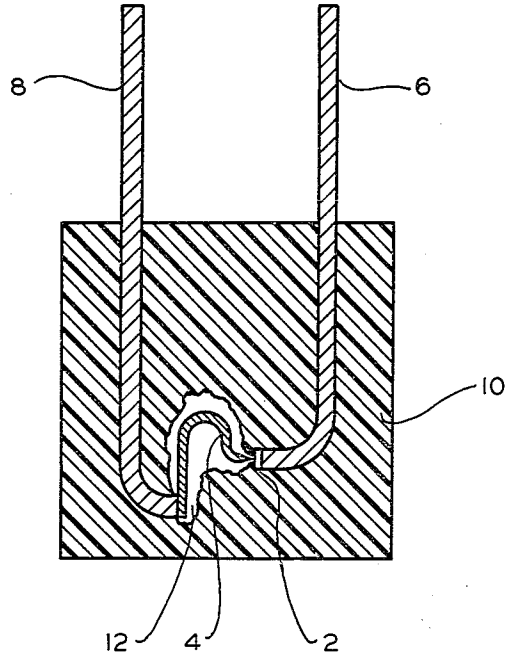
April 10, 1956 H. Q. NORTH 2,741,729

ELECTRICAL TRANSLATING DEVICE

Filed Aug. 31, 1949



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United States Patent Office 2,741,729 Patented Apr. 10, 1956

2,741,729

ELECTRICAL TRANSLATING DEVICE

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Application August 31, 1949, Serial No. 113,282

23 Claims. (Cl. 317—236)

This invention relates to structures of the type in which an article or an assembly is embedded within a solidified casing of protective material, and relates more particularly to such a structure in which the encased article is a point-contact translating device.

The principal object of the present invention is to provide a protectively encased device of such structure that stresses and strains which tend to occur under certain conditions of use are prevented from adversely affecting its characteristics and performance.

The invention will be described with particular reference to a crystal rectifier, a diode type of point-contact translating device which has now for several years found widespread use in electronic equipment. The active elements of such rectifiers are a suitably prepared pellet of silicon, germanium or other material of like nature, and a thin wire "cat whisker" held in contact against the pellet. The typical conventional structure of these crystal diodes includes a hollow cylindrical body of insulating material, and a relatively large number of cooperating members or fittings which function to support the pellet and whisker elements in contact relationship within the cylindrical body and to provide connection terminals for the said elements.

The above-described conventional crystal diode structure poses many manufacturing difficulties which are reflected in an expensively high reject rate for these devices, and I have regarded it as desirable to avoid these difficulties, and to achieve certain other objectives, by first pre-assembling and adjusting the active elements of the point-contact device in a suitable jig and then, by a casting or molding procedure, embedding the pre-assembled elements within a mass of synthetic resin or other suitable material. It has been found, however, that when encased point-contact devices made in this immediate fashion are subjected to conditions which cause differential expansions in the structure, the physical and electrical characteristics of the critical point contact experience serious variations. By practice of the instant invention the point-contact variation difficulty is overcome, without loss of the many advantages otherwise gained by molding the point-contact device in suitable material.

At this point briefly stated, the invention as applied in one form to point-contact translating devices contemplates a crystal assembly including a whisker having spring-action conformation, a daub of viscid substance upon the whisker in the region including its resilient section and its point-contact end, and a suitable synthetic resin molded in place about the point-contact crystal assembly. The viscid material thus determines the volume of the hollow chamber within the molded housing and thereby prevents the co-acting portion of the whisker from being gripped by the solidified resin and provides sufficient space and freedom for deformation of the whisker's resilient portion to enable the pre-adjusted characteristics of the point contact to be stably maintained.

Among the objects of the invention are: to provide a

method of fabrication yielding a rugged, stable point-contact translating device lending iself to large-scale low-cost manufacture; to provide such a translating device having relatively small physical size; to provide a point-contact translating device which is not adversely affected by the often severe conditions of humidity, pressure, temperature and vibration encountered in certain instances, as in airborne operation; and to provide other improvements in such devices and in their methods of manufacture as will become apparent from the following description and appended claims.

Referring now to the drawing, the single figure is an enlarged view illustrating in cross-section a crystal rectifier embodying the principles of the present invention. In this structure, a suitably prepared germanium pellet **2** and a fine wire whisker **4** made of hard platinum alloy are mounted upon copper leads **6** and **8**, respectively. The germanium pellet **2** may be secured to copper lead **6** by means of a plating and soldering process and may then be ground and etched to provide a suitable contact surface as is now well understood in the art. The free end of whisker **4** is pointed to provide an extremely small area of contact when engaged against the germanium pellet, and the whisker is further kinked or bent as shown to provide it with resiliency or spring action for purposes which will appear. The whisker may be secured to copper lead **8** by spot welding. Copper leads **6** and **8** are bent at their element-carrying ends in such manner that when the said leads are supported in a suitable jig for pre-positioning of the active elements and for adjustment of their point-contact relationship, prior to a molding operation, an overall U-configuration is imparted to the assembly, facilitating the ensuing molding operation which embeds the assembly in a mass of thermo-setting material **10**.

In accordance with principles of the present invention, it is of importance to the suitability and effectiveness of the final structure to insure that the point contact region of the germanium pellet **2** and the cooperating portion of resilient whisker **4** be free of any restraining engagement by the encasing material **10**. A preferred manner of providing such freedom, to accommodate strains produced within the structure while retaining the necessary contact engagement of the active crystal elements, is to apply a daub or blob **12** of non-conductive, viscid, substantially inert material to the whisker **4** before mounting it in contact against the germanium pellet. For example, the material commercially identified as Dow-Corning No. 7 silicone grease has been found particularly suitable in such use, for its electrical and physical characteristics are satisfactory and remain nearly constant over wide ranges of temperature. This silicone grease blob **12** is not displaced during the molding or casting operation and thus, in the final structure, provides the required freedom for the whisker and the point contact region. The silicone grease has a further important function in the end structure, for it acts as a mechanical damping medium to inhibit displacement of the whisker under conditions of impact and vibration.

The embedding of the assembly in a protective material may be accomplished simply by lowering the jig-mounted assembly into a suitably shaped mold form containing the protective material in a fluid or viscous state, and maintaining the assembly in position relative to the mold during the conventional hardening and curing steps. A number of materials are available for use as the insulating, protective casing material **10**. One which has been found satisfactory is a thermosetting synthetic resin sold by the Pittsburgh Plate Glass Company under the trade name "Selectron" and identified in particular as No. 5003 Selectron. This material comprises about 70% polystyrene and about 30% methacrylate resin, and silica powder is

added thereto as a filler in order to increase the hardness and lower the expansion coefficient of the final casing.

It is apparent that various modifications of the described structure and method of fabrication may be made without departing from the teachings of the present invention. For example, the whisker shown in the drawing has been described simply as making point-contact against the germanium pellet, but the drawing may also be understood as representing a welded type of point-contact often used in other crystal assemblies. As another example, while the free-movement region encompassing the whisker and contact area is believed to be best provided in the manner set forth herein, other methods are available, as by injecting air or an inert gas, at the time that the embedding material is in a viscous state, to form a bubble encompassing the desired free-movement region. Again, the structure and configuration of the active elements, the manner of their support, the configurations of the supporting leads or other terminal devices and the external configuration of the final structure may take many other forms.

While the invention has been described with particular reference to encasing methods and means as applied to crystal rectifiers, it is to be further understood that the principles of the invention are as fully applicable to semiconductor transistors, to electronic semiconductor assemblies in general, and to many other articles for which molded enclosures having the described functions may be desirable.

I claim:

1. A translating device comprising: an operative assembly of crystal and contact elements, supporting members therefor, and spring means urging said crystal and contact elements into engagement; solidified insulating material which surrounds and pervades all parts of the assembly except for a cavity encompassing said elements, said spring means, and external portions of said supporting members extending through said insulating material to provide external connection facilities; and a silicone grease filling said cavity and having a substantially constant consistency over a range of temperatures normally encountered by said device.

2. A translating device comprising: an operative assembly of crystal and resilient contact elements and supporting members therefor; solidified insulating material which surrounds and pervades all parts of the assembly except for a cavity encompassing said crystal, contact elements, and external portions of said supporting members extending through said insulating material to provide external connection means; and a silicone grease filling said cavity and having a substantially constant viscidity over an operating temperature range of said translating device.

3. A translating device comprising: a crystal, crystal contact elements, supporting members for said crystal and contact elements, a spring means urging said crystal and contact elements into engagement; solidified insulating material which surrounds and pervades all parts of the assembly except for a cavity encompassing said elements, said spring means and the outer ends of said supporting members, and a viscid insulating means filling said cavity and having a substantially constant viscidity over a wide range of temperatures.

4. A translating device comprising: an operative assembly of crystal and contact elements, supporting members therefor, and spring means urging said crystal and contact elements into engagement; solidified insulating material which surrounds and pervades all parts of the assembly except for a cavity encompassing said crystal, said elements and said spring means, said supporting members extending through said insulating material to provide external connection facilities; and a viscid material filling said cavity and having a stable consistency over a range of temperatures normally encountered by said device.

5. A translating device comprising: an operative assembly of crystal and resilient contact elements and supporting members therefor; solidified insulating material which surrounds and pervades all parts of the assembly except for a cavity encompassing said crystal and contact elements, said supporting members extending through said insulating material to provide external connection facilities; and a viscid material filling said cavity and having a stable consistency over a range of temperatures to which said device normally may be subjected during its useful life.

6. A translating device comprising: an insulative housing having an inner chamber; at least two conductors each having one end terminating within said chamber and the other end extending without said housing, said housing forming a gas-tight bond with the intermediate portions of said conductors; a translating element positioned within said chamber and in contact with said one end of each of said conductors; and a viscid insulating material filling said chamber.

7. A translating device as defined in claim 6 in which said viscid insulating material is a silcone grease havng a substantially constant viscidity over the operating temperature range of said device.

8. A translating device comprising first and second metallic conductors, a resilient electrode welded to the lower end of the first conductor, a translating element conductively attached to the lower end of the second conductor, a housing of insulative, thermosetting material surrounding the lower portion of said first and second conductors, an inner chamber within said housing, said inner ends of said first and second conductors, said translating element, and said electrode being within said chamber, and a viscid material filling said chamber.

9. A method of making a translating device including at least two conductors with a translating element mounted between said conductors, said method including the steps of mounting said conductors in a jig, dipping said translating element and a portion of said conductors in the immediate vicinity of said element into a viscid, insulating material to form a globule of said viscid material over a combination of said element and said portion of said conductors, placing said globule surrounding said combination into a mold filled with a substantially fluid thermoplastic material, and molding a housing, with a centrally located chamber, composed of said thermoplastic material around said globule, said chamber having a volume equal to the volume of said globule.

10. A method of making a translating device including at least first and second conductors, a resilient contact electrode, and a translating element, said method including the steps of mounting said translating element at the lower end of the first conductor, welding said resilient electrode to the lower end of the second conductor, placing said conductors in a jig and making a contact between said electrode and said translating element, surrounding the combination of said translating element, said electride, and the lower ends of said first and second conductors with a globule of viscid material having a substantially constant viscidity over a normal operating temperature range of said device, placing said globule and said combination into a mold filled with a substantially liquid thermoplastic material, and molding a housing composed of said thermoplastic material around said globule.

11. As an article of manufacture, a solidified thermoplastic casing, a cavity within said casing, said cavity being completely surrounded by said casing, a viscid globule filling said cavity, and means surrounded by said globule, said globule defining the volume of said cavity within said casing.

12. The method of manufacture of a molded translating device comprising a crystal, at least one resilient contact element and connection members therefor, said method including the steps of mounting said crystal and contact elements upon the inner ends of said connection

members, assembling said elements and members in operative relationship in a jig, surrounding said crystal, said element and the inner ends of said connection members with a viscid material and molding a layer of plastic material over said assembly.

13. In a semiconductor translating device, the combination comprising: a crystal element; a contact element contacting said crystal element; two lead wires, the inner ends of said lead wires supporting the combination of said crystal element and said contact element; a viscid material surrounding said combination; and an insulative thermo-plastic casing molded over said viscid material, the outer ends of said lead wires extending without said casing.

14. A semiconductor device comprising: a germanium crystal; at least first and second metallic electrodes; a conductive connection between said crystal and said first electrode; a rectifying connection between said crystal and said second electrode; a viscid globule surrounding said crystal and adjacent portions of said electrodes; and an insulative housing cast around said globule.

15. A semiconductor device comprising: a semiconductor crystal element; at least first and second metallic electrodes in contact with said element; a viscid globule encompassing said element and adjacent portions of said electrodes; and an insulative housing molded over said viscid globule, the outer ends of said electrodes extending without said housing.

16. The method of hermetically enclosing a semiconductor translating element including a semiconductor crystal and at least two electrodes contacting the crystal, said method comprising the steps of: surrounding the crystal and adjacent portions of the electrodes with a globule of viscid material; and enclosing said globule in an insulative thermosetting housing.

17. A semiconductive translating device comprising a semiconductive body, a first electrode making contact to said body, a second electrode secured to said body, a seamless hollow envelope of insulating material surrounding said body and engaging said electrodes and securing them in their relative positions, said envelope having a cavity which contains at least a portion of said semiconductive body and said first contact, a flexible section in said first electrode within said cavity and intermediate said envelope and said first contact, and a yieldable, nonconducting material surrounding said flexible section and filling said cavity.

18. A semiconductive translating device comprising a semiconductive body, a first electrode making a limited area contact to said body, a second electrode secured to said body and making a contact thereto of greater area than said first contact, a seamless hollow envelope of insulating material surrounding said body and engaging said electrodes and securing them in their relative positions, said envelope having a cavity which contains at least a portion of said semiconductive body and said contact of limited area, and a soft protective material for said semiconductive body filling said cavity.

19. A semiconductive translating device comprising a semiconductive body, a wire, a point contact on one end of said wire, said wire having a first bend and a second bend intermediate said first bend and said point maintained in compression to resiliently bias said point against said body, a seamless envelope of insulating material surrounding said body, said envelope having a cavity containing said point contact, and said second bend, said first bend being secured in the wall of said envelope to fix said wire, and a yieldable, nonconducting material surrounding said second bend and filling said cavity.

20. In the method of manufacturing semiconductive translating devices, the steps which comprise mounting a semiconductive body on a conductive base, mounting a limited area contact on the body with a spring biasing it toward the body, placing a globule of material which remains soft over the contact and spring, and forming a bead over the globule, the walls of the bead securing the conductive base, the spring and the contact.

21. In the method of manufacturing semiconductive translating devices the steps which comprise mounting a semiconductive body on a conductive base, forming an S-shaped bend in a pointed resilient wire, mounting the pointed end of the wire with the bend in compression on a semiconductive surface, placing a globule of material which remains soft over the contact and the turn of the S-shaped bend adjacent the contact, and forming a bead over the globule, the walls of the bead securing the conductive base and the exposed portion of the S-shaped bend.

22. A semiconductor translating device comprising a semiconductive body, a first electrode making a limited area contact to said body, a second electrode secured to said body and making a contact thereto of greater area than said first contact, a seamless hollow envelope of resinous insulating material surrounding said body, said envelope engaging a portion of said electrodes and said body and securing them in their relative positions, a bend in said first electrode embedded in said resinous material to anchor the electrode, said envelope having a cavity encompassing that portion of said first electrode and of said semi-conductive body surface including said limited area contact, a flexible section in said first electrode within said cavity, and a soft protective material for said semiconductive body filling the cavity.

23. In the method of manufacturing a semiconductive translating device, the steps which comprise securing an electrical contact to a semiconductive body, mounting a second contact on the body at a location spaced from said contact, forming a flexible section in the lead to the second contact, placing a globule of material which remains in a yieldable state over the second contact and flexible lead section, and forming a continuous layer of rigid nonconductive material over the globule, the semiconductive body, and the contacts to said body, said rigid material securing at least a portion of the leads associated with the contacts.

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