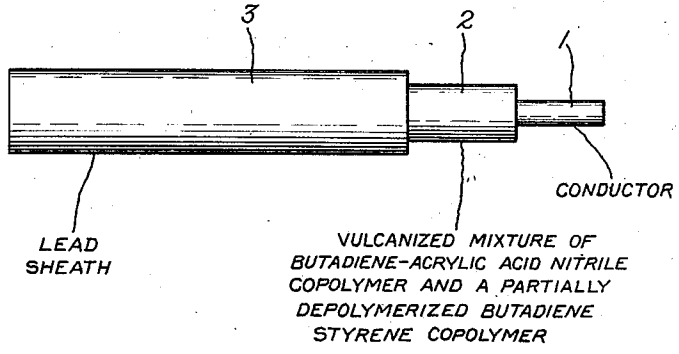
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ELECTRICAL INSULATION

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ELECTRICAL INSULATION

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This invention relates to electrical insulating materials and is particularly concerned with electrical conductors or cables insulated or sheathed with such materials.

It is an object of this invention to provide a permanently flexible electrically insulating material suitable for conductor insulation and sheaths.

Another object of the invention is to provide a non-volatile plasticizer or softener for synthetic rubber-like materials which plasticizer does not materially affect the toughness of the plasticized material.

Various highly polymerized synthetic compounds have previously been suggested as sheaths for electrical conductors including such compounds as the polymers of acrylic acid compounds, mixed butadiene polymers, polyvinyl halides and the like. The use of softeners or plasticizers in combination with such materials is usually necessary in order to permit the proper extrusion of the material about the conductor and to impart the necessary flexibility to the extruded insulation particularly at low temperatures. The various softeners previously used for this purpose, such as triphenyl phosphate, phthalic acid esters and the like, have not been particularly satisfactory due to the fact that at high temperature these materials volatilize thus seriously diminishing the flexibility of the mixture both during and after the extrusion thereof. Furthermore, as these softeners generally were of low molecular weight, any increase in flexibility or pliancy of the mixture was obtained only at the expense of its toughness.

In accordance with the present invention, flexible electrically insulating materials capable of retaining their flexibility for long periods of time and over a wide range of temperatures are obtained by incorporating with the various rubber-like polymerized hydrocarbons an unsaturated polymerized hydrocarbon of high molecular weight of oily or plastic character, which will function as a softener for the rubber-like insulating material. A partially depolymerized mixed polymer of butadiene and styrene, known in the trade as Buna S, has been found particularly suitable for this purpose. This mixed polymer is further characterized by the fact that, although it acts as a plasticizer, it can also be vulcanized or at least partially so, thus permitting use of the finished product over a wide temperature range without substantial loss of flexibility.

The depolymerization of the mixed polymer of butadiene and styrene is effected by the well known process which comprises subjecting the copolymer to a carefully controlled hot air treatment at a temperature of from 110° to 140° C. Preferably, this depolymerization process in the presence of air or oxygen is carried to a point where the mixed butadiene-styrene polymer exhibits a softness equal to or softer than a Defo-hardness of 100. This process, in accordance with the present invention, is further advanced than is ordinarily customary with such mixed polymers.

The Defo-hardness method of measuring the plasticity is described in an article by Harro Hagen entitled "Die Plastizierung von Buna" appearing in Kautschuk, vol. 14 (1938), No. 11, page 203. According to this method, cylinders of the material to be tested 10 millimeters high and 10 millimeters in diameter are compressed between parallel plates to a thickness of 4 millimeters in 30 seconds at a temperature of 80° C. The force necessary for this compression measured in grams is the Defo-hardness of the material. The higher the Defo-hardness is, the lower the plasticity of the material being tested.

A particularly useful insulating composition prepared in accordance with this invention is one prepared from the following ingredients:

	Parts by weight
Mixed polymer of butadiene and acrylic acid nitrile (known in the trade as Perbunan)	25
Polyacrylic acid ethyl ester	5
Partly depolymerized mixed butadiene-styrene polymer (of a Defo-hardness of 100 or less)	10
Remaining ingredients	60

The mixed butadiene-styrene polymer may be used in amounts ranging from 10 to 40 per cent by weight of the remaining polymeric ingredients.

The remaining ingredients comprising 60 parts by weight of the above mixture consist of fillers, accelerators, sulphur, anti-aging compounds, pigments and similar materials. Suitable fillers comprise gas carbon black, quartz powder, talcum, kaolin or similar materials. As accelerators, either an inorganic material, such as litharge, or any of the well known organic accelerators, such as diphenylguanidine, di-o-tolylguanidine or the like, may be used. β-naphthylamine or aldol resins are suitable anti-aging compounds.

Preferably, the compounding of these ingredi-

nts is accomplished by milling all of the components except the sulphur and the accelerator until a homogeneous mass is obtained and thereafter adding the remaining two ingredients and continuing the mixing only long enough to obtain complete dispersion of these two materials in the composition.

Compounds made in accordance with this invention are suitable for application directly to an electric conductor or as a sheath for previously insulated conductors by means of any of the usual rubber extruding machines. The compositions may be vulcanized under a lead sheath and also without said sheath by methods usually followed in curing these synthetic materials.

One embodiment of my invention is illustrated in the accompanying drawing wherein is shown an electric conductor 1 provided with a layer of my insulating compound 2 and a lead sheath 3.

The outstanding advantages of this highly polymerized, non-volatile, vulcanizable softener are that it does not reduce the final strength of the vulcanized compound and does not leave the compound through volatilization even at the high temperatures encountered during production of insulated or sheathed conductors. Mixtures made in accordance with the above formula exhibit good impact strength at temperature as low as —30° C. and good compressive strength up to +150° C.

Compositions prepared in accordance with this invention comprising mixed polymers of butadiene and acrylic acid nitrile plasticized and partially depolymerized mixed polymer of butadiene and styrene resist attack by gasoline, lubricating oils and similar organic solvents, have good heat and abrasion resistance and possess outstanding flexibility over a wide temperature range.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electrically insulated conductor, the insulation of which comprises a vulcanized mixed polymer of butadiene and acrylic acid nitrile and a partially depolymerized mixed polymer of butadiene and styrene as a plasticizer therefor.

2. A composition of matter comprising a mixed polymer of butadiene and acrylic acid nitrile plasticized with from 10 to 40 per cent by weight of a mixed polymer of butadiene and styrene partially depolymerized to hardness less than a Defo-hardness of 100.

3. A composition of matter comprising 25 parts by weight of a mixed polymer of butadiene and acrylic acid nitrile, 5 parts by weight polyacrylic acid ethyl ester, 10 parts by weight of a partially depolymerized mixed polymer of butadiene and styrene and 60 parts by weight of a mixture of fillers, accelerators, sulphur and pigments.

4. An insulated conductor the insulation of which comprises the composition set forth in claim 3.

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