

March 4, 1958

A. SALECKER
CONTACT STRUCTURE

2,825,857

Filed Dec. 31, 1953

2 Sheets-Sheet 1

Fig. 1.

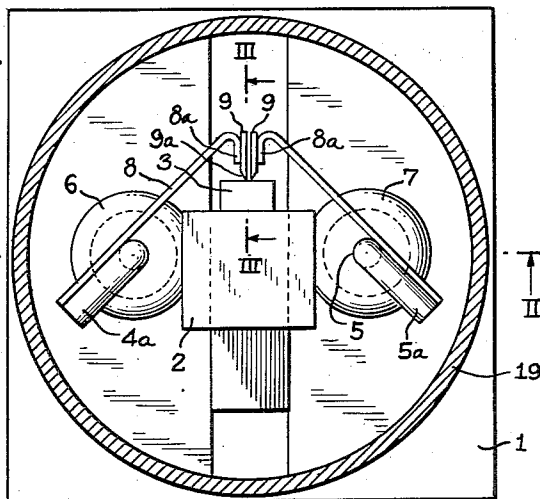


Fig. 4.

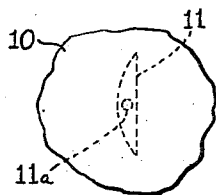


Fig. 2.

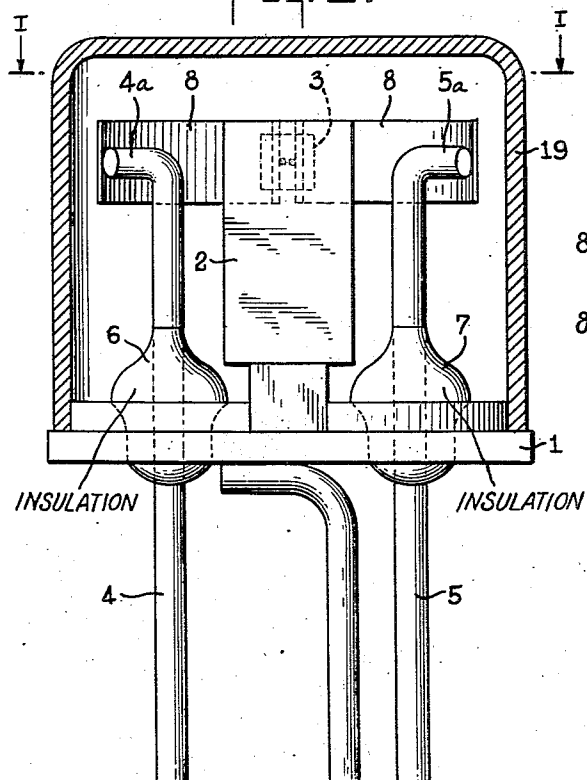
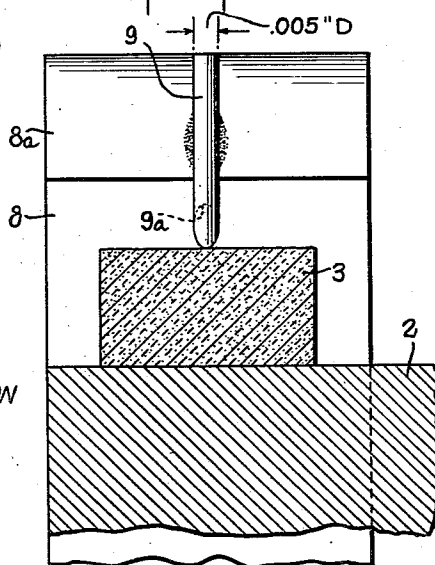


Fig. 3.



INVENTOR.
ANTON SALECKER

BY
P. E. Henninger
ATTORNEY

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A. SALECKER

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Fig. 5.

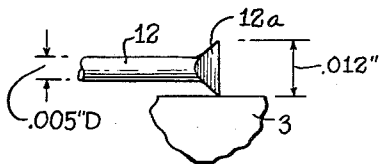


Fig. 6.

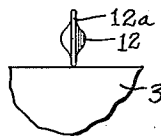


Fig. 7.

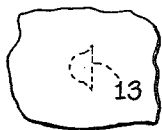


Fig. 8.

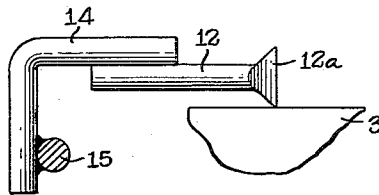


Fig. 9.

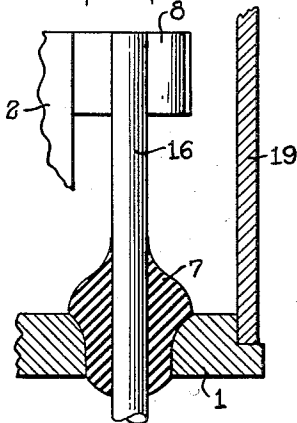


Fig. 10.

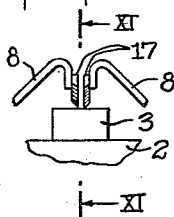


Fig. 11.

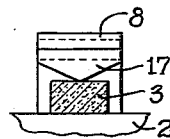


Fig. 12.

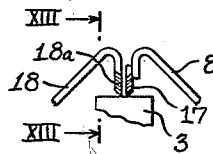
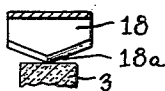


Fig. 13.



INVENTOR.
ANTON SALECKER

BY
P. E. Hanning
ATTORNEY

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CONTACT STRUCTURE

Anton Salecker, Poughkeepsie, N. Y., assignor to International Business Machines Corporation, New York, N. Y., a corporation of New York

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4 Claims. (Cl. 317—235)

This invention relates to contact structures, especially to fixed contact structures for use in connection with semi-conductive devices, e. g., transistors.

A point contact transistor commonly consists of a semi-conductive body, a metal plate attached to and supporting the body and forming a fixed base contact or electrode of substantial area, and two point contacts or electrodes, respectively identified as the emitter and collector electrodes. The emitter and collector contacts are commonly formed as points by sharpening the end of a cylindrical wire by forming thereon a ground plane surface at an angle of 45° to the wire axis. Wires having diameters of the order of .005" are common. This contact has its point placed on the surface of the semi-conductive body. The contact is spring loaded by bending the wire, the spring loading tending to hold the point firmly in its established position on the semi-conductive body, which is usually germanium.

Many difficulties have been experienced with transistors because of their failure to hold their electrical characteristics over a substantial period of time. It is considered that some of these difficulties may be due to small changes in the position of the contacts, or to variations in the spring loading of the contacts with age. The characteristics of the transistors are also subject to variation with temperature, and it is considered that this variation may also be due, at least in part, to a concomitant variation of the spring loading.

An object of the present invention is to provide an improved contact structure for point contact transistors.

A further object is to provide an improved contact structure for transistors having higher spring loading and higher contact pressures than the contacts of the prior art.

Another object is to provide a transistor contact structure having more stable characteristics, especially with regard to spring loading and contact pressure, than the transistors of the prior art.

Another object is to provide a novel transistor contact tip structure having improved mechanical characteristics.

The foregoing and other objects of the invention are attained by providing a composite contact structure including a sharpened contact of wire or strip material fastened to a spring member of other material. The spring rate of the latter member may be determined independently of the characteristics of the wire, so that the wire may be chosen for its contact characteristics alone. Higher contact pressures and more stable contact pressures may be secured in this manner.

In one modification of the invention there is employed a contact tip formed by flattening the end of the wire or strip, as with a hammer and anvil, and using one corner of the flattened tip as a contact.

In another modification, the contact tip is formed from strip material rather than wire. The strip material may be ground to a point in the conventional fashion, or may be hammered to form a tip as described above.

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In still another modification, the collector contact is formed as a composite structure, as described, while the emitter contact is formed by fashioning a point on the end of the spring strip.

Other objects and advantages of the invention will become apparent from a consideration of the following specification, claims and drawing.

In the drawing:

Fig. 1 is a horizontal cross-sectional view taken on the line I—I of Fig. 2, showing a transistor constructed in accordance with the invention;

Fig. 2 is a vertical cross-sectional view taken on the line II—II of Fig. 1, looking in the direction of the arrows;

Fig. 3 is a detailed view, partly in elevation and partly in section on the line III—III of Fig. 1, and on an enlarged scale, showing the details of one of the contacts;

Fig. 4 is a fragmentary plan view showing part of the surface of a semi-conductive body upon which a so-called "point" contact rests, on a greatly enlarged scale, so as to illustrate the contour of the area of contact;

Fig. 5 is a fragmentary elevational view illustrating a contact formed according to a feature of the invention;

Fig. 6 is a right-hand elevational view of the contact of Fig. 5;

Fig. 7 is a view similar to Fig. 4, showing the contour of the contact area which is secured with the contact structure of Figs. 5 and 6;

Fig. 8 is a view similar to Fig. 5, on a smaller scale, and generally similar to a fragment of Fig. 1, showing the relationship of the contact structure of Fig. 5 to the supporting parts;

Fig. 9 is a fragmentary view similar to a portion of Fig. 2, showing a modified form of supporting structure for the spring member which in turn supports the contact;

Fig. 10 is a fragmentary view similar to a portion of Fig. 1, showing a modified form of contact structure;

Fig. 11 is a cross-sectional view taken on the line XI—XI of Fig. 10, looking in the direction of the arrows;

Fig. 12 is a view similar to Fig. 10 showing another modified form of contact structure; and

Fig. 13 is a view similar to Fig. 11 taken on the line XIII—XIII of Fig. 12.

Figs. 1 to 3

These figures illustrate a transistor including a metal base plate 1 on which is mounted an upright 2 standing vertically upward from the center of the base plate and carrying on one side adjacent to its upper end a semi-conductive body 3. The upright 2 forms the base electrode for the transistor. A pair of wires 4 and 5 extend upwardly through the base 1, being insulated therefrom by insulating sleeves 6 and 7. The entire transistor structure is enclosed within a metal casing 19.

The upper ends of wires 4 and 5 are bent over as shown at 4a and 5a. Flat leaf spring members 8 are attached to the bent over portions 4a and 5a, for example, as by spot welding or brazing. The spring members 8 project laterally from the wire 4a and have their free ends bent at substantially 135°, as shown at 8a in Fig. 1. Fastened on the bent over ends 3a of the spring member 8, as by spot welding or brazing, are contact tips 9, each comprising a short section of cylindrical wire, having its end sharpened by grinding a single flat 9a at an angle of 45° to the axis of the wire. The tip of this flat 9a is held in engagement with the semi-conductive body 3 by the tension of the spring member 8.

By way of comparison of the structure illustrated to conventional contact structures, it was found that a conventional wire having a diameter of .005" was deflected

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.004" from its free position to form a transistor contact, the stress in the wire when deflected being 2.7 grams. Another conventional wire of .007" diameter, with the same deflection of .004", had a stress of 9.2 grams. By way of comparison, a contact structure built in accordance with the invention included a spring member 8 of nickel $\frac{1}{32}$ " wide and .005" thick. When deflected .004" to form a transistor contact, the stress in the spring member was 24 grams. The spring loading thereby obtained was almost three times the greatest spring loading obtainable with the conventional contact structure, and more than eight times the loading of the other conventional contact mentioned. The contact pressure was increased in proportion since the same type of contact contour was used in both cases.

Figs. 4 to 8

Fig. 4 shows the contact area contour obtained with conventional contact structures. There is shown in Fig. 4 a fragment 10 of a germanium body, with an elongated area 11 shown in dotted lines, representing the area at which the tip of a contact such as the contact 9 touches the germanium. Within this area 11 is a small central area 11a, of approximately circular contour, where a very high contact pressure is developed.

Figs. 5 to 8 illustrate a modified form of contact structure constructed in accordance with a feature of the present invention. These figures show a contact formed from the tip of a wire 12 by flattening the end thereof, as between a hammer and anvil, to form a generally wedge-shaped tip, as shown at 12a. Fig. 7 shows the contour of the contact area 13 obtained with a tip formed as illustrated in Figs. 5 and 6. It may therefore be seen that the contact area 13 has a form generally similar to that of a segment of a circle defined by a chord and an arc slightly larger than a semicircle.

The wedge-shaped tip 12a may be manufactured considerably easier and faster than the ground tip structures of the prior art, and has equally good electrical characteristics.

Fig. 8 illustrates one method of supporting the contact 12 to secure suitable contact pressure conditions. The contact 12 in Fig. 8 is illustrated as being supported on a spring member 14 having a right angle bend and fastened as by brazing or spot welding to an upright post 15. The post 15 may correspond for example to the wire 5 of Figs. 1 and 2.

Fig. 9

This figure illustrates a modified form of structure for supporting a spring member 8. In this figure the spring member 8 is fastened as by brazing to the upper end of a wire 16 which is of somewhat larger diameter than the wire 5 of Fig. 2. The wire 16 extends vertically throughout its length, and does not have its upper end bent over. While the lack of a bent over end decreases the length of the supporting bond between spring member 8 and the wire 16, as compared to the corresponding bond in the case of the bent over tip 5a of the wire 5, it has nevertheless been found that by making the wire 16 of larger diameter than wire 5, the bond may be made sufficiently strong and the manufacture of the transistor may be facilitated.

Figs. 10 and 11

These figures illustrate a modified form of construction of the contact tip members. The spring members 8 and the semi-conductive body 3 are the same as in the previous figures. The contact tip members 17 are different, however, being formed from flat strip material rather than wire material as in the previous figures. The points on the contact members 17 may be formed by grinding as in the case of the conventional wire tip, or they may have a wedged-shaped point formed by hammering, as described in the case of Figs. 5 to 8.

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Figs. 12 and 13

The figures illustrate a still further modified form of transistor structure. In the transistor of these figures, the collector electrode has a tip 17 formed in the manner illustrated in Figs. 10 and 11. The emitter electrode is different, however, being formed directly on the free end of a spring member 18, which replaces the spring member 8 of the previous figures. This contact tip 18a or the end of spring member 18 may be formed either by the conventional grinding method or by the hammering method disclosed herein.

It has been found that the electrical characteristics of the emitter electrode are less inclined to be adversely affected by changes in the nature of the contact materials used, and that in many cases a satisfactory emitter electrode contact may be formed as shown in Figs. 12 and 13, directly on the end of a spring member 18 whose material is selected primarily for its spring characteristics rather than for its electrical characteristics.

In an effort to secure long life and stable characteristics in transistors, it has been desired to bake most of the moisture out of the transistors before sealing them in plastic, glass, etc., envelopes. It has been impossible, however, to bake at very high temperatures, because the wire materials commonly used, for example, copper alloys, lose their tension at such temperatures. Any transistor constructed in accordance with the present invention, however, may be baked at high temperatures by selecting for the spring members 8, spring materials having low relaxation or load loss at high temperatures. For example, Inconel and Permanickel will allow a high temperature processing and still retain good spring characteristics. Nickel iron alloys and some silicon alloy steels are also desirable from this standpoint.

While I have shown and described certain preferred embodiments of my invention, other modifications thereof will readily occur to those skilled in the art and I therefore intend my invention to be limited only by the appended claims.

I claim:

1. A transistor comprising a base plate, a base electrode member mounted on said plate and projecting therefrom and having at least one flat surface, a body of semi-conductive material mounted on said flat surface in electrically conductive contact therewith, a pair of stiff wires extending through said base plate and substantially parallel to said flat surface, a pair of leaf spring members of material having a substantial spring rate, each having a flat surface adjacent one end thereof welded along one side of one of the wires adjacent the outer end thereof, each spring member extending laterally from its associated wire with its free end aligned with said semi-conductive body, and a pair of short, pointed contact tips, each welded to the free end of one of said spring members, said spring members being stressed to hold said contact tips in firm contact with said semi-conductive body.

2. A transistor as defined in claim 1, in which the outer ends of said wires are bent over to provide end portions of substantial length, and said spring members have said one ends thereof welded to said wires along substantially the entire lengths of said end portions.

3. A transistor as defined in claim 1, in which the free ends of said spring members are bent over to extend at right angles to but spaced from a flat surface on said semi-conductive body, and said contact tips are wires having ground points and are welded along one side to said free ends and project therefrom so that said points engage said body.

4. A transistor as defined in claim 1, in which the free ends of said spring members are bent over to extend parallel to a flat surface on said semi-conductive body, said contact tips are wires having hammered wedge-shaped points with an edge extending transversely of the

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wire, and said contact tips are welded to said free ends of the spring members and project therefrom with one end only of said edge engaging said body.

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