March 24, 1959 F. S. NICHOLS ET AL 2,879,323

ELECTRICAL INSULATING CEMENT

Filed Dec. 7, 1954

Fig. 1.

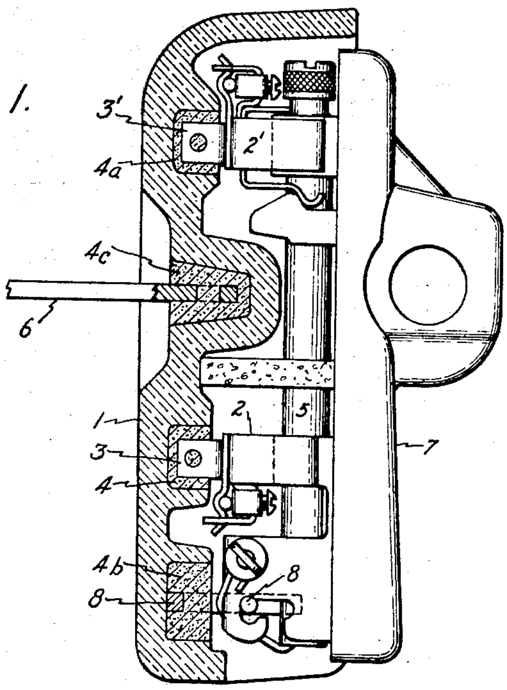
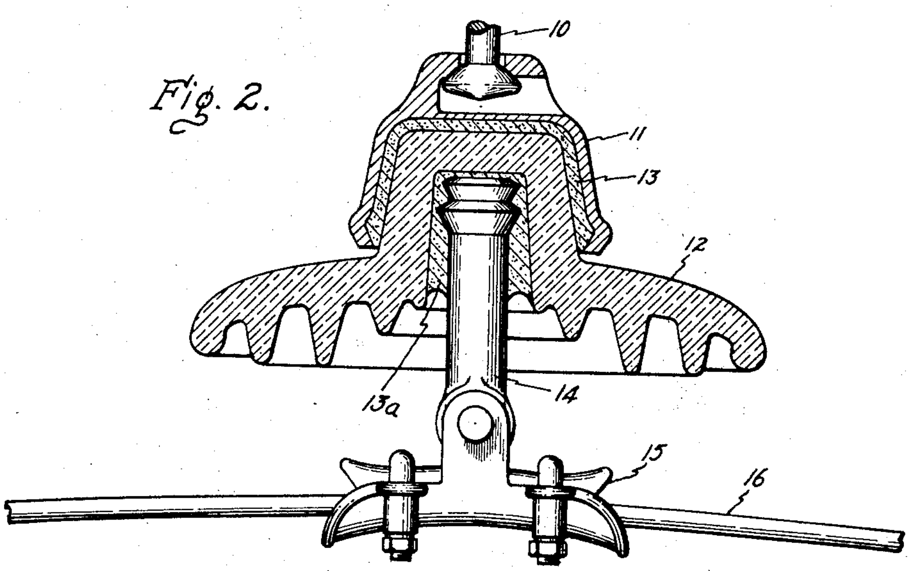


Fig. 2.



Inventor
Frank S. Nichols
Sidney R. Smith, Jr.
by Gilbert P. Tarleton
His Attorney

United States Patent Office 2,879,323

Patented Mar. 24, 1959

1

2,879,323

ELECTRICAL INSULATING CEMENT

Frank S. Nichols, Pittsfield, and Sidney R. Smith, Jr., Stockbridge, Mass., assignors to General Electric Company, a corporation of New York

Application December 7, 1954, Serial No. 473,696

5 Claims. (Cl. 174—177)

The present invention relates to cement materials. More particularly, the invention relates to a synthetic resin cement serving as an electrical insulating bond between ceramic, especially porcelain, insulator members and metallic hardware.

Among the types of insulating devices with which the present invention is particularly concerned and for which the disclosed cement is especially suitable are support insulators and enclosures for cutouts and lightning arresters, suspension insulators for power lines, support insulators for bus bars and switchgear, and bushings for transformers and capacitors.

Electrical insulators of the above types are frequently required to operate in outdoor locations where they are exposed to weathering conditions or in locations subject to moisture condensation or atmospheric pollution, and they are usually made of ceramic materials such as porcelain, or, less frequently, from certain types of glass. These materials are practically the only ones which in the course of many years of service have been demonstrated to combine good insulating properties with the required resistance to prolonged exposure to weathering under high voltage stress. Certain plastics and synthetic resins have been found to be excellent insulating materials and to withstand long exposure to atmospheric conditions. However, under the combined effect of weather and high voltage stress they are subject to "tracking"—the formation of a conducting carbon path which quickly results in failure of the insulator.

In the various applications of electrical insulating material such as mentioned, the porcelain is required to insulate a high voltage conductor from a grounded metallic structure such as mounting brackets or tanks. A problem which has always been present in mounting the insulator is the proper attachment of the insulator to such metal parts, since it is not usually practical to cast in these or other metal parts for their attachment during manufacture of the porcelain. It is the usual practice to secure the metal parts to the porcelain insulator by means of a cement, which is used either to bond the metal part inserted in a recess in the porcelain or to bond a projection on the porcelain which extends into a corresponding opening in the metal part.

Bonding materials which have been commonly used heretofore for this purpose include sulfur cement, Portland cement and solders formed of metal alloys, but these bonding materials have several disadvantages. Sulfur cement is subject to excessive shrinkage often necessitating more than one filling, and is highly corrosive to many metals, the fumes evolved during handling tending to corrode silver contacts in its vicinity. Portland cement requires a long, carefully controlled steam cure making it poorly adapted for high speed insulator mounting processes. Metal solder alloys are generally expensive and because of their high melting point the application of such alloys in molten state to the porcelain subjects the porcelain to excessive thermal shock. Also, they have no electrical insulating properties.

2

It is an object, therefore, of the present invention to provide a cement which is suitable for use with electrical insulators of the above type and which avoids the disadvantages of insulating cement materials heretofore used.

It is another object of the present invention to provide an insulator structure comprising a ceramic especially porcelain to metal joint wherein the bonding material is characterized by ease of handling, rapidity of hardening, low application temperature, relatively low shrinkage on hardening, non-corrosion of metals, high mechanical strength, good resistance to weathering, and high resistance to arcing and tracking.

A further object of the present invention is the provision of a composite insulating structure of the above type consisting of the ceramic insulator and cement wherein the cement material has a dielectric constant at least as high as the ceramic insulating material which it bonds to the metal hardware.

Another object of the invention is the provision of an electrical structure having the cement and ceramic of the composite insulation arranged in series between electrical conductors bonded thereto.

In accordance with the invention, an insulating structure is provided which comprises a ceramic body, a metallic body and a cement material firmly bonding the ceramic and metallic bodies together, the cement having a dielectric constant at least equal to the dielectric constant of the ceramic body and comprising a 100% reactive polymerizable synthetic resin selected from the group consisting of polyester resins and epoxy resins, an inorganic filler, and a polymerizing agent for polymerization of the synthetic resin.

The expression "100% reactive polymerizable synthetic resin" as used herein is intended to cover compositions of matter which are polymerizable materials substantially free of inert, volatile solvents and which by the incorporation of a suitable polymerizing agent may be caused to polymerize to form substantially infusible and insoluble materials without the necessity of taking up oxygen from the air and without forming volatile products. Further, the expression "polymerizing agent" as used herein is intended to cover a catalyst or a cross-linking reactant which participates in the reaction bringing about polymerization of the polymerizable materials, examples of such catalysts and reactants being given below.

The expression "polyester resins" as used herein is intended to denote synthetic resins produced by polymerization of polybasic acids with polyhydric alcohols, either or both the acids and alcohols being unsaturated, with co-polymerization of an admixed vinyl monomeric compound.

The invention will be better understood by referring to the accompanying drawings in which:

Fig. 1 is a cross-sectional view of an enclosed type cutout embodying a cement in accordance with the invention; and

Fig. 2 is a cross-sectional view of a suspension insulator utilizing the present cement.

Referring now to the drawings, and particularly to Fig. 1, there is shown an enclosed type electrical cutout of known construction, the cutout having a housing **1** made of porcelain or the like in which combination terminal clamp and contact devices **2, 2'** are mounted by metal brackets **3, 3'** cemented to housing **1**. The terminals of the power line in which the fuse is in circuit are connected to the opposite terminals of the fuse assembly **5** by means of the clamp and contact devices **2,2'**. Brackets **3, 3'** are secured to porcelain housing **1** by means of cement joints **4, 4a**, the composition of which is a feature of the present invention and which is more fully described below. The door **7** of the cutout carries the fuse assembly **5**, and in the embodiment shown is mounted for turning about trunnion structure **8** secured to the cutout housing **1** by cement joint **4***b*. Mounting bracket **6** which attaches cutout housing **1** to a pole or similar support is likewise secured to housing **1** by a cement joint **4***c* of similar composition. The metallic parts which are joined to the porcelain by the present cement composition are usually made of galvanized steel, but it is to be understood that any other electrically conductive metals could be effectively bonded to ceramic insulation by the present cement material.

The conditions of operation of the illustrated type of cutout cause considerable stresses to be placed on the various cement joints described. For example, the type of fuse illustrated is commonly designed to produce a gas when the fuse is blown for extinguishing the resulting arc, and the expulsion of the gas from the fuse tube exerts a thrust on the latch mechanism associated with the upper terminal device **2'**, which in turn exerts a force on the cement joint **4***a* of the upper bracket **3'**. The same thrust force may also be exerted on the lower cement joint **4***b* through the trunnion structure. The dropping out of the fuse door **7** and its associated fuse assembly **5** with the latter members bearing on trunnion structure **8** in a somewhat modified type of cutout arrangement (not shown), which provides for such action upon blowing of the fuse, also subjects the cement joints to a rather severe mechanical shock. Further, the cement joints may be subjected to strong mechanical stress due to tension exerted by the power lines attached to the terminal mounting brackets.

Fig. 2 illustrates a type of known suspension insulator device which may include stacked interconnected insulating members arranged with adjacent members linked together by a connecting pin **10**. The enlarged end of pin **10** fits into and thereby holds in suspension a cap **11** made of steel or the like into which fits a projecting portion of a glazed porcelain insulating member **12**, cap **11**, and insulating member **12** being joined by a cement bond **13** having a composition in accordance with the present invention. The porcelain insulator member **12** in turn carries suspension link **14** by means of a cement joint **13***a* also corresponding to the present composition, the suspension link **14** being connected by means of an eye at its lower end to suspension clamp **15**. A power line **16** is carried and clamped by suspension clamp **15** in the known manner. It is clear that in such an arrangement the weight of the power line exerts a considerable tensile stress on the cement joints referred to above tending to separate the component parts of the insulator support.

In the operation of the insulator devices such as described and illustrated, the cement and porcelain serve as dielectric media arranged in series between two conductors, e.g., in the Fig. 1 cutout, the power line terminals and the cutout mounting bracket, across which there is a high voltage. Under these conditions it is known that the voltage stress between the conductors distributes itself in inverse proportion to the dielectric constants of the two dielectrics, that is, the voltage stress is concentrated on the dielectric having the lower dielectric constant.

In view of the superior electrical insulating and dielectric properties of the porcelain, it is desirable in accordance with the invention to concentrate the stress on the porcelain by providing a cement which has a dielectric constant at least as great as and preferably greater than that of the porcelain. We have found that such results can be achieved by incorporating certain filler materials in particular resin compositions to produce cements adapted for use in electrical insulators of the type described and shown.

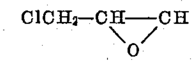
One type of 100% reactive polymerizable resins found suitable for use in the invention includes the polyester resins which are formed from a mixture of an unsaturated alkyd resin and a vinyl monomer. The unsaturated alkyd resins are the reaction products of polyhydric alcohols, mixtures of polyhydric alcohols, or mixtures of polyhydric and monohydric alcohols, and one or more polycarboxylic acids, either the alcohols or the acids or both being unsaturated. Examples of such polyhydric alcohols are ethylene glycol, di- and triethylene glycols, propylene glycol, trimethylene glycol, tetramethylene glycol, pentamethylene glycol, glycerine or pentaerythritol in combination with a monohydric alcohol. Examples of unsaturated polycarboxylic acids are maleic, fumaric, and itaconic acids. Anhydrides of polycarboxylic acids may also be employed. The term "polycarboxylic acid" as used herein is intended to include within its meaning the anhydrides of such acids. In addition to one or more of the unsaturated polycarboxylic acids, saturated polycarboxylic acids may also be present in the reaction mixture in the preparation of the resins referred to above. Examples of such saturated polycarboxylic acids are succinic, adipic, sebacic, and phthalic acids.

Of the vinyl monomers used in accordance with the invention to form the polyester resin cement, styrene has proved particularly suitable. Examples of other vinyl monomers which may be used include esters of unsaturated monohydric alcohols and carboxylic acids, including unsaturated carboxylic acids, halogenated aromatic carboxylic acids and inorganic acids. Examples of such substances are diallyl phthalate, diallyl succinate, diallyl maleate, diallyl fumarate, diallyl itaconate, diallyl chlorophthalates, triallyl phosphate, and vinyl acetate. Other substances which may be incorporated in these polymerizable liquids are esters of monohydric alcohols and unsaturated carboxylic acids which are capable of copolymerizing with unsaturated alkyd resins, such as, for example, dioctyl itaconate, dibenzyl itaconate, diethyl fumarate, dibenzyl fumarate, methyl acrylate and methyl methacrylate.

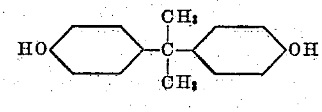
A suitable commercial polyester resin is Laminac 4128, which is a styrene-unsaturated alkyd resin manufactured by the American Cyanamid Company.

While the above polyester resins may be cured to an infusible state by means of heat alone, e.g., at temperatures of 80–150° C., a small amount of catalyst is preferably added to the polyester resin mixture to facilitate polymerization. Among the substances which may be used as catalysts for this purpose are inorganic super oxides such as barium peroxide and sodium peroxides; aliphatic peroxides such as acetyl peroxide, lauroyl peroxide, stearoyl peroxide and the like; aromatic acid peroxides such as benzoyl peroxide; and other mixed organic peroxides such as acetyl benzoyl peroxide and ketone peroxides such as acetone peroxide and triacetone peroxide. A particularly suitable catalyst composition which is commercially available is a benzoyl peroxide suspension in tricresyl phosphate.

Instead of the polyester resins described, epoxy resins may be used, these resins being condensation products of polyhydroxy compounds, such as polyhydric phenols and polyhydric alcohol, and epichlorhydrin. Examples of polyhydroxy compounds which may be used as glycerol, diphenylol propane, and the mixed poly (hydroxyl phenyl) pentadecanes derived from cashew nuts. An example of a suitable epoxy resin is Araldite CN502 of the Ciba Company, which is the condensation product of epichlorhydrin



and 2,2' bis phenylol propane



In the case where epoxy resins are used, the polymerizing agent employed is a cross-linking reactant, examples of which are polyamines, e.g., diethylene triamine, or dibasic anhydrides, e.g., phthalic anhydride.

With respect to the inorganic filler materials which are used with the above resins to raise the dielectric constant of the cement, it has been found that in general the stannates and titanates of the alkaline earth metals, i.e., barium, strontium and calcium, may be used satisfactorily for the purposes desired, and of these barium titanate and barium strontium titanate have proved especially suitable. Further, titanium dioxide, e.g., in the form of rutile, and certain forms of impure alumina have been discovered to constitute very satisfactory inorganic fillers. Ruflux #84 made by the National Lead Company is a granular rutile composition found to be satisfactory for the present cement.

The dielectric constant of a composite material is a logarithmic function of the dielectric constants of the constituents and of their proportions by volume. Since the dielectric constant of the resin constituent of the present cement composition will be only of the order of 3 to 5, the dielectric constant of the inorganic filler must be relatively very high in order to obtain the desired dielectric constant of the mixture. Therefore, the inorganic substance used to raise the dielectric constant of the cement composition should have a dielectric constant of not less than 30 and preferably of several hundred. In this connection, it is to be understood that the dielectric constant values as recited in the claims are as measured at 60 cycles.

In addition to the above inorganic materials, the inorganic filler may, if desired, contain a finely divided mineral substance such as ground silica, talc, clay, or mica, for the purpose of controlling the viscosity of the cement, which is of particular advantage in proper application of the cement to the bodies to be bonded, and for imparting mechanical strength to the final joint structure.

In the preparation of the cement, the amounts of ingredients as set forth herein are weighed out accurately, particular attention being paid to the amount of polymerization catalyst used. The resin material is first added to a mixer, the polymerizing agent then added and dissolved before addition of the inorganic fillers. Thorough mixing is then carried out to ensure ease of flow of the mixture. Ordinarily 30 minutes of mixing are necessary to obtain good flow. It is desirable for the mixer apparatus to be equipped with a cold water jacket to dissipate the heat generated in mixing.

When polyamine cross-linking reactants are used with the epoxy resins, because of the high reactivity of these reactants at room temperature, this procedure should be modified to allow the cross-linking reactant to be added at the end of the mixing period.

The cement made as described using the polyester resins cures hard in about 2 minutes at 125° C. If treated at 110° C., the cure is somewhat slower. Therefore, the cement is preferably heated as rapidly as possible to 115 to 135° C. The cement may be applied to the parts to be bonded at room temperature and the assembly heated to the required temperature. The time required to do this depends on the parts to be bonded and the method of heating. Alternatively, the porcelain may be preheated to between 110° C. and 135° C. and the cement is then applied to the hot porcelain, the residual heat of the porcelain being sufficient to harden the cement. In some cases, it may be more convenient or otherwise desirable to preheat the hardware.

As is known in the art, the curing time and temperature of the epoxy resins depend on the particular cross-linking reactant used. For example, a polyamine cross-linking reactant would permit the curing of epoxy resins at room temperature, whereas the use of dibasic anhydrides as cross-linking reactants would require cures at higher temperatures, e.g., at 150° C. for 6 hours.

The amount of resin used in the present cement composition whether the polyester or epoxy resin, ranges approximately from 10 to 80% by weight, while the inorganic filler for both types of resins ranges between 20 to 90%. The catalyst used for the polyester resin is present in the range of 0.25–5% by weight of the polyester resin and the amount of cross-linking reactant for the epoxy resin is about 5–45% by weight of the epoxy resin. The silica or other mineral substance used for viscosity control may vary between 5–50% of the total cement composition.

Illustrative cement compositions in percent by weight are set forth in the following examples, it being understood that the invention is not limited to the specific formulations given since considerable variations may be made depending on the type of materials to be bonded, the desired viscosity, and other factors:

Example I

	Percent
Titanium dioxide	76.4
Styrene-unsaturated alkyd resin mixture	12.9
Silica	10.2
Benzoyl peroxide (50% suspension in tri-cresyl phosphate)	0.5

The properties of this material are as follows:

Tensile strength	1,600 p.s.i.
Compressive strength	15,000 p.s.i.
Impact strength, Izod	0.22 ft.-lb. per inch of notch.
Dielectric constant, 60 cycle:	
25° C.	16.4.
100° C.	19.5.
Percent power factor, 60 cycle:	
25° C.	4.1.
100° C.	10.2.
Insulation resistance, ohm/cm.	
25° C.	5.5×10^{13}.
100° C.	2.8×10^{12}.
Dielectric strength, step by step, 60 cycle	96 VPM (0.25" section).
Arc resistance (ASTM)	207 secs.
Shrinkage on setting:	
Linear	0.27%.
Volume	0.9%.
Flammability, ASTM DD635	Self extinguishing.
Specific gravity	2.89.
Coefficient of thermal expansion	21.6×10^{6}.
Moisture absorption, 24 hours' immersion	0.4%.
Oil resistance	Unaffected.

A cement of the above composition has been exposed to weather under voltage stress for almost three years without visible deterioration. Flashover experiments on cutouts utilizing the above type of cement showed no carbonization of the cement nor fall of flashover voltage on subsequent flashes.

Example II

	Percent
Titanium dioxide	74.7
Styrene-unsaturated alkyd resin mixture	14.8
Benzoyl peroxide (50% suspension in tri-cresylphosphate)	0.6
Silica	9.9

The above cement when cured has properties similar to those of the cement of Example I, but flow of the uncured material is considerably greater.

Example III

	Percent
Styrene-unsaturated alkyd resin mixture	18.5
Ground silica	40.5
Titanium dioxide	40.5
Benzoyl peroxide	0.5

The above cement composition has the following properties:

Dielectric constant, 60 cycles, 25° C.	7.8
Power factor, percent, 60 cycles, 25° C.	2.6
Insulation resistance (ohm cms.)	9.6×10^{14}

This cement cures hard in two to three minutes at 125° C.

Example IV

	Percent
Styrene-unsaturated alkyd resin mixture	23.8
Sand	38.0
Alumina (impure)	38.0
Benzoyl peroxide	0.2

The impure alumina referred to above has the following approximate composition in parts by weight, and in this connection it is to be understood that the expression "impure alumina" as used in the claims is construed as having this composition:

	Parts
Al_2O_3	26
Fe_2O_3	17
SiO_2	14
TiO_2	11
CaO	10
Na_2O	10
Loss on ignition	10

An impure alumina of the above type known as R20 Insulating Powder is manufactured by the Aluminum Company of America.

The above cement composition has the following properties:

Dielectric constant, 60 cycles, 25° C.	9.5
Power factor, percent, 60 cycles, 25° C.	18.4
Insulation resistance (ohms cm.)	3.8×10^{13}

Example V

	Percent
Titanium dioxide	77.0
Silica	10.2
Epoxy resin (Ciba Araldite CN502)	11.8
Diethylene triamine	1.0

The above cement composition has the following properties:

Dielectric constant, 60 cycles, 25° C.	18.0.
Power factor, percent, 60 cycles, 25° C.	4.7.
Insulation resistance, 60 cycles, 25° C.	5×10^{11} ohms.
Dielectric strength (step by step), 60 cycles, 25° C.	100 VPM on ¼" thickness.

The cement compositions of the present invention are characterized in general by excellent weathering properties, high mechanical strength, low coefficient of expansion and marked ability to withstand electrical stresses without deterioration. Moreover, they are easy and economical to produce, are readily applied to the materials to be bonded, and form therewith a strongly adherent permanently hardened cement bond.

While the cement compositions of the present invention have been mainly described with respect to their use as bonding material between porcelain insulators and metal hardware and particularly as utilized in electrical devices such as cutouts and insulators, it will be understood that other members may be effectively bonded by the use of the present cements and that the latter may be used in devices other than those shown and

described. For example, the cement may be used for bonding glass insulators to metal, or joining ceramic insulators to each other. Therefore, the described embodiments are not to be construed as limiting the scope of the invention.

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

1. A ceramic to metal joint structure comprising a ceramic body; a metallic body; and a cement material firmly bonding said bodies together, said cement material having a dielectric constant at least equal to that of said ceramic body and being formed from a 100% reactive polymerizable synthetic resin selected from the group consisting of polyester resins and epoxy resins, a polymerizing agent for polymerization of said synthetic resin, and an inorganic filler material having a dielectric constant of at least 30.

2. A ceramic to metal joint structure comprising a porcelain body; a metallic body, and an electrical insulating cement material firmly bonding said bodies together, said cement material having a dielectric constant at least equal to the dielectric constant of said porcelain body and being formed from a 100% reactive polymerizable synthetic resin selected from the group consisting of polyester resins and epoxy resins, a polymerizing agent for polymerization of said synthetic resin, and an inorganic filler material including an inorganic substance having a dielectric constant of at least 30 and a finely divided mineral substance for controlling the viscosity of the cement composition, said inorganic substance being selected from the group consisting of titanium dioxide, titanates of the alkaline earth elements, and impure alumina which consists essentially of oxides of aluminum, iron, silicon, titanium, calcium and sodium.

3. A ceramic to metal joint structure comprising a porcelain body; a metallic body; and an electrical insulating cement material firmly bonding said bodies together, said cement material having a dielectric constant at least equal to the dielectric constant of said porcelain body and being formed from a 100% reactive polymerizable synthetic resin comprising a styrene-unsaturated alkyd polyester resin, a polymerizing catalyst for polymerization of said synthetic resin, and an inorganic filler material including an inorganic substance having a dielectric constant of at least 30 and a finely divided mineral substance for controlling the viscosity of the cement composition, said inorganic substance being selected from the group consisting of titanium dioxide, titanates of the alkaline earth elements, and impure alumina which consists essentially of oxides of aluminum, iron, silicon, titanium, calcium and sodium.

4. A ceramic to metal joint structure comprising a porcelain body; a metallic body; and an electrical insulating cement material firmly bonding said bodies together, said cement material having a dielectric constant at least equal to the dielectric constant of said porcelain body and being formed from a 100% rective polymerizable synthetic resin comprising an epoxy resin obtained as the reaction product of epichlorhydrin and 2.2' bis phenylol propane, a cross-linking reactant for polymerizing said epoxy resin, and an inorganic filler material including an inorganic substance having a dielectric constant of at least 30 and a finely divided mineral substance for controlling the viscosity of the cement composition.

5. An electrical structure comprising a plurality of electrical conducting members, a porcelain body, and an insulating cement material firmly bonding said electrical conducting members to said porcelain body and forming in series with said porcelain body a composite insulating joint between said conducting members, said cement material having a dielectric constant at least equal to that of said porcelain body and being formed from a 100% reactive polymerizable synthetic resin selected from the group consisting of polyester resins and epoxy resins, a polymerizing agent for polymerization of said

synthetic resin, and an inorganic filler material including an inorganic substance having a dielectric constant of at least 30 and a finely divided mineral substance for controlling the viscosity of the cement composition.

References Cited in the file of this patent

UNITED STATES PATENTS

1,725,097	Naylor	Aug. 20, 1929
2,175,672	Scott et al.	Oct. 10, 1939
2,514,141	Phillips	July 4, 1950
2,528,933	Wiles	Nov. 7, 1950
2,537,375	Simons et al.	Jan. 9, 1951
2,577,005	Di Giacomo	Dec. 4, 1951

FOREIGN PATENTS

706,067	Great Britain	Mar. 24, 1954
716,987	Great Britain	Oct. 20, 1954

OTHER REFERENCES

Libbey-Owens-Ford Glass Company, Plaskon Division, Bulletin A-4, page 1, Properties of Plaskon Alkyd 420. Received U.S. Patent Office March 13, 1952.

Libbey-Owens-Ford Glass Company, Plaskon Division, Bulletin A-7, page 1, Properties and Uses of Molded Plaskon Alkyd. Received U.S. Patent Office March 17, 1952.

Moss: "British Plastics," November 1948, pages 521, 523, 524.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,879,323 March 24, 1959

Frank S. Nichols et al

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 4, line 62, for "used as" read -- used are --; line 68, the formula should appear as shown below instead of as in the patent:

$$\mathrm{ClCH_2{-}\underbrace{CH{-}CH_2}_{O}}$$

Signed and sealed this 8th day of September 1959.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

UNITED STATES PATENT OFFICE

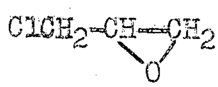
CERTIFICATE OF CORRECTION

Patent No. 2,879,323 March 24, 1959

Frank S. Nichols et al

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 4, line 62, for "used as" read -- used are --; line 68, the formula should appear as shown below instead of as in the patent:



Signed and sealed this 8th day of September 1959.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents