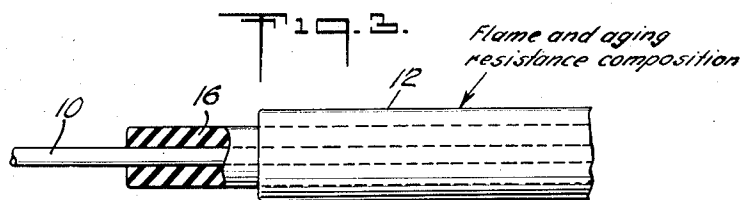
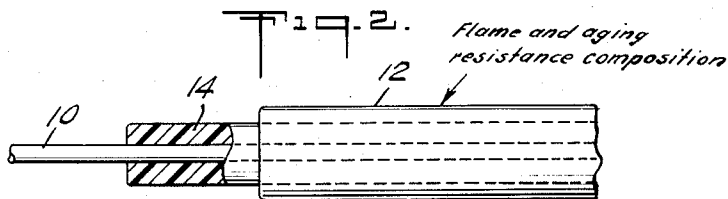
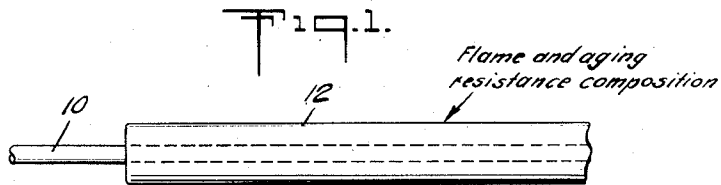


April 15, 1958

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INSULATED CONDUCTOR COATED WITH
POLYETHYLENE BUTYL RUBBER RESIN
Filed July 13, 1955

2,830,919



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2,830,919

INSULATED CONDUCTOR COATED WITH POLY-ETHYLENE BUTYL RUBBER RESIN

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Application July 13, 1955, Serial No. 521,893

5 Claims. (Cl. 117-232)

This invention relates to an insulated electrical conductor adapted for a wide variety of uses.

More particularly it relates to such conductors employing polyethylene and successfully retaining to a large degree the physical and electrical qualities of polyethylene while having a high degree of flame resistance.

It is an object of this invention to provide an insulated electrical conductor which combines good physical and electrical properties with resistance to flame.

Another object of the invention is to provide such a conductor which is stable and has long life over a wide temperature range and under a wide variety of climatic conditions.

Another object of the invention is to provide a multi-purpose insulated conductor.

Another object of the invention is to provide an insulated electrical conductor comprising polyethylene, which has enough flame resistance for a wide variety of commercial uses and retains to a high degree the desirable physical and electrical properties of polyethylene.

Another object of the invention is to provide a protective covering or sheath for insulated power and control cable.

Another object of the invention is to provide insulated electrical conductors well adapted for use as communication cable as well as high voltage cable, and for appliance wiring, as in radio and television sets, and for equipment wiring, as in machine tools, and in general for insulation or sheath of power and control cable.

Other objects of the invention will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts, and in the several steps and relation and order of each of said steps to one or more of the others thereof, all as will be pointed out in the following description, and the scope of the application of which will be indicated in the following claims.

As an aid to a full understanding of the problems of making insulated cable employing flame resistant polyethylene the following manufacturing example is given. In combining the core of an insulated conductor with insulating compound the compound is first, mixed in a Banbury mixer for about eight minutes at a temperature in the range of 230°-300° F.; second, worked in a mill at about 250° F. and sheeted; third, taken off the mill at about 190° F. and granulated at room temperature; and fourth, fed into an extruder heated, by electricity or other means, to a temperature of from 300-400° F., and extruded onto the core.

The composition may be in the extruder from five to ten minutes. Many prior art compositions suitable for rendering certain materials flame resistant, such as paper for example, break down under the temperature conditions described above and liberate the flame resistant

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agent or agents they contain thus ending their flame resistant potential.

On the other hand I have found that in flame resistant compounds of the general kind I employ and comprising polyethylene, chlorinated paraffin, antimony trioxide and phenoxypropylene oxide or their equivalents, high loadings of both organic and inorganic material are undesirable. High loadings of inorganic material promote progressive increase in brittleness of the conductor insulation or ageing, seriously limiting its life and its usefulness. They tend to promote a high dielectric constant and so are detrimental when a low dielectric constant is desirable. High loadings of organic material promote softening of the insulation which of course is undesirable. Electrical conductors having substantial loading of flame retardant mixtures operated at ordinary temperatures of conductivity in service such as 60° C., age rapidly, i. e., become brittle, or in other words experience a rapid reduction of elongation not characteristic of unloaded polyethylene. The effect increases as higher loadings are used. I have found that a small amount of butyl rubber, or polyisobutylene, replacing a like amount of polyethylene in the formulae, greatly decreases this ageing or embrittlement of the conductors and therefore greatly increases their life and usefulness in service. I have also found that such change does not affect the electrical characteristics or the flame resistance.

The invention will best be understood if the following description is read in connection with the drawings, in which

Figure 1 is a side elevation of an insulated conductor comprising a core insulated with flame and aging resistance composition,

Figure 2 is a similar view showing a core insulated with a plastic insulation which is covered by a layer of flame and aging resistance composition and

Figure 3 is a view similar to Figure 2 showing a core insulated with rubber insulation covered with a layer of flame and aging resistance composition.

Insulated conductors embodying my invention comprise a metal core of copper or other suitable metal and a covering of insulation, or sheath, or both, formed preferably by extrusion, and comprising, polyethylene and an organic chlorine bearing compound which is compatible with polyethylene and has a high chlorine content, such for example as chlorinated paraffin having substantially 69-71% chemically combined chlorine which is commercially available under the trade name "chlorowax" (I use the term chlorinated paraffin 70 hereafter to mean such a compound), butyl rubber or polyisobutylene of higher molecular weight, and an agent such as antimony trioxide which together with the chlorinated material acts as a synergist for flame retardance.

In the embodiment of the invention shown in Figure 1 a conductor core 10 is shown insulated with a flame and aging resistance composition 12 of the kind disclosed herein. In the embodiment of the invention shown in Figure 2 the flame and aging resistance composition 12 is shown applied as a sheath over a layer of plastic insulation 14, and in the embodiment of the invention shown in Figure 3 a flame and aging resistance composition 12 is shown applied as a sheath over a layer of rubber insulation 16.

I have found it is sometimes desirable to add small amounts of suitable stabilizing catalysts to stabilize the decomposition of the chlorine bearing material, such for example as phenoxy-propylene oxide, or basic silicate of lead, or preferably a monohydrated tribasic lead salt of maleic acid, such as is available commercially under the

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trade name "Trimal." Small amounts of various fillers, such, for example, as carbon black or "Santocel" (Monsanto Chemical Co. brand of light-weight, porous silica aerogel from which the water has been removed by a process which does not destroy the original gel structure) may be employed. The formula for the covering may be written:

55-	75%	polyethylene
2-	5%	butyl rubber or polyisobutylene
43-	20%	of a mixture comprising:
	20-	50% chlorinated paraffin 70
	80-	50% antimony trioxide
100	100	100

Example 1

The following compound has been tested, under conditions met in actual use, for three years with good results.

95%	polyethylene, 5%	butyl rubber	65
	Antimony trioxide		20
	Chlorinated paraffin 70		12
	"Trimal"		1
	Santocel		2

The butyl rubber employed was GR-I-35 (U. S. Government designation which is a copolymer of isobutylene and isoprene, the Government specification reading as follows:

	Percent
Isobutylene	99.0
Isoprene	1.0
Antioxidant	PBNA

The term butyl rubber is used herein to include also the Government designation GR-I-50 which is a copolymer of

	Percent
Isobutylene	98.0
Isoprene	2.0

This compound has excellent electrical properties and good flame resistance.

As examples of substitute materials, zinc borate may be employed in place of antimony trioxide; and chlorinated diphenyl may be substituted for chlorinated paraffin; chlorinated naphthalene may be employed under controlled conditions in sufficient quantities to provide the desired amount of chlorine.

The invention comprises insulated conductors having cores of various sizes with surrounding coverings the thickness of which may vary according to the diameter of the metal core and the use for which they are intended.

A test was run for two years immersed in water at 50° C. comparing four samples of insulated conductor comprising a metal core insulated by extruding thereon plain polyethylene, with four samples of insulated conductor embodying my invention and comprising a metal core insulated with a composition extruded directly thereon comprising the following ingredients in substantially the following proportions:

Example 2

Polyethylene	66
Chlorinated paraffin 70	8
Antimony trioxide	20
Butyl rubber	3
Phenoxy-propylene	1
Inorganic filler	2
	100

Both sets of samples were continuously energized with 600 volts D. C., one set positive and one set negative. The result of this test after two years showed two of the four samples with plain polyethylene insulation failed while none of the samples made in accordance with my formulae failed.

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By way of further illustrating the invention I set forth below two other embodiments of my invention which have given good results. Examples 3 and 4 each comprise a core of No. 12 solid bare wire insulated with $\frac{1}{32}$ in. wall thickness of a compound extruded onto the wire, the compounds being as follows:

Example 3

10	Butyl rubber	5	80
	Polyethylene	95	
	Chlorinated paraffin 70		10
	Antimony trioxide		10
	Trimal		1
15			100.5

Example 4

	Polyethylene	95	65
20	Butyl rubber	5	
	Antimony trioxide		20
	Chlorinated paraffin 70		12
	Trimal		1
	Carbon black		2
25			100

It will be noted that Examples 1, 2 and 3 comprise respectively 12%, 8%, and 10% of a chlorine bearing compound which contains substantially 70% of chlorine.

Example 4 is of a covering, or sheath, applied around a metal core insulated with rubber or plastic such for example as polyvinyl chloride or polyethylene.

Polyethylene is available in different molecular weights. I prefer to use a polyethylene having a molecular weight as high or higher than the one designated by Union Carbide & Carbon Co as Polyethylene DYNH.

Electrical conductors made in accordance with the formulae disclosed and claimed herein have distinct physical as well as electrical advantages over conductors having coverings consisting of loading added to polyethylene in an amount substantially in excess of the examples set forth above. Polyethylene used alone has excellent physical and electrical properties and the advantage of these properties is retained to an unexpectedly large degree in electrical conductors embodying my invention. I have found, however, that when the polyethylene is loaded with chlorine and other substances to an extent substantially greater than the range of 20.5-45% of the combined weight of polyethylene plus loading specified in the examples given above, and in the claims, the physical as well as the electrical advantages of the polyethylene are seriously reduced thereby similarly reducing the uses for which conductors so loaded are qualified. I have found that the combination of qualities which is the subject of this application is best attained when the total loading is within said 20.5-45% range, and the electrical characteristics are not affected by a long period of immersion of the cable in water.

For instance, after immersing a 15 ft. length of No. 12 A. W. G. wire insulated with $\frac{1}{32}$ " of the polyethylene compound set forth in Example 4 the power factor after one day immersion at 70° C. was 1.2 and after six months was 1.4. This is both an ageing and a moisture test and an indication of the remarkable electrical stability which is maintained. The dielectric strength after one immersion was 1215 volts/mil and after six months immersion was 1000 volts/mil, which are approximately the same values as for uncompounded polyethylene after immersion for the same periods.

Electrical conductors insulated with a compound including an amount of butyl rubber in accordance with the present invention have the advantage not only of initial flexibility but of retaining the flexibility even after exposure to heat, and ageing. This is illustrated by the following laboratory data comparing the changes in tensile

strength and elongation of compounds A and B, when subjected to ageing:

	Compound A		Compound B
Polyethylene.....	60	Butyl Rubber 5%.....	60
Chlorowax 70.....	20	Polyethylene 95%.....	20
Antimony Oxide.....	20	Chlorowax.....	20
"Trimal".....	1.0	Antimony Oxide.....	20
		"Trimal".....	1.0
	101.0		101.0

Compound	Aged at 100° C.			
	Initial	1 day	7 days	30 days
A				
(1) Tensile Strength, p. s. i.....	1,670	2,000	1,840	2,115
(2) Elongation, Percent.....	500	175	75	50
B				
(1) Tensile Strength, p. s. i.....	1,665	1,665	1,840	1,880
(2) Elongation, Percent.....	533	508	350	350

Without butyl rubber or high molecular weight polyisobutylene the maximum loading without seriously affecting the life of the polyethylene compound is limited to approximately 25%, while with butyl rubber or high molecular weight polyisobutylene, as above described, the loading range may be extended to approximately 45% and the compound will retain excellent stability both electrically and physically. The fact that the loading threshold critically influences the ageing characteristics of polyethylene, and that this may be extended by the use of relatively small amounts of butyl rubber, has not heretofore been known.

Electrical conductors embodying my invention are unique in their combined qualities of excellent insulating maintained over a wide range of temperature and moisture conditions, flexibility which is retained after exposure to heat and ageing, and flame resistance of a high order necessary for use in power, control and appliance wiring as well as other locations where flammability is a hazard. It is surprising to find these qualities co-existing in an insulated conductor and together they provide a product of all around high quality well adapted for many different purposes and widely varied uses. Unlike prior art combinations including chlorinated compounds compatible with polyethylene which are unstable at temperatures slightly higher than room temperatures, insulated conductors embodying my invention are stable at temperatures of 300° F. and above, which are ordinarily factory processing temperatures. The practical utility of conductors comprising my invention is further evidenced by the fact that conductors insulated with compounds of the formulae given above comply with the flammability test of the "Joint Army and Navy specifications for 'Cable (Hook-up Wire), Electric, Insulated, Radio and Instruments, Jan-C-76, 19 August 1945.'"

It will thus be seen that there has been provided by this invention an insulated conductor in which the various objects hereinabove set forth together with many practical advantages are successfully achieved. As various possible embodiments might be made of the above invention and the art herein described might be varied in various parts, all without departing from the scope of the inven-

tion, it is understood that all matter hereinbefore set forth is to be interpreted as illustrative and not in a limiting sense.

What I claim is:

1. An electrical conductor provided with a stable insulating composition comprising the following constituents in approximately the following proportions:

	Percent
Polyethylene	55-75
Butyl rubber.....	2-5
Antimony trioxide.....	10-34.4
Chlorinated paraffin 70.....	8.6-21.5

said composition being flame- and aging-resistant and having the electrical and physical characteristics of polyethylene.

2. An electrical conductor provided with a stable insulating composition comprising the following constituents in approximately the following proportions:

	Percent
Polyethylene	61.75
Butyl rubber.....	3.25
Antimony trioxide.....	20
Chlorinated paraffin 70.....	12

said composition being flame- and aging-resistant and having the electrical and physical characteristics of polyethylene.

3. An electrical conductor provided with a stable insulating composition comprising the following constituents in approximately the following proportions:

	Percent
Polyethylene	61.75
Butyl rubber.....	3.25
Antimony trioxide.....	20
Chlorinated paraffin 70.....	12
Stabilizing catalyst.....	0-1
Inorganic filler.....	0-2

4. A composition for extrusion onto an electrical conductor comprising substantially: 61.75% polyethylene, 3.25% butyl rubber, 20% antimony trioxide, 12% chlorinated paraffin 70, 1% monohydrated tribasic lead salt of maleic acid and 2% dehydrated, light-weight porous silica aerogel, the said composition being stable to heat and moisture, flame- and aging-resistant and retaining the electrical and physical characteristics of polyethylene.

5. An extrudable insulating composition comprising the following constituents:

	Percent
Polyethylene	55-75
Butyl rubber.....	2-5
Antimony trioxide.....	10-34.4
Chlorinated paraffin 70.....	8.6-21.5

said composition being flame- and aging-resistant and having the electrical and physical characteristics of polyethylene.

References Cited in the file of this patent

UNITED STATES PATENTS

2,312,024	Brown	Feb. 23, 1943
2,480,298	Happoldt	Aug. 30, 1949
2,569,540	Selby	Oct. 2, 1951
2,569,541	Selby	Oct. 2, 1951
2,581,930	Albert	Jan. 8, 1952
2,618,624	Sparks et al.	Nov. 18, 1952

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,830,919

April 15, 1958

Rudolph A. Schatzel

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 13, for "desirable" read -- desired --; line 48, for "chlorowax" read -- "Chlorowax", a trade-mark of Diamond Alkali Company, --; line 50, for "higher" read -- high --; column 4, lines 3 and 4, for "comprise" read -- comprises --; line 14, Example 3, for

Trimal ----- 1
read

Trimal ----- 0.5

Signed and sealed this 8th day of July 1958.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

UNITED STATES PATENT OFFICE
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