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2,688,110

SEMICONDUCTOR TRANSLATING DEVICE

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FIG. 1

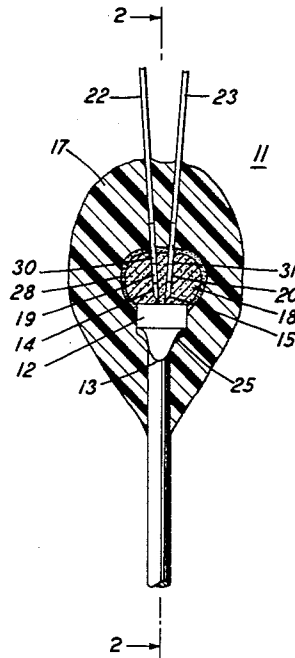
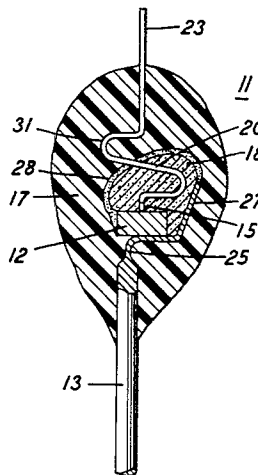


FIG. 2



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SEMICONDUCTOR TRANSLATING DEVICE

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13 Claims. (Cl. 317—235)

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This invention relates to translating devices and more particularly to translating devices including a body of semiconductive material on a surface of which one or more point contacts bear, and to methods of manufacture of such devices.

One form of translating device of the type to which this invention pertains comprising a block of semiconductive material mounted on a conductive backing member, termed the base, and a pair of closely spaced limited area contacts which make asymmetric connections with the surface of the conductive body is disclosed in Patent 2,524,035 of John Bardeen and Walter H. Brattain issued October 3, 1950. The limited area contacts termed the emitter and collector are spaced for mutual influence and in one form of the device are formed of fine wire.

Since the operation of such devices is dependent upon the accuracy of spacing between the emitter and collector, heretofore it has been found necessary to mount the units in rather bulky assemblies which provide mechanical ruggedness. Such assemblies are space consuming and difficult to manufacture readily in quantity.

One object of this invention is to simplify the structure and manufacture of translating devices of the above-noted type. More specific objects of this invention are to reduce the size of translating devices and also their cost by reducing the amount of material employed and eliminating the precision work and the number of steps necessary in their manufacture.

In accordance with one feature of this invention, a semiconductor translating device of the general construction described above is encased in a bead of insulating material.

More specifically, in accordance with one feature of this invention the contact or contacts and the semiconductor body are fabricated in a unitary assembly and are secured and protected in prescribed relationship by an encasing bead or capsule of insulating material. Contacts may be so arranged and the casing material so applied to the assembly that the portion of the bead or capsule wherein the contacts engage the semiconductor surface is hollow. The contacts are provided with spring sections within the cavity thereby insuring the maintenance of a spring pressure biasing the contacts toward the semiconductor throughout the life of the device without the danger of losing contact or shifting the position of the contacts due to mechanical strains applied to the bead or to expansion and contraction of the bead with temperature.

The above-noted and other objects and fea-

tures of this invention will be understood more clearly and fully from the following detailed description when read in conjunction with the accompanying drawings, in which:

Fig. 1 is a sectioned front elevation of a three-electrode translating device illustrative of one embodiment of this invention; and

Fig. 2 is a sectioned side elevation of the device of Fig. 1 taken along the line 2—2.

Referring now to the drawings, Figs. 1 and 2 show a three-electrode translating device 11 including a semiconductive body 12 of germanium or silicon secured to a base member 13 by an ohmic connection, and having a pair of point contacts 14 and 15 engaging its other surface to provide an emitter and a collector. The contacts are of spring material; favorable results have been obtained with a beryllium copper emitter and a Phosphor bronze collector. This assembly is surrounded by a bead 17 which may be of a styrene-polyester casting resin and which contains a cavity in the region 18 surrounding the point contacts and the associated semiconductor surface. Situated in this cavity 18 are the spring sections 19 and 20 of the point contacts. These spring sections are biased in compression toward the semiconductor so that through all temperature cycles or other mechanical stresses to which the unit will be subjected during its operation the points will be stable mechanically. While the cavity 18 of the bead might conveniently be left empty, it has been found that the surface of the semiconductor can be readily protected from contamination and that the hollow can be maintained and controlled in the bead by filling the region with a material which stays soft at any operating temperature to which the device is to be subjected, which will not contaminate the wafer surface, and which will protect the surface from contamination by any of the other materials employed. These requirements are fulfilled by materials such as a high purity paraffin or polyethylene polyisobutylene.

In order to further simplify the construction of the device, the ends of the contact wires 22 and 23 are utilized as terminals. These wires may be bent around the surface of the bead 17 and secured with an outer layer of beading material (not shown), although they are anchored to the bead sufficiently by the bend 31 embedded therein.

The illustrative unit can be constructed by forming a spade end 25 on a suitable conductive base 13, for example a 20-mil copper wire. The

spade end 25 is then bent at 90 degrees to the axis of the wire and the portion 27 near its end is bent in the direction of the axis to form an offset. Alternatively, a flat conductive strip can be employed as the base 13 and can be bent as above or otherwise to form a pocket in which the semiconductive wafer can be mounted, this strip can be copper 50 mils wide and 5 to 10 mils thick. A semiconductive wafer 12 of silicon or germanium 25 mils square is then polished mechanically on both major surfaces, and one surface is tinned and soldered or welded to the portion of the spade end 25 on the base 13 extending at 90 degrees to its axis. The other major surface is then etched, for example as disclosed in the application of R. D. Heidenreich, Serial No. 164,303 filed May 25, 1950, in an etchant comprising 15 parts of acetic acid, 25 parts of nitric acid, 15 parts of 48 per cent hydrofluoric acid and 1 part of liquid bromine. This etch is followed by a rinse. The order of this operation may be reversed and the chemical polish completed prior to mounting the wafer.

The wafer-base assembly is then mounted in a suitable jig. A pair of point contacts 14 and 15, which may be formed from 5-mil phosphor bronze wire having sheared ends, are secured in a jig which maintains the spacing of their ends at from 2 to 5 mils. These wires and their jig are advanced to contact the polished and etched surface. These contacts are each provided with a section 19 and 20 adjacent the point suitable for providing spring action and a means for mechanically securing them in the bead material. An S-shaped portion adjacent the pointed ends is employed to obtain these desired characteristics. A globule of polyethylene polyisobutylene or some other material which will remain soft at the operating temperatures of the unit is applied to the assembly to encompass the wafer point and one bend of the S-shaped portion of each contact wire adjacent the point. This globule, which provides a means of attaining a cavity within the encasing bead, is supported in position by the pocket formed by the offset portion 27 of the spade end 25 of the base in cooperation with the contact wires. A crust 28 is formed over the globule by applying a quick drying lacquer thereto in a thin layer. This lacquer should be of a type that is not detrimental to the material of the globule and is tough enough to form a supporting crust over it; a vinyl lacquer may be used for this purpose. A bead 17 of the encasing material is then formed over the shaft of the base contact 13, over the globule forming cavity 18, and over the upper bends 30 and 31 of the S-shaped portions of the point contacts to encompass the entire assembly. The encasement of the upper bends of the contact wires by the beading material serves to secure them rigidly in place.

A suitable beading material is a styrene-polyester casting resin, for example that identified as "Selectron," applied either in the clear state or with a silica loading to increase the heat dissipation from the operating elements. A successful beading material has been "Selectron" loaded 45 per cent with silica. This coating is then cured for example by heating to from 80° C. to 120° C. for one hour after which the point contact wires may be bent around the bead and a second application of the beading material applied and cured to insure a rugged mechanical assembly.

Such a construction, as set forth above, is

small, electrically and mechanically rugged and is extremely well suited for package circuits which are potted. The units may be constructed with a single point contact and function either as a point contact rectifier or with a suitable choice of translucent encasing material as a photosensitive translating device of the type disclosed in J. N. Shive application Serial No. 110,684, filed August 17, 1949. Where photo effects are undesirable it may be found advantageous to employ beading compositions which are opaque to light.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of this invention and numerous other arrangements may be devised by those skilled in the art without departing from its spirit and scope.

What is claimed is:

1. 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.

2. A semiconductive translating device comprising a conductive member containing a pocket, a semiconductive body electrically and mechanically connected to said member in said pocket, a contact to said body, a conductive lead engaging and extending from said contact, a conductive lead extending from said conductive member, a seamless hollow envelope of insulating material surrounding said member and said body and engaging a portion of said member and said leads and securing them in their relative positions, said envelope having a cavity partially defined by said pocket and containing at least a portion of said semiconductive body and said contact, a flexible section in said lead intermediate said envelope and said contact and within said cavity, and a yieldable, nonconducting material surrounding said flexible section and filling said cavity.

3. 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.

4. 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

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in the wall of said envelope to fix said wire, and a yieldable, nonconducting material surrounding said second bend and filling said cavity.

5. A semiconductive translating device including a base, an emitter and a collector electrode comprising, a wire, a semiconductive body secured to said wire with an ohmic contact, a pair of wires of resilient material, a point contact on the end of each of said resilient wires engaging said body in critically spaced relationship, S-shaped bends in said resilient wires, and a bead having a cavity containing said body, said point contacts and the turn of each S-shaped bend adjacent said contacts, the wall of said bead securing said wire and the turn of each S-shaped bend farthest removed from said contacts.

6. 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.

7. 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, coating the globule with a tough protective layer, and forming a bead over the globule, the walls of the bead securing the conductive base, the spring and the contact.

8. 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.

9. In the method of manufacturing semiconductive translating devices, the steps which comprise forming a spade end on a conductive rod, securing a semiconductive body to a portion of said spade end adjacent the rod, bending another portion of said spade end in the direction of the body, mounting a pair of spring biased point contacts on said body in critically spaced relationship, placing a globule of material which remains soft in the pocket formed by the bent spade end and over the contacts, coating the globule with a tough protective layer, and forming a bead over the globule, the walls of the bead securing the conductive rod and the contacts.

10. 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 polyethylene polyiso-

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butylene over the contact and spring, coating the globule with a vinyl lacquer, forming a bead of a styrene-polyester casting resin over the globule to secure the conductive base, the spring and contact, and curing the bead by heating at about 80° C. for about one hour.

11. A semiconductive translating device comprising a semiconductive body, base, emitter and collector contacts to said body, leads extending from each of said contacts, a flexible section in at least one of said leads adjacent its respective contact, a seamless hollow envelope of insulating material surrounding said body, said envelope engaging and securing in fixed relationship at least a portion of each of said leads, said envelope having a cavity which contains at least a portion of the semiconductive body and said flexible section of said lead and its respective contact to said body, and a yieldable, nonconducting material surrounding said flexible lead section and filling said cavity.

12. 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.

13. 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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