric possesses very satisfactory mechanical properties. Tests carried out on tubes of the improved dielectric obtained by withdrawing the conductor from the insulated wire or cable gave the following results:—

Normal tensile strength in lbs/□" of rubber/neoprene and of rubber/selenium rubber/neoprene dielectric - - = 1100—1300

Percentage elongation at breaking load of each of above dielectrics - - = 450— 500

The improved construction of insulated conductors also has the important advantage that the dielectric is more resistant to oils and greases than is the dielectric of the ordinary V.I.R. insulated cables at present in general use.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. An electric conductor having a composite dielectric comprising an inner

layer (or layers) consisting of insulating vulcanised india-rubber compound and an outer layer (or layers) of a flame resistant rubber-like compound containing not less than 20% by weight of neoprene, the thickness of the layer of the said flame resistant compound being from 33%—75% of the whole.

2. An electric conductor having a composite dielectric comprising an inner layer (or layers) consisting of insulating vulcanised india-rubber compound and an outer layer (or layers) of flame resistant rubber-like compound containing not less than 20% by weight of neoprene, the thickness of the layer of the said flame resistant compound being from 70%—75% of the whole.

3. An electric conductor having a composite dielectric comprising an inner layer of insulating vulcanised india-rubber compound, an intermediate layer of selenium rubber compound, and an outer layer of a flame resistant rubber-like compound containing not less than 20% by weight of neoprene, the thickness of the layer of the said flame resistant compound being from 33%—45% of the whole.

Dated this 3rd day of October, 1938.

R. L. CLEAVER,
Agent for the Applicants,
Cable Research House,
~~Silver~~ Street, W.C.1.

Barter

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I certify this to be a true copy
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