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NEOPRENE COMPOUND, SELF-ADHERING TO LEAD

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Fig. 1

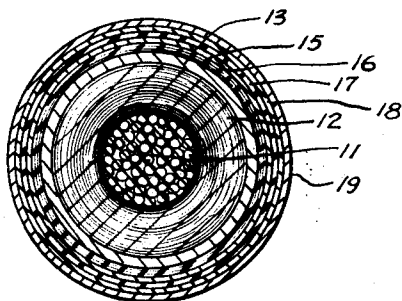


Fig. 3

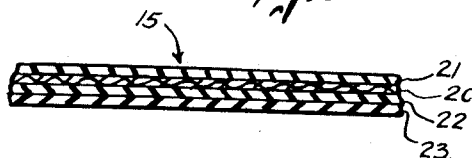


Fig. 2

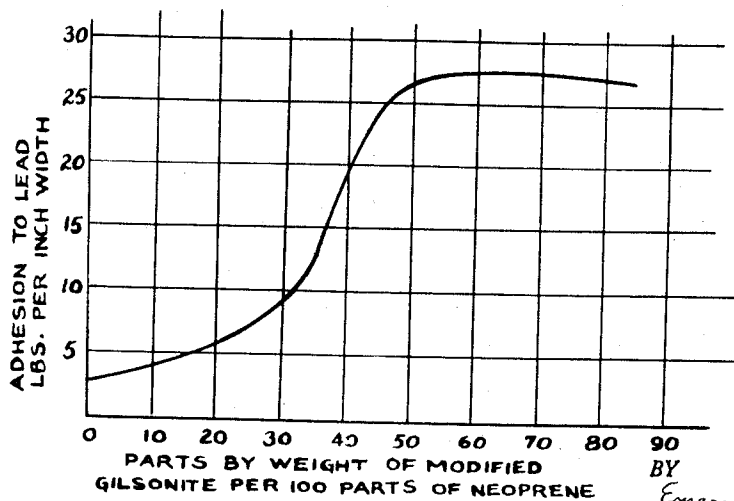
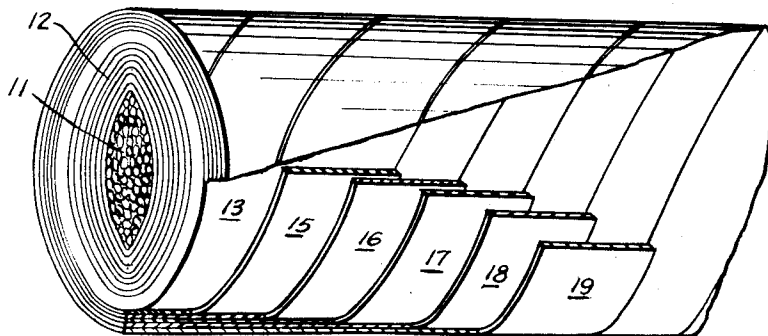


Fig. 4

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NEOPRENE COMPOUND, SELF-ADHERING TO LEAD

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2 Claims. (Cl. 174-107)

This invention relates to an improvement in protective coverings for metal sheathed electric cables, and in particular is concerned with a product most suitable for direct application to the lead sheaths of cables.

This application is a continuation-in-part of my prior application Serial No. 635,805, filed January 23, 1957, and now abandoned.

Cables used in the distribution of electric power frequently are placed underground. The insulated conductors of such cables commonly are encased in lead sheaths for protection against moisture. It is often desirable further to protect such cable by enclosing the lead sheath in some kind of corrosion-protective layer, usually a wrapping of rubber, or a rubberlike or plastic material, for example a neoprene composition, reinforced with cotton or glass. Certain disadvantages flow from this procedure, because, not only is the cost of such cable high, but the possibility of failure of the protective coating is strong. Failure frequently results from an inadequate bond between the protective covering material and the metal sheath.

Specifications of the AEIC (Association of Edison Illuminating Companies) and the IPCEA (Insulated Power Cable Engineers Association) have tentatively defined a desirable degree of adhesion between the protective jackets and the lead sheaths. The customary practice now in vogue of obtaining an adequate bond between a neoprene composition jacket and a lead sheath, for example, is to apply an adhesive cement layer to the lead prior to wrapping it with neoprene tape. The term "neoprene" will be used herein to include compositions in which the base polymer is neoprene. The lack of uniformity of product and uncertainty of the firmness of bond makes the method less than satisfactory. When this is coupled with the variables involved in the plant in the handling of adhesives, with attendant fire and health hazards flowing from the use of volatile solvents, it is quite clear that the product and process in use prior to this invention leave much to be desired.

It is, accordingly, an object of this invention to provide a method of inducing firm adhesion of a neoprene base covering on lead or other metal sheathed cables, useful in providing an improved jacket for effectively protecting the cable sheaths.

It is another object of the invention to provide an improved metal sheathed electric cable jacketed with a neoprene base material which is characterized by its efficiency in self-bonding to the metal sheath without the prior application of an adhesive, liquid or otherwise, to either of the surfaces to be bonded.

It is another object of the invention to provide such a product which will be self-bonding to a degree sufficient to meet and surpass the most rigid requirements of specifications for adhesion of neoprene protective jackets to metal cable sheaths.

Other objects and advantages of the invention will in part be obvious, and in part will appear hereinafter.

The invention, accordingly, is embodied in a product

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useful by itself, or in conjunction with known jacketing materials, for forming a self-bonding protective jacket on metal sheathed cable, the product preferably being in the form of a tape suitable for helical wrapping on said cable. This material may be applied in the form of a laminated tape comprising a woven fabric supporting member, a neoprene base composition on its outer surface, and the modified neoprene composition of this invention on the lead-contacting inner or adhesive surface, or it may be an unsupported tape of the modified neoprene compound. In the manufacture of such cable the method of applying the improved tape is to wrap it helically on the lead sheath. Ordinarily this will be done at room temperatures. Conventional neoprene tapes then may be wrapped thereover, after which the neoprene covering is vulcanized. The vulcanizing temperature, which will be commensurate with the time of vulcanization and in accordance with accepted practices, ordinarily will be in the range of about 150° F. to about 400° F. The bonding composition to be described herein is not a pressure sensitive material, but becomes firmly adhered to the lead sheath upon vulcanization.

In the drawings illustrating a preferred embodiment of the invention:

Figure 1 is a transverse section through a metal sheathed cable having a protective covering made in accordance with this invention;

Figure 2 is a perspective view showing a progressive section through the several layers of the helically wrapped cable;

Figure 3 is a detailed sectional representation of the layers forming one improved tape; and

Figure 4 is a graph showing the effect of the modified gilsonite described herein on the adhesion of neoprene base material to lead.

The adhesion of neoprene or other jackets to lead sheathed cables can be tested directly by measuring the force necessary to separate the adhered material from the lead.

The IPCEA has devised a method for testing adhesion of reinforced neoprene jackets to lead cable sheaths which is as follows:

"Adhesion between jacket and lead shall be determined by making two parallel longitudinal cuts at least 1/2" apart in the jacket on a 12" sample of finished cable. A section of the jacket shall be separated from the lead between the knife cuts and a weight of 5 lbs. per inch of width of strip clamped to the separation. With the sample held vertically and the weight allowed to hang parallel to the sample, there shall be no further separation of the jacket from the lead in 5 minutes.

"If separation does occur, then two additional tests shall be made at 120° intervals around the circumference of the sample. To be accepted, neither of the two additional tests shall show separation with the 5 lbs. per inch of width."

A second method of testing has been proposed by the AEIC, which method is as follows:

"The adhesion of the jacket to the lead sheath shall be determined in accordance with ASTM Specification D413-39 using the dead weight method. Ring specimens shall be tested and the adhesion shall be such that it will require a force of not less than 5.0 lbs. per inch of width to start separating the jacket from the lead. The maximum force required to separate jacket and lead at any point around the periphery shall be not less than 75% of the required maximum starting value."

These methods are based on experience and represent accepted empirical measures of the degree of adhesion required between the neoprene covering and the metal sheath.

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I have found that the direct bonding of a neoprene composition to lead can be effected without the use of any intermediate adhesive coating on the metal. This is accomplished by modifying the neoprene composition through blending it with a modified gilsonite which is characterized by having a paraffin wax content of about 3 percent to about 15 percent by weight, and a microcrystalline wax content of about 2 percent to about 15 percent by weight, the total wax content being at least about 11 to 12 percent, with at least about 3 percent being paraffin. The modified gilsonite further has a reduced volatile content, at least about 5 percent less than the natural product, and has a melting point in the range of 200° to 250° F. One modified gilsonite suitable for the present purpose is manufactured by the Haven Chemical Company of Baltimore, Maryland, and is designated G.P.H. No. 8. Specifically, I have found that when neoprene of general purpose grades commercially available and sold for use in wire jacketing and insulating applications is compounded with the modified gilsonite containing paraffin and microcrystalline wax it gives a product peculiarly useful for self-adhering to a lead cable sheath.

The reason why this combination of neoprene and modified gilsonite is effective in the manner and to the degree disclosed herein is not fully understood, but a theory is as follows:

The gilsonite derivative promotes the flow of the compound materially as temperature of the mass is raised. In any bond to metal there exists an extreme sensitivity to flaws in the interface. In being thermoplastic during the initial stages of cure, the material flows into the minute surface crevices on the metal, thereby making intimate contact. Maximum flow takes place prior to vulcanization. The unique property of the particular gilsonite derivative employed is that it does not liberate gases during the vulcanization heating cycle which would tend to act as a separator between the neoprene bonding compound itself and the metal. Any gases which would form would separate the two materials to be bonded, and once vulcanization of the rubber component had taken place, a bond would no longer be feasible. During the preparation of the gilsonite derivative to which the wax components are added, thermal cracking of the raw gilsonite by high heat takes place, which drives out volatile matter. The absence of the volatiles allows the flowed material to remain in intimate contact with the metal throughout the course of the heating cycle.

I have found that a general purpose neoprene blended in the ratio of about 100 parts thereof to about 50 to 85 parts of the modified gilsonite, by weight, gives optimum adhesion, but the advantages of greatly improved adhesion are obtained over a considerably wider range of proportions. With smaller amounts of the gilsonite the effectiveness of the bond is less, but even with as low as 30 parts of modified gilsonite to 100 parts of general purpose neoprene the adhesion is well in excess of that required to meet and surpass the prevailing industry specifications. When the proportion of the gilsonite exceeds about 85 parts per hundred parts of neoprene the effectiveness of the bond may be somewhat reduced and the properties of the product for handling begin to be adversely affected. Compounds containing in excess of about 85 parts of modified gilsonite are difficult to process satisfactorily into a tape because of the decrease in viscosity of the mass as shown in the Mooney plasticity figures. Moreover, the tensile strength of compounds containing in excess of about 85 parts of modified gilsonite decline rather sharply, limiting the usefulness of the material for the present purpose.

In the formulation of the neoprene-gilsonite blends I have also found it important to eliminate entirely, or at least substantially to minimize and reduce, the amount of carbon black incorporated into the mix, because it appears that the carbon black filler conventionally used

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with neoprene prevents a strong bond from being obtained between the neoprene and the lead. In preference to the carbon black I have found mineral fillers most useful, particularly those like hydrated alumina, which appear to promote flow of the neoprene compound onto the lead sheath. Also I have found that zinc oxide and magnesium oxide are of value as curing agents to promote more rapid vulcanization.

The structure of the tape may be best understood by reference to the drawings. Figure 1 shows a cable having conductor 11, insulation 12, and metal sheath 13, usually of lead or lead alloy, although other metals may be employed. While this invention will be described with particular reference to lead sheathed cables it is intended that the claims shall cover equivalent constructions utilizing sheaths made of other metals. This much of the cable may be of any conventional form, the importance of this invention being in the product most useful for application in bringing about firm adhesion between the metal sheath and an external jacket applied thereover. Applied directly to the metal sheath, therefore, is the tape 15 specially prepared in accordance with this invention to provide a self-adherent material as a base for an overlying neoprene jacket. Over the tape 15 may be applied additional layers 16 and 17 of conventional unsupported neoprene tape and, if desired, final outer layers 18 and 19 of double faced neoprene filled cotton tape.

The tape 15 may be either an unsupported tape of the modified neoprene, or a laminate having a coating of the modified neoprene on one surface. Figure 3 illustrates a suitable laminate in enlarged detail. This tape consists of a cotton base 20, upper and lower impregnating frictioned coats 21 and 22 of neoprene, and a lower layer 23 of the modified neoprene coating as described herein, which may be applied as a skim. The self-adherent neoprene composition 23, upon vulcanization, becomes strongly self-adherent to the lead jacket and provides at least the desired degree of bond strength.

A preferred formulation for the modified neoprene composition is the following:

Ingredient	Parts by Weight	Percent by Weight
Neoprene GN.....	100	43.3
Antioxidant (e.g., phenyl beta naphthylamine).....	2	.86
Stabilizer and acid acceptor (e.g., magnesium oxide powder).....	4	1.73
Modified gilsonite (as described herein).....	60	26.00
Fillers and extender (e.g., calcium carbonate).....	25	10.80
Filler (e.g., aluminum oxide).....	35	15.15
Curing agent (e.g., zinc oxide).....	5	2.16

The composition is prepared by charging the ingredients in the amounts indicated into a Banbury or other conventional rubber mixing equipment, and the temperature is controlled so as not to exceed about 200° F. during the operation as the ultimate milling temperature. If other types of neoprene are used the limiting temperature may be different, for example with the W types of neoprene the temperature may safely rise to about 225° F. Generally it will be found preferable to add the neoprene and antioxidant together, followed in about one minute by half of the filler. After two minutes this is followed by the remainder of the filler and the acid acceptor. When this basic neoprene mixture has been worked for about three minutes in the mixer, the gilsonite is added to it, and mixing is continued for about six to eight minutes. Actually the details of mixing, which will be carried out to obtain an end product of a uniform consistency, may be varied considerably.

The composition, after being thus prepared may then be calendered into thin tape, say 5 to 30 mils thick, or it may be applied to other tapes, as the underface for

direct contact with lead by standard tape coating techniques. Cotton tape, for example of 12 mil thickness formed from standard sheeting for the purpose and having its upper and lower faces friction coated with a conventional neoprene composition, is a preferred material for use as the tape base. A skim coat of the modified neoprene is applied to the underface. A typical neoprene formulation for impregnating the tape in preparation for the modified coating is the following:

Ingredient:	Percent by weight
Neoprene GN -----	54.20
Antioxidant -----	1.11
Carbon black filler -----	32.36
Acid acceptor (magnesium oxide) -----	2.27
Sunproofing wax -----	0.83
Paraffin -----	1.11
Lubricant (petrolatum) -----	0.51
Lubricant (stearic acid) -----	0.25
Mineral oil softener -----	7.36

This composition is sufficiently soft to penetrate cotton fabric and it may be frictioned into both faces of the tape fabric. On one face of such treated fabrics I apply a skim coat of the modified neoprene composition described above. Since the cable protective covering made with the tape is of laminated construction, each layer must be strongly bonded to the adjacent layer. Coating one face of the treated cotton fabric with the modified neoprene skim coating assures a bond between the metal sheath and the non-metallic covering. If an unsupported modified neoprene tape is used, the modified neoprene itself assures a bond between the metal sheath and the non-metallic covering.

The tape thus formed may be applied with the coat 23 directly contacting the metal sheath. It has been found that upon vulcanization exceptionally good bonding of the coat to lead is obtained, and where additional wrappings are applied to the cable the skim coat 23 is sufficiently compatible with the conventional friction coats 21 and 22 on the tape so that a unitary jacket is obtained.

The modified neoprene used as the skim coat was found not to be suitable as the friction coat, because it seems it does not penetrate the cotton adequately. Accordingly, the final preferred laminated form of tape characterizing this invention consists of the cotton or other fabric layer frictioned top and bottom with an essentially conventional neoprene coating to fill the fabric, and provided with a skim coat of the modified neoprene composition on one surface to bond this tape to the lead.

A large scale experimental run of several thousand feet of cable was produced on a trial basis and measurements of adhesion were taken on lengths of the cable so made. The method of production involved helically winding directly onto lead sheathed cable a modified neoprene coated tape as herein described, with the modified neoprene coating next to the lead. Over this winding were applied, in like manner, unsupported neoprene tapes and neoprene frictioned fabric tapes as hereinabove described. All tapes were applied with tape edges substantially butting. The construction is illustrated in Figures 1 and 2 of the application drawings. This covering or jacket then was vulcanized at a temperature in the range of about 200° F. to 220° F.

Specimens from each cable length so made were tested using the IPCEA test method. Each of the samples produced with tape made and applied in accordance with the present invention successfully met the 5 pound requirement with a generous margin. It appears that the tape thus formulated with the modified neoprene is efficiently self-bonding and self-adherent to the lead jacket and in production consistently achieves at least the required bond.

The following table summarizes the results of the measurements:

TABLE

Results of adhesion tests¹—modified neoprene compound

A. Self-bonding tape:

Sample I—

Start: Passed, 20 lb. 0 oz.	Passed, 20 lb. 0 oz.
Finish: Passed, 12 lb. 0 oz.	Passed, 12 lb. 0 oz.
Start: Passed, 12 lb. 0 oz.	Passed, 13 lb. 2 oz.
Finish: Passed, 12 lb. 0 oz.	Passed, 12 lb. 3 oz.
Start: Passed, 23 lb. 0 oz.	Passed, 17 lb. 6 oz.
Finish: Passed, 15 lb. 0 oz.	Passed, 17 lb. 6 oz.
Start: Passed, 7 lb. 8 oz.	Passed, 9 lb. 0 oz.
Finish: Passed, 11 lb. 8 oz.	Passed, 9 lb. 0 oz.
Start: Passed, 14 lb. 4 oz.	Passed, 14 lb. 12 oz.
Finish: Passed, 9 lb. 2 oz.	Passed, 11 lb. 8 oz.
Start: Passed, 13 lb. 12 oz.	Passed, 13 lb. 12 oz.
Finish: Passed, 12 lb. 8 oz.	Passed, 15 lb. 0 oz.

B. Tape—plain gilsonite formula: Moderate bond—separation, easy failure.

C. Tape—pitch formula: Virtually no adhesion—complete failure.

D. Tape—commercially available rubber cement:

Start: Failed, 3 lb. 8 oz.	Failed, 2 lb. 10 oz.
Finish: Failed, 2 lb. 4 oz.	Failed, 2 lb. 4 oz.

¹ All tests conducted per present IPCEA method, then weight increased to failure point.

In the tests tabulated, the A series was conducted on cable wrapped with the improved tape as above described. Two samples were taken from the starting end of the cable, and two from the other, or finishing, end.

In the B series, the tape formed employed the formula described, except that natural gilsonite was employed in place of the modified gilsonite to provide a blank test.

In the C series, the tape formed employed the formula described, except that a coal tar pitch was employed in place of the modified gilsonite.

The D series was conducted on cable made with a conventional neoprene tape and using a commercially available rubber cement to cause adherence to the lead sheath. The particular rubber cement used is typical of those used for this purpose.

In all of these cables the tape was applied to the cable butt lapped and under maximum tension which would not tear or break the cotton base.

The aging characteristics of the bond were tested both under conditions of accelerated air oven aging and immersion in hot water. Samples of typical jacket constructions bonded to the lead were examined periodically. Those tested in the air oven disclosed an improved bond with age. Tests were discontinued after 60 days at 70° C. The immersed samples were in boiling water up to 30 days without materially affecting the bond. Beyond 30 days the bond depreciated. However, the samples tested were in the form of one inch wide rings so that the water could at all times work directly at the interface of the lead and modified neoprene tape from both edges. This is considered materially more severe than the action of water which would be felt on a cable jacket under service conditions.

The storage life of the tape has been found to be reduced materially by the application of zinc stearate to the tape surface. This material acts in the same way as zinc oxide in effecting a cure. Thus, the surface of the tape becomes pre-vulcanized in storage and in this condition will not effectively bond to the lead. It has not been found necessary to employ any form of lubrication or a separator to prevent layers from sticking together in a pad.

The age of the tape also has been found to influence the bond strength. After three weeks from the date of calendering, a slow steady decline in the bond strength achieved with the modified tape is noticeable. This is

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due to pre-vulcanization of the tape surface, which prevents adhesion. The modified tapes should be used reasonably promptly after manufacture and preferably should not be used after a three to four week storage period. The life of the tape and the degree of bond developed may be improved, or at least preserved, if adequate precautions are taken to store it at a temperature of about 65° F. to 70° F. Temperatures lower than about 65° F. may also be used, providing that the tape is brought to room temperature slowly to prevent condensation of moisture on the surfaces prior to use. Such condensation, even if minute, will interfere with adhesion and will cause blisters as well.

Another factor influencing the bond strength is the surface condition of the lead. Dirt, grease, lead oxide or lead carbonate accumulated on the surface may prevent adequate bonding. A mild brushing with a rotating nylon brush with auxiliary dust collecting equipment should be suitable to remove foreign material such as dirt and oil, and the oxide and carbonate formations. It is not necessary to expose a fresh metal surface by sand blasting, scouring, or chemical action, common practices in bonding rubber to metal.

This invention provides an improved material for use in forming adherent protective coverings on metal sheathed cables without the use of a separate adhesive, an improved method of inducing adhesion and an improved cable. The invention may be variously modified and embodied within the scope of the subjoined claims and equivalents.

What is claimed is:

1. The method of inducing firm adhesion of a neoprene base covering on lead sheathed cables comprising

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the steps of mechanically cleaning the sheath, applying thereto a neoprene tape characterized by the face thereof applied to the lead comprising a composition consisting essentially of the following ingredients:

	Parts by weight
Neoprene	100
Gilsonite	30 to 85

wherein the gilsonite contains about 3 to 15 percent by weight of paraffin and about 2 to 15 percent by weight of microcrystalline wax, the total wax content of said gilsonite being at least about 11 percent, with at least about 3 percent being paraffin, and vulcanizing the covering to cause the neoprene-gilsonite composition to adhere to the lead sheath.

2. An electric cable comprising a conductor, insulation therefor, a lead sheath enclosing the insulated conductor, and a neoprene jacket over said lead sheath, the said neoprene jacket being characterized by its being closely adhered directly to the lead, the adherent face immediately adjacent the lead consisting essentially of a composition containing the following:

	Parts by weight
Neoprene	100
Gilsonite	30 to 85

wherein the gilsonite contains about 3 to 15 percent by weight of paraffin and about 2 to 15 percent by weight of microcrystalline wax, the total wax content of said gilsonite being at least about 11 percent, with at least 3 percent being paraffin.

No references cited.