

May 8, 1956

G. T. LOMAN

2,744,308

SEMI-CONDUCTOR TRANSLATING DEVICE AND METHOD OF MANUFACTURE

Filed Nov. 17, 1950

FIG. 1

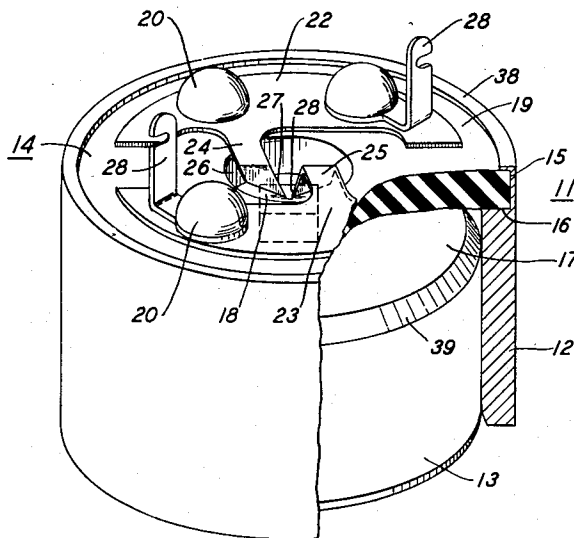


FIG. 2

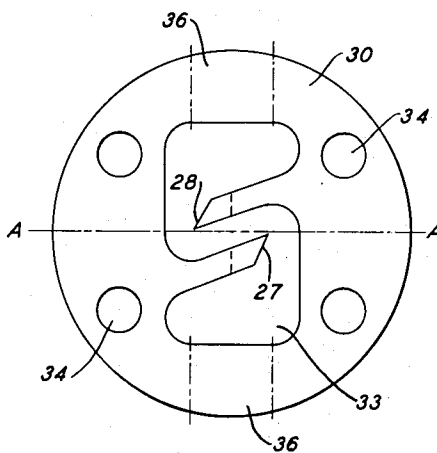
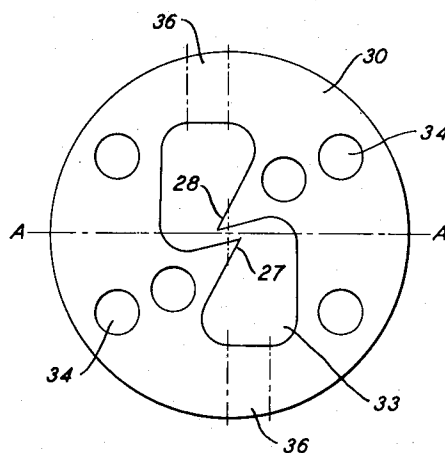


FIG. 3



INVENTOR
G. T. LOMAN

S. J. Guenther

ATTORNEY

1

2,744,308

SEMI-CONDUCTOR TRANSLATING DEVICE AND
METHOD OF MANUFACTURE

George T. Loman, Berkeley Heights, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New York,
N. Y., a corporation of New York

Application November 17, 1950, Serial No. 196,141

5 Claims. (Cl. 29—25.3)

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

An illustrative device of the general type to which this invention pertains is disclosed in Patent 2,524,035, granted October 3, 1950 to John Bardeen and Walter H. Brattain, and comprises a block of semiconductive material mounted on a conductive backing member and a pair of limited area contacts which make asymmetric connections with the surface of the semiconductor body sufficiently close together for mutual influence.

The mechanical parameters of the elements of such translating devices are such that considerable difficulty is encountered in reproducing them, and in their handling and assembly. For example, one type of device includes a square germanium wafer 50 mils on a side and about half as thick, and a pair of contacts of 5-mil Phosphor bronze wire having pointed ends which contact the wafer surface with an optimum separation of about 2 mils. This separation is not only difficult to obtain in manufacturing the devices, manual adjustment being necessary, but also tends to be unstable when the unit is subjected to vibration and temperature changes.

One object of this invention is to improve translating devices of the above-described type. More specific objects are to provide a rugged device which is of a construction that can be produced economically and readily by a series of machine operations and yet is amenable to control of contact pressure area and spacing.

In accordance with one feature of this invention, a translating device of the general construction set forth above is provided with a pair of closely spaced contacts formed from sheet metal.

In one embodiment of a translating device constructed in accordance with this invention, the contact structure is arranged to provide a pair of closely spaced, parallel, line contacts by cutting bodies from a piece of sheet material having a thickness equal to the desired length of the line contacts. The contact bodies can be of various shapes having a sharp angle cut on one side which is set down on the semiconductor to provide the line contact.

Another feature of this invention, which facilitates manufacture of the devices, is a construction wherein the relative position of the contacts is determined simultaneously with the forming of the contact bodies by a simple cutting or punching operation. The contacts are punched from sheet metal in a unitary body which is in the form of an open center body having a pair of tabs extending into the open portion. The ends of the tabs extend more than half way across the open portion and are each terminated with an acute angle. The tabs are so positioned that when they are properly bent out of the plane of the sheet the lines of their apexes are located in a plane parallel to the sheet, are parallel to each other, and are

2

accurately spaced for mutual influence when mounted on a semiconductive surface. The contact carrying body is secured to an insulating member and the portions of the body associated with the contacts are isolated from each other by cutting away the intermediate body portion. This assembly can then be associated with a semiconductive body to form a complete translating unit.

The above and other objects and features of this invention will be more fully and clearly understood from the following detailed description when read in conjunction with the accompanying drawing in which:

Fig. 1 is a perspective view of a translating device constructed in accordance with this invention, with portions of the casing wall broken away to show the internal construction;

Fig. 2 is a plan view of the contact blank employed in the assembly of Fig. 1; and

Fig. 3 is a plan view of another form of contact blank.

Referring now to the drawing, a translating device 11 comprising a housing 12, a semiconductor assembly 13 and a contact assembly 14 is disclosed in Fig. 1. Translating devices of this type include three electrical connections commonly termed the base, emitter and collector, the latter two being closely spaced for mutual influence. In the device of Fig. 1, the housing 12 comprises a conductive cylinder of some material such as brass, having an enlarged inner diameter 15 at one end to provide a shoulder 16 on which the contact assembly 14 is mounted, and arranged to receive in its other end the semiconductor assembly 13.

The semiconductor assembly is formed of a conductive plug 17 on which is mounted a semiconductive wafer 18. The wafer may be soldered or welded to the plug 17 to provide an ohmic contact thereto thereby enabling the base connection to be established through plug 17 to the housing 12.

Contact assembly 14 includes an open centered disc or annulus 19 of some insulating material, such as a molded ceramic or phenol fiber, on which is secured as by rivets 20 a pair of sheet metal bodies 22 and 23. Tabs 24 and 25 extend from the bodies 22 and 23 over the open portion 26 of the disc 19 and have their ends bent downward and into that portion. The ends of these tabs are terminated in acute angles 27 and 28 and are so positioned relative to each other that the lines formed by the thickness of the sheet metal material at the apexes of both are parallel, in a plane parallel to the plane of the disc surface and critically spaced, say 1 to 5 mils, for mutual influence when they engage the surface of the semiconductive wafer 18. Connections may be made to the emitter and collector contacts formed by the tab apexes either by means of the lug 28 or where the tab stock is heavy enough by integral lugs (not shown).

The production of units as shown in Fig. 1 is effected by a series of mechanical operations which lend themselves to mass production techniques.

In forming the semiconductor assembly the wafer may be severed from an ingot of suitable material, such as high purity germanium containing traces of impurities, and mechanically ground on its major surfaces with 600 mesh aluminum oxide. It is then rinsed, tinned or rhodium plated on one side and secured to plug 17 by soldering or welding. The exposed surface is next chemically polished in a suitable solution for about a minute, one suitable polish solution comprises 15 parts of acetic acid, 25 parts of nitric acid, 15 parts of 48 per cent hydrofluoric acid, and one part of liquid bromine. After the polish, the surface is rinsed in high purity water or alcohol and kept free from contaminants.

The contact assembly is formed of two principal elements, an insulating base shown in the form of a disc 19

and a contact punching 30 as shown in Figs. 2 and 3. The disc 19 can be cut from sheet material and requires no special treatment other than to maintain it relatively smooth and free of burrs. A die punching of suitable contact material, for example, .005 inch Phosphor bronze sheet, in a form similar to that shown in Figs. 2 or 3 provides a contact blank. In determining the form of blank to be employed several factors must be considered. First, since clean acute angles are made at the ends of the tabs to form substantially line contacts, the most convenient means of determining the region of the semiconductor surface which is to be affected by the contacts is by determining the length of the line contacts employed, and this in turn depends upon the thickness of the sheet stock employed. Second, although the force of the contacts against the germanium can be determined by the extent of the advancement of the semiconductor assembly into the housing, for a given advancement the force can be controlled by the thickness, free length and cross sectional area of the tabs. Finally, since mechanical stability of the contacts is essential and any substantial amount of deflection of the tabs tends to cause the contacts to walk on the germanium surface when the contacts do not lie on the lines of applied force, the tabs and contacts should be designed so that the contacts are on or close to their lines of applied force. A desirable feature of the design of the contact blank is that the tabs extend more than half way across its open center portion 33. With such an arrangement the spacing of the contacts on the germanium surface can be controlled by punching operations. Thus, where a 2 mil separation of contacts is desired a blank of the form shown in Fig. 2 is arranged so that its two sides across a diameter are superposable when rotated 180 degrees. The tabs on each side are so positioned that the contact forming apexes at their ends are each located half the spacing, in this case 1 mil, short of a diameter, such as A—A in Figs. 2 and 3, and the tabs are bent, as by a punching operation, along a diameter perpendicular to the first-mentioned diameter so that their end surfaces are at right angles to the surface of the blank and are coplanar. The blank is then secured to the disc 19 as by the rivets 20 through the holes 34 and the portions 36 of the blank intermediate the portions supporting the tabs are cut away to electrically isolate them. This sequence of assembly operations may be modified so that the blank is mounted before the tabs are bent and the tabs bent and the blank severed either in a single or several operations.

The final assembly of the unit is effected by mounting the contact assembly in the housing with the undersurface of the disc 19 against the shoulder 16 and then spinning a lip 38 over the outer periphery of the disc. The semiconductor assembly is then forced into the housing, the chamfered periphery 39 on the plug being provided for ease in assembly and as a space into which foreign matter may collect. The plug is advanced until the centrally mounted wafer 18 engages the contacts, as determined by electrical or optical means, after which the plug is further advanced a distance suitable to provide the desired contact pressure. The planes of the tab ends are thus in common plane perpendicular to the surface of the wafer to produce, where the sheet material has been cut perpendicular to its surface, a pair of parallel line contacts.

While the construction shown is not arranged to be impregnated with any protective material, where the unit may be subjected to contaminating atmospheres it may be desirable to protect the germanium with some material such as polyethylene polyisobutylene. Where impregnation is desirable, it may conveniently be accomplished by employing a closed disc 19 with the contact blank 30 secured to its undersurface. In this assembly the central portion of the disc undersurface is cut away so that the tabs 23 and 24 are free to provide resilience. With such a construction the impregnating material can be applied

through a suitable aperture in the housing wall in any well-known manner.

What is claimed is:

1. In the manufacture of semiconductive translating devices the steps which comprise forming a sheet metal body having a pair of protuberances terminating in acute angles, the apexes of which are critically spaced, securing the body to an insulating member at a point in the vicinity of each protuberance, severing the body intermediate the secured portions adjacent each of the protuberances, bending a portion of the protuberances out of the plane of said body to establish a predetermined separation of their apexes on a plane intersecting said apexes at their greatest separation from the plane of the body, and mounting a semiconductive body in contact with the apexes.

2. In the manufacture of semiconductive translating devices the steps which comprise cutting a pair of critically spaced tabs in a metallic sheet, bending the tabs out of the plane of the sheet to establish a predetermined separation of their edges having the greatest separation from the sheet on a plane intersecting said edges, affixing the sheet to an insulating member in a region adjacent each tab, severing the affixed sheet intermediate its tab supporting portions to electrically isolate the tabs, and mounting a semiconductive body in contact with said tab edges.

3. In the manufacture of semiconductive translating devices the steps which comprise forming a sheet metal member having an open center portion and a pair of tabs each terminated in an acute angle extending into the open portion, bending the ends of the tabs out of the plane of the member so the planes of the ends lie in a common plane and the apexes of the angles are critically spaced, securing the sheet metal member to an insulating support, severing the secured member intermediate the tabs and mounting a semiconductive body perpendicular to the coplanar tab ends and in contact with the tab apexes.

4. In the manufacture of semiconductive translating devices the steps which comprise forming an open centered sheet metal blank having a pair of superposable sides each including a tab terminated in an acute angle extending into the open portion across a diameter of the blank, bending the ends of the tabs perpendicular to the plane of the blank along said diameter thereof so the apexes of the angles are critically spaced, securing the blank to an insulating support, severing the blank at points intermediate the tab supporting portions and mounting a semiconductive body in contact with the tab apexes.

5. In the manufacture of a semiconductive translator, the steps which comprise securing a thin resilient metal plate on an insulating support member at at least two points, severing the plate between the two mounting points to form two electrically independent sections, bending opposed portions of the sections out of the plane of said plate to a predetermined separation on a plane intersecting the portion of their edges having the greatest separation from the plane of the plate, and contacting a semiconductive surface with said edges.

References Cited in the file of this patent

UNITED STATES PATENTS

2,030,187	Salzberg	Feb. 11, 1936
2,252,899	Reynolds	Aug. 19, 1941
2,270,166	Hiensch	Jan. 13, 1942
2,339,402	Herzog	Jan. 18, 1944
2,495,716	Girard	Jan. 31, 1950
2,503,837	Ohl	Apr. 11, 1950
2,609,427	Stelmak	Sept. 2, 1952

OTHER REFERENCES

Audio Engineering, August 1948.
Electronics, September 1948.