Aug. 16, 1960 E. F. DILLABY 2,948,951

FORMATION OF POINT CONTACT TRANSISTORS

Filed Nov. 19, 1957

FIG. 1.

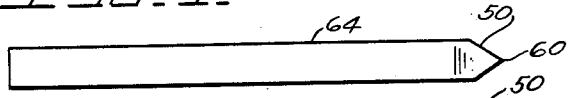


FIG. 2.

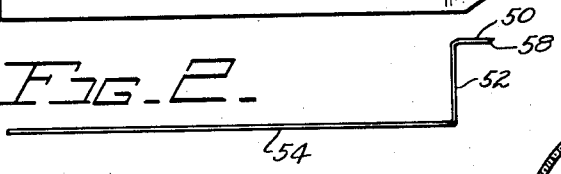
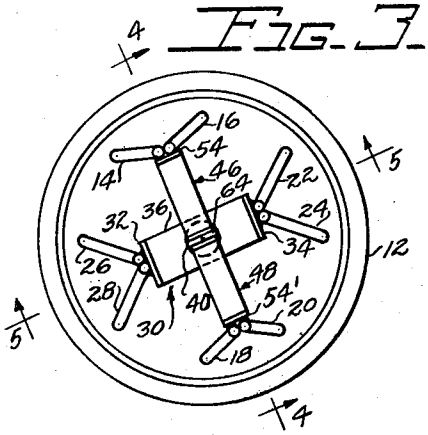


FIG. 3.



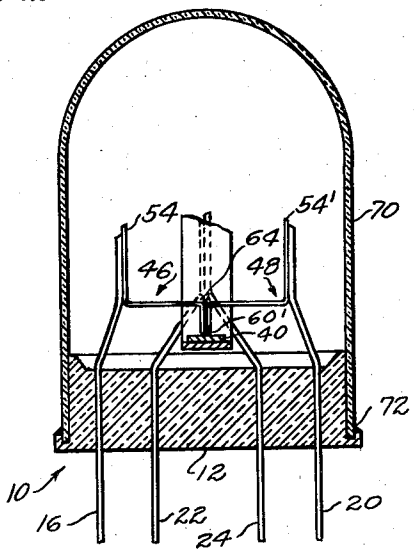


FIG. 4.

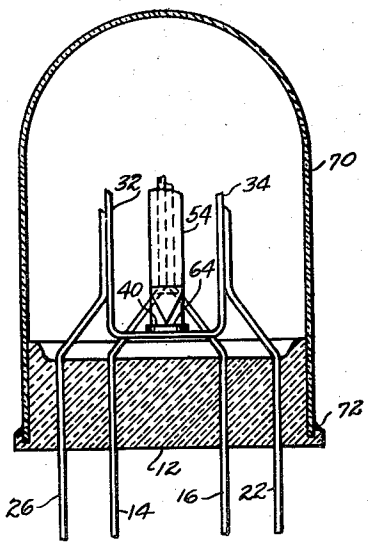
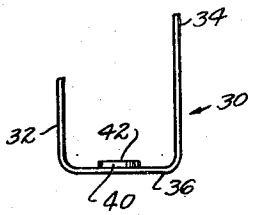


FIG. 5.

FIG. 6.



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United States Patent Office

2,948,951

Patented Aug. 16, 1960

2,948,951

FORMATION OF POINT CONTACT TRANSISTORS

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Filed Nov. 19, 1957, Ser. No. 697,500

4 Claims. (Cl. 29—25.3)

This invention relates to a point contact transistor and a method for constructing the same and, particularly to a point transistor having a high-frequency alpha cutoff and a method of forming the transistor to achieve this cutoff.

It has heretofore been desired to utilize transistors in applications requiring high-frequency cutoff with stable operation. It has heretofore been proposed to construct point transistors having high-frequency cutoff characteristics by applying relatively heavy forming currents. It is believed that the use of high current for forming transistor points is effective in reducing the effective contact area. However, such utilization of high current has an additional effect of reducing collector impedance and therefore reduces the frequency of response.

It has also been proposed to utilize chemical means such as arsenic chloride as a dope or coating on the contact point to produce the necessary forming action without high forming current. However, transistors so formed have proven unstable in operation.

The present invention relates to the utilization of a chemical coating as a dope or forming agent together with relatively low current forming impulses to produce the necessary high multiplying action without reducing the collector impedance. In general the treatment was effective in reducing the necessary forming current when the dope solution was a dilute acid producing chloride ions and having a surface tension such that the dope solution would collect accurately on the point of the contact electrode. Also, the dope when dry must not leave a large crystal deposit on the point. It is believed that such crystals either insulate the contact or push it out of contact. While several solutions tested as a dope gave a material decrease in forming current pulses, selenic acid prepared by oxidizing selenium metal in sulphuric acid (H_2SO_4) when used for doping gave the lightest forming pulse. After a light forming pulse, these units displayed an alpha cutoff of 20 to above 50 M c.p.s. and remained stable during operation.

In utilizing transistors made by this low current impulse chemically assisted manner the transistors were found to be vulnerable to shock, probably, because the very small contact point resulting from the chemical action is mechanically weak under shock conditions.

In order to offset this mechanical weakness a structure was devised which rigidly supports both the germanium pellet and the contact points so that the point contact is substantially unstressed by impact conditions.

In a construction according to the invention a support member such as a glass header has a plurality of support pins firmly imbedded in the header and two or more pins are secured together for the purpose of rigidity and the base conductor as well as the collector electrode strips are rigidly secured to a plurality of the supporting pins in order to provide a completely rigid assembly. The final assembly may be readily incapsulated by providing

a cover which is connected to and hermetically sealed to the support member by any means such as soldering.

It is accordingly an object of the invention to provide an improved point contact transistor.

It is a further object of the invention to provide a point contact transistor operable at a high alpha frequency cutoff.

It is still another object of the invention to provide a point contact transistor formed by a low forming current.

It is another object of the invention to provide a rigid point contact transistor device.

It is a further object of the invention to provide a process of forming transistor contactor point under low forming current.

It is a still further object of the invention to provide a method utilizing chemical means to reduce the forming current.

Other objects and advantages of the invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

Figure 1 is a plan view of a point contact electrode element according to the invention;

Figure 2 is a side elevation of the element of Figure 1;

Figure 3 is a top plan view (with the cover removed), of a point contact transistor according to the invention;

Figure 4 is a vertical elevation through the transistor device taken substantially on the plane indicated by the line 4—4 of Figure 3;

Figure 5 is a similar view taken substantially on the plane indicated by line 5—5 of Figure 3; and

Figure 6 is a side elevation of a base contact and pellet support according to the invention.

In the illustrative embodiment, according to the invention, a support member indicated at **10** is constituted by a glass header **12** in which is imbedded a plurality of support pins herein indicated as **8** in number and identified as **14** to **28**. The pins **14** to **28** are herein shown as being regularly spaced in a circle in the header **12** and all of the pins **14** to **28** are shown as extending completely therethrough. However, it is apparent some of these pins **14** to **28** may terminate within the header **12** as their sole function is to provide mechanical stability while others may be utilized for making electrical connections to the transistors. Likewise, it will be apparent that the pins may be placed in irregular or planned figurations so that the extending conductors may be selectively applied to a base.

A base conductor **30** is composed of a metallic strap normally bent into substantially U-shaped forms with upstanding legs **32** and **34** and a bite member **36**. Bite member **36** can be of any desired length with upwardly extending legs **32** and **34** connected to support pins as will hereafter be described. A germanium pellet **40** is mounted on the base member **30** by any means such as soldering or the like. The exposed surface **42** of the germanium pellet is etched by any suitable standard etch such as etch CP–4 which is composed of 50 parts nitric acid, 30 parts acetic acid, 30 parts hydrofluoric acid and one part liquid bromine.

The emitter contact **46** is constructed from a ribbon of stainless steel and the collector electrode **48** is constructed from a ribbon of Phosphor bronze. Both of the electrodes **46** and **48** are constructed as shown in Figures 1 and 2. One end of the strip is bent laterally, preferably at an angle of substantially 90° from the body **52** of the strip to provide a tip **50** and the opposite end is bent transversely substantially at an angle of 90° from the body **52** and provides a securing or anchor portion **54**. To prepare the electrodes the tips **50** are shaped to provide an acute angle portion **56** which is sharpened as is **58** to provide an extremely sharp point **60**. The points **60** of the electrodes **46** and **48** are doped by applying a

current reducing chemical thereto. The best current reducing dope heretofore found is dilute selenic acid. However, solutions of HCl, H_3PO_4, $HClO_4$ and $AgNO_3$ both as a solution and a tincture have given improved results over the heretofore known high current forming process.

In a mechanical construction of the base, the base conductor **30** is mounted on the support **10** by securing one end **34** of the base support **30** to a plurality of the support pins such as pins **22** and **24** which are bent into close proximity with each other to provide a mutually bracing support and secured to leg **34** of base conductor **30** by soldering or the like. Also the pins **26** and **28** are likewise bent into bracing relation and soldered to leg **32**. Preferably the bight **36** of base conductor **30** is of such length that the supports connected to legs **32** and **34** are bent inwardly toward each other. It will thus be seen that the U-shaped member is rigidly mounted in a fixed relationship by at least two pair of mutually bracing support pins. The emitter element **46** has the attaching portion **54** rigidly connected to supporting pins such as **14** and **16** which are likewise bent into an efficient bracing relationship with each other. It is apparent that the body portion **52** of electrode **46** may be of any desired length to extend from support pins **14** and **16** to engage the point **60** of the electrode **46** with the etched surface of the collector **40**. Likewise, the collector electrode **48** has its anchoring portion **54** connected to the supporting pins **18** and **20** by soldering in the right structural position so that the point **60'** is in contact with the etched surface in closely spaced proximity to the point **60** of the electrode **46**. The tips of the emitter electrode **46** and collector electrode **48** are maintained in closely spaced insulated relationship by innerposing a film **64** of insulating material therebetween. For this purpose a polyester film approximately 0.0003" thick has been found suitable.

The entire structure may be further protected by incapsulation by providing a cover **70** which will fit over the header **12** and may be secured thereto in hermetically sealed relationship by using suitable soldering material. An eutectic solder composed of the eutectic alloy of bismuth, lead, cadmium and tin has been found satisfactory.

After the device has been rigidly assembled with points **60** and **60'** fixed in closely spaced relation in contact with the etched surface **42**, forming currents slightly in excess of the load currents but materially less than the heretofore known forming currents will be transmitted to the device to form the transistor contacts to produce the desired multiplying action. Since these impulses are of low value the collector impedance will remain high so that the alpha cutoff frequency will be high.

While for purposes of exemplification a particular embodiment of the invention has been shown and described according to the best present understanding thereof, it will be apparent to those skilled in the art, that various changes and modifications in the construction or arrangements of the parts thereof may be resorted to without departing from the true spirit and scope of the invention.

I claim:

1. The method of constructing a high-frequency response point contact transistor which comprises mounting a germanium crystal on a conducting base, rigidly securing the base on a support, etching the exposed surface of said crystal, sharpening a stainless steel emitter electrode to provide a contact point, sharpening a bronze collector electrode to provide a contact point, doping each of said contact points with selenic acid, arranging the doped points in contact with the etched surface in closely spaced insulated relation to each other, rigidly securing said electrodes to said support to maintain the position of said points and applying forming pulses having a current level of the same order of magnitude as the load current.

2. The method of constructing a high-frequency response point contact transistor which comprises mounting a germanium crystal on a conducting base, rigidly securing the base on a support, etching the exposed surface of said crystal, sharpening a stainless steel emitter electrode to provide a contact point, sharpening a bronze collector electrode to provide a contact point, doping each of said contact points with selenic acid, arranging the doped points in contact with the etched surface in closely spaced insulated relation to each other, rigidly securing said electrodes to said support to maintain the position of the points, applying forming pulses having a current level of the same order of magnitude as the load current, applying a cover over said transistor and hermetically sealing said cover to said support.

3. The method of constructing a high-frequency response point contact transistor which comprises mounting a germanium crystal on a conducting base, rigidly securing the base on a support, etching the exposed surface of said crystal, sharpening a stainless steel emitter electrode to provide a contact point, providing a collector electrode composed of bronze having a small phosphor content, sharpening said bronze collector electrode to provide a contact point, doping said contact points with an acid solution containing chloride ions, said acid solution, having a surface tension such that the solution collects accurately on the tips of the points and which will dry without leaving a large crystal deposit, arranging the doped points in contact with the etched surface in closely spaced insulated relation to each other, securing said electrodes to said support and applying forming pulses having a current level of the same order of magnitude as the normal load current.

4. The method of constructing a high-frequency response contact transistor which comprises providing a conducting base, mounting a germanium crystal on said base, providing a support, rigidly mounting said base on said support, etching an exposed surface of said crystal, sharpening a stainless steel emitter electrode to provide a sharp contact point, sharpening a bronze collector to provide a sharp contact point, doping each of said points with an acid solution containing chloride ions, said solution having a surface tension such that the solution collects accurately on the points, said solution having a composition such that it will dry without forming a large crystal deposit, placing an insulating film between said points, rigidly mounting said electrodes on said support so that said points are in closely spaced contact with the etched surface of said crystal, applying forming pulses of the order of magnitude of the load currents to be carried by said transistor.

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