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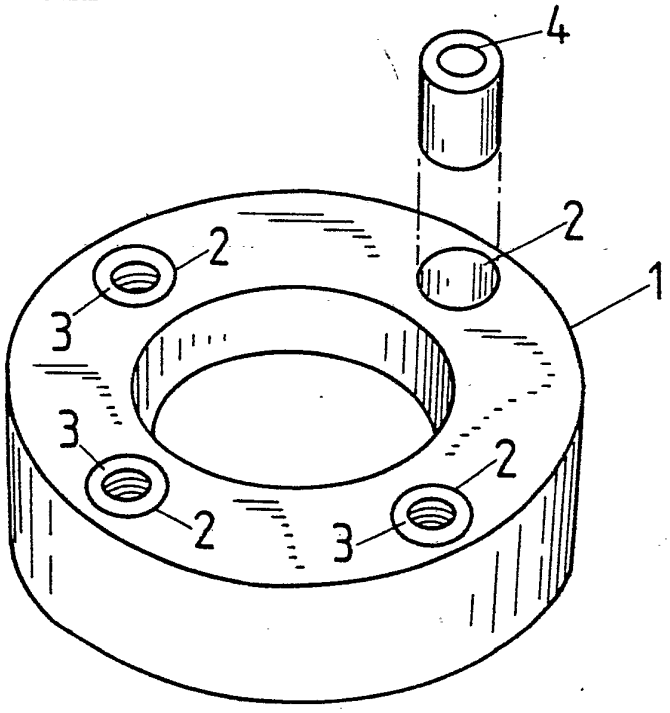
(54) Title: COMPOSITE ELECTRICAL INSULATOR CONTAINING A POLYMER CERAMIC HIGH-STRENGTH INSULATED INSERT



(57) Abstract

An electrical insulator structure (1) is a combination of a first insulator body of a material having a first particle size which has a receptacle portion (2) and a second insulator body (3) adapted to be received by a receptacle portion said second body comprising an acicular aggregate bonded by a cured synthetic resin binder having at least one thread (4) vibration molded therein, the aggregate having a second particle size being such that at least two individual acicular particles can simultaneously be at least partially contained within the triangular cross-section volume defined between adjacent thread faces.

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COMPOSITE ELECTRICAL INSULATOR CONTAINING A POLYMER CERAMIC HIGH-STRENGTH INSULATED INSERT

BACKGROUND OF THE INVENTION

The need to attach electrical components such as wires and the like to insulation bodies is usually satisfied by bolting the components into the body. The insulator bodies are usually made of porcelain and any threads in such porcelain bodies are so difficult to produce that they are rarely, if ever, made. If they were produced for some specific reason, a bolt or other fastener inserted into these threads easily strips the threads so that the attached component easily pulls loose from the insulator body. To make attachments to porcelain, it is conventional to cement a metal cap to the insulator body to attach the electrical components to the metal cap.

The conventional metal caps have three major disadvantages, namely they present a large area of conductive metal, the cap is the most expensive part of the insulator structure, and the incompatability of the thermal characteristics between the metal and porcelain give rise to additional problems. Despite these disadvantages, the metal cap has been considered necessary and is in wide-spread commercial use.

Copending application Serial No. (C-1907 (ER/MRD)) of even date herewith and assigned to

the same assignee as this invention describes a superior insulator body having at least one thread produced by vibration molding an acicular aggregate and a synthetic resin binder against an appropriate die. The threads so formed are strong and resistant to stripping and, amazingly, are even stronger than the rest of the insulator body. As a result, the metal cap and its associated disadvantages can be completely eliminated.

The threads in most electrical equipment are a 1/2-13 inch thread size. There are, however, instances when a thread of a different size is desirable and the particle size of the acicular aggregate appropriate for forming a 1/2 - 13 thread is not appropriate for forming a different size thread. For example, if the aggregate used to form a 1/2 - 13 thread is used to form a 10-32 thread, the acicular particles will not line up properly to form a strong thread and instead, a resin rich weak thread will be produced. In this case, acicular particles of a smaller size must be used in order to adequately form the finer thread and to maintain the strength and stripping resistance. Similarly for larger size threads, the acicular particles must be of a larger size in order to maintain the strength and stripping resistance. If the acicular particles are not of appropriate size, the resulting body threads will have too much polymer present and will be weak and amenable to stripping.

For a variety of reasons, it may be necessary or desirable to form the main body of an insulator of a material, which may or may not contain an acicular aggregate, whose particle size may not be appropriate to the formation of the strong and stripping resistant threads described above. It may be very difficult or impossible to incorporate some acicular particles in such a body in such a way that the desired strong and stripping resistant threads can be formed.

Accordingly, it is the object of this invention to provide a superior insulating body having one or more threads therein which are strong and resistant to stripping and in which the thread size can be varied independently of the composition of the bulk of the body so that the conventional metal caps can be eliminated. This and other objects of the invention will become apparent to those skilled in this art from the following detailed description in which:

Figure 1 is a representation of a cross-section of a thread formed in accordance with the present invention, and

Figure 2 is a representation of an insulator ring formed in accordance with the present invention.

SUMMARY OF THE INVENTION

This invention relates to a superior insulating body having threads therein. More particularly, it relates to a superior body of a first insulator material having a first particle size and a receptacle portion and a second insulator body adapted to be received by the receptacle portion which comprises an acicular aggregate bonded by a cured synthetic resin having at least one thread vibration molded therein, in which the aggregate has a second particle size different from the first particle size and the second particle size is such that at least two individual acicular particles can simultaneously be at least partially contained within the triangular cross-section volume defined between adjacent thread faces.

DESCRIPTION OF THE INVENTION

The insulator structure of the present invention is a combination of a first insulator body which contains a receptacle portion and a second insulator body which is adapted to be received by the receptacle portion of

the first insulator body.

The first insulator body can be constructed of any suitable insulation material such as a filled synthetic resin, porcelain, and the like. The first insulator body can also, but need not necessarily be, constructed of the same material used to construct the second insulator body. The first insulator body can be composed of particles of material bonded together in an appropriate way or may be constructed of a material in which discrete particles cannot be identified. The material of the first insulator body has a first particle size which will be understood to refer to the size of the particles when such particles can be identified or the size of the entire body in the case that individual particles cannot be identified. The receptacle portion of the first insulator body can be in any desired configuration and the receptacle portion in the majority of instances will probably be cylindrical.

The second insulator body is formed by a polymer concrete 8 resulting from a mixture of a curable resin and an acicular aggregate. The polymer 9 can be any curable resin, preferably electrical insulation grade, which will bind the aggregate particles together and substantially fill the porosity when it is hardened. Accordingly, epoxy resins, polyester resins, polyurethane resins, polyolefin resins, silicon resins, and the like can be used. The polymer 9 is chosen from commercially available products on the basis of its physical aspects, electrical characteristics, hydrophobic characteristics, ability to bind the aggregate and handleability. The preferred polymer 9 is an electrical insulation grade epoxy resin. It will be understood by those skilled in the art that the polymer can contain a curing agent which is adapted to be effective in other ambient conditions. For example, it is preferred to formulate the epoxy resin polymer with a suitable hardening agent and

catalyst, such as an anhydride or amine, which cure the epoxy resin at elevated temperature. It is also preferred to use a polymer which has a modulus of elasticity in the range of about 2-10 x 10^6 psi (about 14-7 x 10^5 kg/cm^2) because this will allow small thread deformation when a load is applied to the cast threads. The deformation will act to distribute the stress over the entire thread engagement length and provide maximum strength to the threads. Further, as shown in Figure 1, the aggregate particles are subjected to compression and shearing stresses when the threads are loaded and this is when maximum strength is attained.

The majority of the aggregate particles, i.e., greater than 50%, are acicular particles 7 and have a particle size which is different from that of the first insulator body. Preferably the acicular particles 7 constitute about 65-75% of the aggregate. Any electrically insulating material which can be obtained in acicular shape can be used and it has been found that electrical grade porcelain when crushed forms an excellent acicular aggregate with all the desired properties. The remainder of the aggregate can be those materials which are normally used as fillers in synthetic organic polymer insulation. The conglomeration of materials forming the aggregate should have a variety of particle sizes to reduce the amount of volume which will be filled by the binder portion of the concrete 8. Preferably, at least two different particle sizes of acicular material, adapted to the size of the threads are used. In order to be adapted to the size of the threads, at least two of the individually acicular particles should at least partially, and preferably wholly, be simultaneously contained within the triangular cross-section volume defined between adjacent thread faces. The binder portion

of the polymer concrete 8 should constitute about 5-25%, and preferably about 10-20%, of this volume.

Since the binder is usually the most expensive material in the polymer concrete 8, it is preferred to keep its concentration in the binder-aggregate admixture as low as practical. In general, the aggregate will be about 75-95% of the admixture, preferably about 80-90%.

It has been found necessary to mix the binder of the aggregate under a vacuum in order to eliminate large voids and express air in the final product and to insure a complete wetting of the aggregate with the binder resin. A vacuum above 27 inches of mercury, and preferably about 29-30 inches of mercury has been found to be appropriate. For ease of handling, it is preferable to conduct the mixing under an elevated temperature which is below the curing temperature of the binder. Generally temperatures of about 50-125°C, and preferably about 70-90°C are suitable if an epoxy resin adapted to cure at about 150°C is utilized. The time of mixing is not critical and optimum time intervals can readily be established by a few simple experiments. It is not necessary to vacuum cast the material since it has been found that the existence of a plurality of small voids do not detract from the insulator performance of this product although such vacuum casting can be done if the complete absence of voids is necessary.

The mixing of the aggregate and the binder is accomplished in a separate apparatus followed by introduction of the admixture into the mold. A suitable threaded member can be placed in the mold either before filling with the admixture or can be inserted into the admixture after the mold is filled. It is necessary to vibrate against the threaded member in order to achieve the objects of this invention. Machined in threads do not have the strength of the threads of this invention and

would be very difficult and expensive to produce due to the hardness of the aggregate. The amplitude of vibration is not critical and can be varied as desired as long as it is not so violent as to trap air in the admixture. This can be readily ascertained by observation and a just sufficient amplitude should be applied to give mobility to the mass. It is preferred to conduct the vibration at the same temperature as the mixing of the aggregate of the binder but any temperature below the curing point of the binder can be employed if desired. The length of time vibration continues is a function of the amplitude of the vibration and the temperature conditions. The vibration should be continued at least until the extrudation of binder resin on the surface of the admixture can be observed and preferably until the extrudation has substantially ceased. This observation of extrudation of a vibrating mixture is similar to that encountered when vibrating Portland cement concrete.

When vibration is complete, the admixture is cured by raising the temperature to or above the curing temperature of the binder resin. As is known in the art, voiding can be eliminated during cure by applying slight pressure to the admixture. The admixture can be completely cured in the mold or alternatively after the binder has gelled, the admixture can be ejected from the mold and cured in an oven thereby freeing the mold for other operations.

It is preferred to coat the threads of this invention with a conductive paint 5, such as those having a graphite or silver base. Such a paint distributes the electrical stress around an inserted metal bolt 6 and lubricates the threads making for ease of insertion and removal.

Without being limited to theory, it is believed that the high strength of the threads prepared in accordance with the present invention is a result of the

alignment of the acicular aggregate in that portion of the concrete body which forms the threads. This alignment is shown in Figure 1.

Figure 2 is a representation of one embodiment of the present invention. An insulation ring 1 of any cylindrical recepticle areas 2 although it will be appreciated that the number and shape of the receptacle portions 2 can be varied as desired. Four preformed inserts 3 of the polymer concrete described above each having one vibration molded thread 4 therein are set within receptacle portions 2 and held in place by the use of a suitable adhesive. When threads 4 are of a 10-32 size, the composition used to form the polymer concrete may be 148 parts of XB-2793 hydantoin epoxy resin (made by Ciba-Geigy Corp.), 174 parts of methyl tetrahydrophthatic anhydride, 0.75 part benzoyl dimethylamine, 4 parts of a flow additive (Modaflow from Dow Chemical Co., 50% in the epoxy), 510 parts of 325 mesh crushed quartz, 396 parts of 60 mesh felspatic porcelain and 756 parts of 100 mesh felspatic porcelain. Electrical wires can be connected to the insulator ring 1 by the use of bolts having the same size thread as the thread 4 of preformed insert 3.

It will be appreciated that various changes and modifications can be made in the products of this invention without departing from the spirit and scope thereof and that the various embodiments disclosed herein were for the purpose of illustration only and were not intended to be limited. Unless otherwise specified, all temperatures have been in degrees centigrade and all parts and percentages by weight throughout this specification and claims.

I CLAIM:

1. An insulator structure comprising, in combination, a first insulator body of material having a first particle size, said first body having at least one receptacle portion therein, and a second insulator body adapted to be received by said receptacle portion of said first body and comprising an acicular aggregate bonded by a cured synthetic resin binder having at least one thread vibration molded therein, said acicular aggregate having a second particle size which is different from said first particle size, said second particle size being such that at least two individual acicular particles can simultaneously be at least partially contained within the triangular cross-sectional volume defined between adjacent thread faces.

2. The insulator structure of claim 1 having a plurality of said receptacle portions and a plurality of said second insulator bodies.

3. The insulator structure of claim 1 wherein said binder occupies about 5-25% of said triangular cross-sectional volume.

4. The insulator structure of claim 3 wherein said binder occupies about 10-20%.

5. The insulator structure of claim 1 wherein said two individual acicular particles are simultaneously wholly contained within said triangular cross-sectional volume.

6. The insulator structure of claim 1 wherein said first particle size is larger than said second particle size.

7. The insulator structure of claim 1 wherein said second particle size is larger than said first particle size.

8. The insulator structure of claim 1 wherein said first insulator body is in the form of an insulation ring.

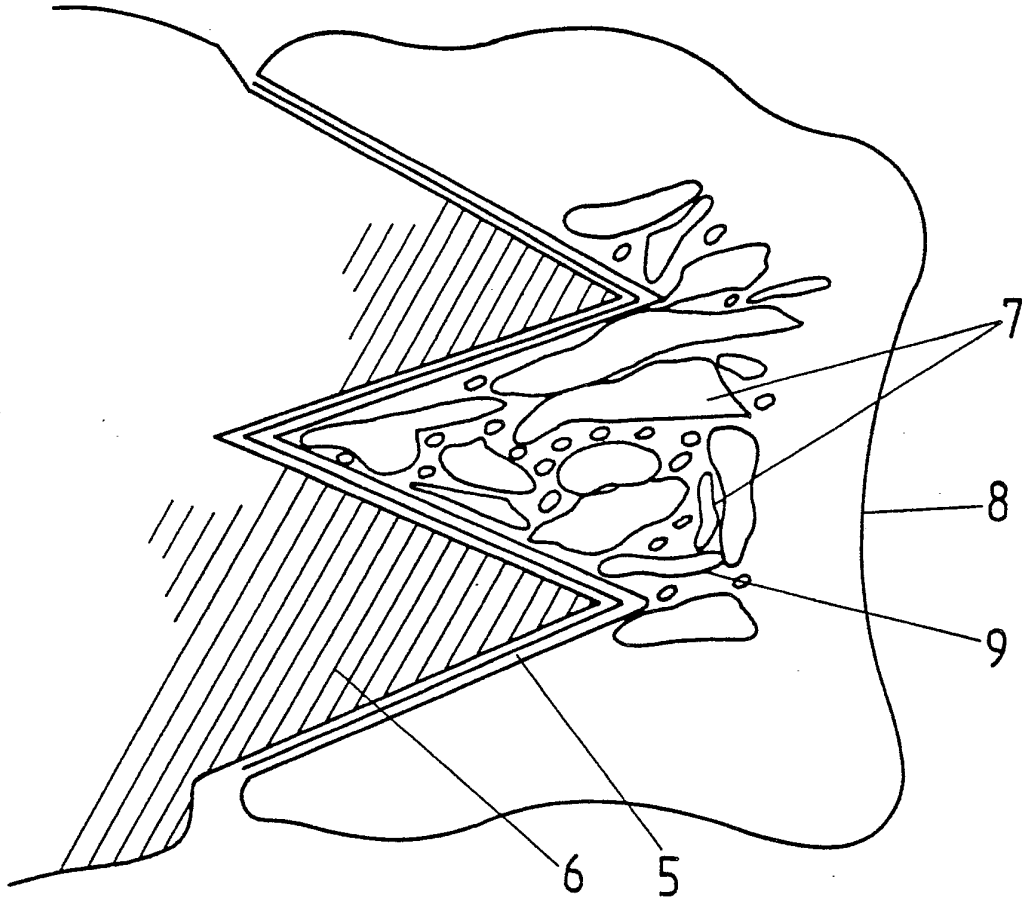

FIG.1

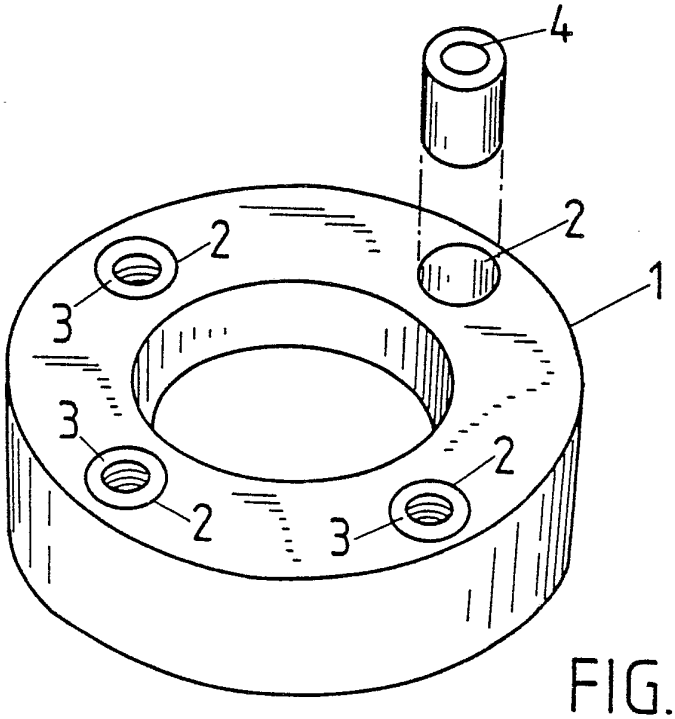

FIG.2

INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 79/00055

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

H 01 B 19/00; H 01 B 17/38; H 01 B 17/40; F 16 B 37/00

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
Int.Cl.[2]	H 01 B 19/00; H 01 B 19/04; H 01 B 17/38; H 01 B 17/40; F 16 B 37/00; F 16 B 13/14

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO SE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	US, A, 3495494, published 28th February 1970, see claim 1, C.P. Corp. --	1
A	US, A, 2949054, published 16th August 1960, see claim 1, The Glass Corp. --	1
A	Bulletin des Schweizerischen Elektrotechnischen Vereins, volume 66, no. 12, issued 1975, June, Switzerland, J.Greenwood: "Faserverstärkte Kunststoffe im Elektromaschinen- und Elektroapparatebau" see pages 617-624, especially page 620, left-hand column, last paragraph --	1
A	BBC Nachrichten, volume 58, no. 1, issued January 1976, Switzerland, B. Bührer: "Werkstoffe für das isolierstoffgekapselte Niederspannungsschaltanlagensystem" see pages 45-50, especially page 49, right-hand column, last paragraph and page 50, left-hand column --	1

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* Special categories of cited documents: [15]

"A" document defining the general state of the art

"E" earlier document but published on or after the international filing date

"L" document cited for special reason other than those referred to in the other categories

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed

"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [3]	Date of Mailing of this International Search Report [3]
09th October 1979	22nd October 1979
International Searching Authority [1]	**Signature of Authorized Officer [20]**
European Patent Office	G.L.M. KRUYDENBERG

Form PCT/ISA/210 (second sheet) (October 1977)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A	FR, A, 1513278, published February 16, 1968, see abstract 1°, Sediver --	1
A	FR, A, 2056084, published May 14, 1971, see claim 1, Sediver --	1
A	DE, B, 1296341, published May 29, 1969, see claim 1, Ciba --	1
A	CH, A, 423911, published May 3, 1967, see claims 1-3, Ciba	1,3,4,5,6

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers....., because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.