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POLYETHYLENE-POLYISOBUTYLENE COMPOSITION

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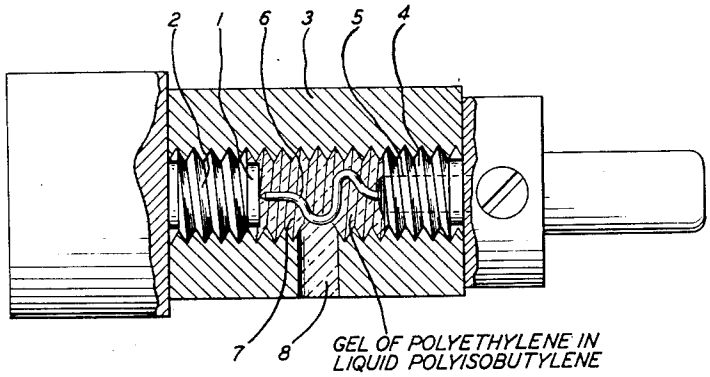

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POLYETHYLENE-POLYISOBUTYLENE COMPOSITION

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This invention relates to novel compositions useful for potting or embedding electrical apparatus.

The novel compositions of the present invention are particularly adapted to the potting of mechanically delicate and chemically sensitive apparatus such as germanium point contact rectifiers and transistors. Such point contact rectifiers or transistors may be made up of a body of germanium, or silicon, to which one or more electrical contacts are made by means of fine pointed wires, held frictionally, or otherwise, against the body. Since displacement of these wires on the surface of the body may result in defective or inoperative devices, it is necessary that some means be employed to prevent such displacement by the jarring incident to manufacture and handling.

In order to protect these devices, it is common to embed the contact wires and at least the contact surface of the body in a suitable material which will lessen the chance of damage upon jarring. This is commonly accomplished by enclosing the device in hollow container and filling this container with the potting material.

There is a definite combination of properties which must be possessed by such a potting material. In view of the delicacy of the apparatus, the potting material must be capable of being reduced to a highly fluid state upon being heated to a moderately elevated temperature so that it can be poured into the container and caused to fill all the space in and around the device quickly and without the application of pressure. It must harden to a non-fluid state upon cooling to ordinary temperatures and must do so without setting up objectionable mechanical stresses which would tend to injure the device. It must be capable of withstanding the entire temperature range to which the device will be subjected in normal use, as from —40° C. to +85° C., without cracking, flowing or setting up undue mechanical stress. It must be as chemically inert as possible so that it will not exert a corrosive or otherwise degrading action upon the device. It must be chemically and physically stable throughout the life of the device. It must, moreover, not possess adverse electrical properties, such as excessive surface or volume current leakage due to electrolyte impurities.

The potting compounds of the present invention possess this requisite combination of properties to a greater degree than any material hitherto suggested for this purpose to applicant's knowledge. These compounds are, at ordinary

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temperatures, gels of normally solid ethylene polymers (polyethylene) in a normally liquid butene polymer (polybutene, or particularly polyisobutylene).

Since these potting compounds are true gels and, therefore, possess finite static shear strengths, they will not flow except upon the exerting of a finite pressure, as contrasted with extremely viscous liquids which, although giving the appearance of rigidity, nevertheless have the zero static shear strength which is characteristic of liquids and, therefore, flow under infinitesimal pressure if given sufficient time.

These potting compounds may be contrasted with solids, on the other hand, in that they are soft and plastic and are, therefore, much more readily and permanently deformable under stress so that they do not set up undesirable mechanical strains and do not crack with temperature change.

Although these potting compounds are non-fluid gels in the normal operating temperature range of the electrical apparatus, they are readily reduced to completely homogeneous liquids of sufficiently low viscosity to permit ready impregnation by heating to a moderately elevated temperature, such as slightly above 100° C. When these homogeneous liquid solutions of polyethylene in polybutene are cooled to ordinary temperatures, the polyethylene becomes somewhat incompatible with the polybutene and small crystallite regions of polyethylene are formed throughout the body of liquid polybutene. The resultant intermolecular forces between the solid polyethylene and the liquid polybutene result in a non-fluid gel.

The components of the potting compounds of the present invention are stable hydrocarbons which are available commercially in a form in which they are free from electrolyte impurities and possess excellent electrical properties. They are chemically inert and, therefore, they exert no undesirable corrosive effect upon the electrical apparatus and they do not degrade even the sensitive germanium surface in germanium rectifiers.

Electrical apparatus embodying the potting compounds described above is shown in the accompanying drawing, which is a front elevation, partly in section, of a point contact rectifier.

In the apparatus shown in this drawing, a wafer 1 of rectifier material, such as germanium, is mounted upon and permanently fixed to an electrically conductive base 2 which is externally threaded. The base 2 is screwed into one end of an internally threaded container 3. Into the

other end of the container 3 is screwed an externally threaded, electrically insulating sleeve 4, through the center of which passes an electrically conducting lead 5 on the end of which is mounted a pointed contact wire 6 so situated that its pointed end makes electrical contact with the surface of the wafer 1.

The space defined by the container 3 and the members closing each end is filled with the gel potting compound 7 described above. This potting compound is applied by heating it to a temperature sufficient to convert it to a homogeneous liquid and it is poured into the opening 8 until the space is filled. The compound is then allowed to cool and to gel to its non-fluid state.

Devices of this type have been subjected to three drops from a height of 60 inches at room temperature without injury and have also withstood five cycles from −55° C. to +80° C. without injury.

A very suitable potting gel according to the present invention is made up of 7.5 per cent by weight of polyethylene having a molecular weight of about 12,000, as determined by the Staudinger method, 92 per cent polyisobutylene having a molecular weight of about 3,000 and 0.5 per cent of an antioxidant, such as polymerized trimethyl dihydroquinoline. This composition is prepared by mixing the ingredients together at a temperature above the melting point of the polyethylene, such as 130° C. to 135° C., until a clear homogeneous mass is obtained.

Soft gels suitable for the present invention can be formed in similar manner from other low molecular weight polyethylenes having a molecular weight between 4,000 and 15,000 or preferably between 7,000 and 15,000. Any viscous liquid polybutene, as of molecular weight between 2,000 and 7,000, or preferably between 2,000 and 5,000, may be used. Particularly when the mixture is to be maintained at elevated temperatures in its fluid state in contact with air, it is desirable that an antioxidant in suitable amount, as from 0.1 per cent to 1 per cent be added.

The gels of the present invention may be formed with widely varying proportions of polyethylene and polybutene. Preferably, the amount of polyethylene in the gel is between 5 per cent and 35 per cent although gels of satisfactory properties may be produced when the amount of polyethylene is as high as 90 per cent, particularly when the lower molecular weight polyethylenes are used. The remainder of the composition, aside from the antioxidant, if any, is polybutene, as discussed above, and therefore the proportions of this ingredient vary preferably from 65 per cent to 95 per cent, although as little as 10 per cent may be present.

Examples of other of the gels of the present invention are one formed from 90 per cent of polyethylene of molecular weight of about 4,000 and 10 per cent of polyisobutylene of molecular weight of about 3,000, together with 0.5 per cent of antioxidant added to this mixture, and one formed from 60 per cent of polyethylene of

molecular weight of about 7,000 and 40 per cent of polyisobutylene of molecular weight of about 3,000, together with 0.5 per cent of antioxidant added to this mixture.

These gels have been described above as applied to the potting of point contact translating devices. Obviously, their advantageous properties as set forth above fit them for the potting of other electrical apparatus.

The invention has been described in terms of its specific embodiments and, since certain modifications and equivalents will be apparent to those skilled in the art, this description is intended to be illustrative of, and not to constitute a limitation upon, the scope of the invention.

What is claimed is:

1. A composition consisting essentially of a gel of between about 5 per cent and about 35 per cent of polyethylene having a molecular weight between about 4,000 and about 15,000 and the remainder a viscous, liquid polyisobutylene having a molecular weight between about 2,000 and about 7,000.

2. A composition as described in claim 1 wherein the composition contains an antioxidant.

3. A composition consisting essentially of about 7.5 per cent of polyethylene of molecular weight of about 12,000 and the remainder polyisobutylene of molecular weight of about 3,000.

4. A composition as described in claim 3 wherein the composition contains an antioxidant.

5. A composition as described in claim 4 wherein the antioxidant is 0.5 per cent of polymerized trimethyl dihydroquinoline.

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