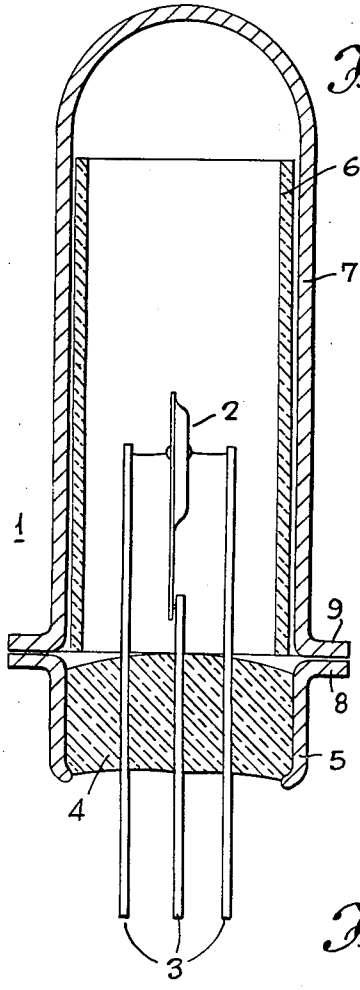
April 17, 1962 P. M. SHEARMAN 3,030,560

TRANSISTORS

Filed May 2, 1960

2 Sheets-Sheet 1

Fig. 1.



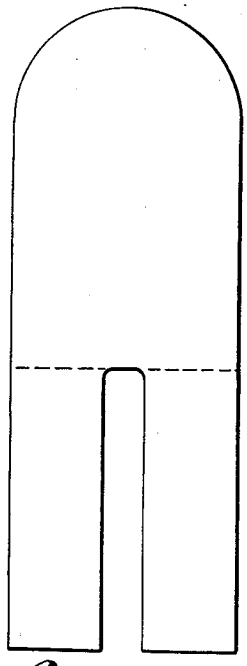


Fig. 2.

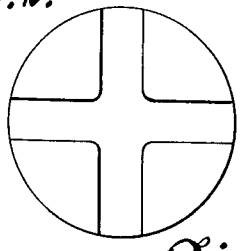


Fig. 3.

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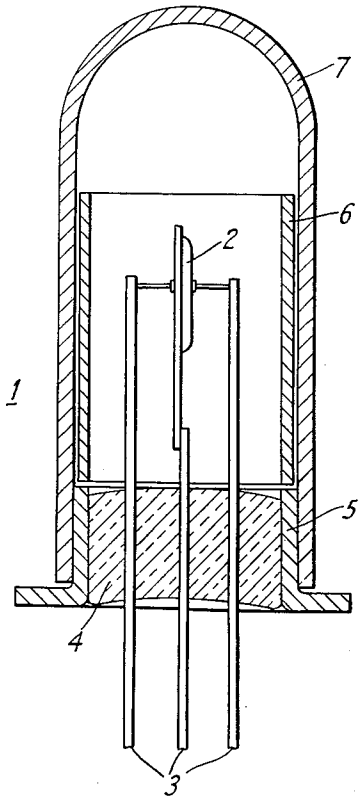

Fig. 4

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3,030,560

TRANSISTORS

Paul Martin Shearman, Harlow, England, assignor to Associated Electrical Industries Limited, London, England, a British company

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Claims priority, application Great Britain May 5, 1959
4 Claims. (Cl. 317—235)

This invention relates to transistors of the kind in which a metal cap is sealed to a metal eyelet for example by welding, and encloses a transistor wafer and its associated supporting conductors, the supporting conductors passing through the eyelet to the exterior of the enclosure in spaced relation to each other and to the inner periphery of the eyelet, said spaced relations being fixed by sealing with a glass bead. Such a transistor is hereinafter referred to as an encapsulated transistor.

In such encapsulated transistors if the internal diameter of the metal cap is small then there is a danger that the transistor wafer or the supporting conductors will come into contact with the inner wall of the cap, thus causing a short-circuit.

It is an object of this invention to provide means to prevent such contact from taking place.

According to the invention, the cap of a transistor of the kind hereinbefore set forth, is provided internally with a refractory electrically insulating insert which prevents the transistor wafer and/or supporting conductors from coming into contact with the inner wall of the cap.

The insert is conveniently made from anodised aluminium.

The insert may consist of a sleeve, the internal diameter of which is sufficient to accommodate the transistor wafer and its supporting conductors.

Alternatively, if the wafer and its supporting conductors are arranged in the form of a cross the insert may consist of a solid cylinder having two transverse slots substantially at right angles to each other cut into one end, the dimensions of the slots being sufficient to accommodate the transistor wafer and the supporting conductors respectively.

The insert may be shaped from aluminium blank and then subjected to any known anodising process as a result of which the aluminium is converted to a considerable depth to the oxide which is an electrical insulator. Preferably the corners of the insert are rounded off before processing since the anodising will not always take place along sharp edges thus leaving the bare metal exposed. The cap into which the insert is fitted is thoroughly washed to remove as far as possible all traces of foreign matter likely to have a harmful effect on the operation of the transistor.

The space between the cap and the insert and between the insert and the transistor wafer and supporting conductors may be filled with silicone grease which may be loaded with powdered silicon, alumina or magnesia, calcium aluminium silicate, or sodium aluminium silicate, or with any other suitable material.

In order that the invention may be better understood, it will now be described with reference to the accompanying drawings, in which:

FIG. 1 is a sectional view of a transistor constructed according to one embodiment of the invention;

FIG. 2 is an elevation of an anodised aluminium insert having transverse slots cut in the base and a domed top which illustrattes a second embodiment of the invention;

FIG. 3 is an inverted plan of the insert shown in FIG. 2, showing more clearly the transverse slots in the base, and

FIG. 4 is a sectional view of a transistor having a modified outer casing, but illustrating the same embodiment of the invention as shown in FIG. 1.

Referring now to FIG. 1, there is shown a transistor 1 comprising a transistor wafer 2 supported by and in electrical contact with supporting conductors 3 which pass through a glass bead 4 in spaced relation to each other and to an eyelet 5 which is flanged at 8. An insert 6, which is in the form of a sleeve, fits around the transistor wafer 2 and the supporting conductors 3 and a cap 7 fits over and around the insert 6, a flange 9 on the cap being welded to flange 8, thus completing the enclosure.

The sleeve may be replaced by the insert shown in FIGS. 2 and 3.

In FIG. 4, a modified arrangement of the cap and eyelet forming the enclosure containing the transistor wafer is shown. The cap 7 is now in the form of a hollow cylinder, closed at one end and with its open end fitting over and sealed to the outer wall of the annular eyelet 5.

The eyelet may be made of any metal which is known to seal to glass, such as the alloy known under the registered trademark "Nilo K" and the cap of any metal which may be secured to the eyelet by such means as welding or soldering. Thus, when the eyelet is of Nilo K the cap may be made of 18% nickel silver since these two metals may be joined together readily by welding.

We have found that the use of anodised aluminium inserts has the added effect of reducing the thermal resistance of encapsulated transistors. The thermal resistance of a transistor is a measure of the rate at which energy dissipated at the collector junction as heat is removed from the junction and thence from the transistor. Thermal resistance is often measured in terms of "degrees centigrade per milliwatt of output power" for a given ambient temperature. Thus, if for an ambient temperature of 25° C. the thermal resistance is 0.1° C./mw., the temperature of the transistor will rise by 0.1° C. for each milliwatt of output from the transistor. The effect of introducing the anodised aluminium insert has been to halve the thermal resistance of at least one type of transistor, i.e., reducing it from t° C./mw. to $\frac{1}{2}$ t° C./mw. For every transistor there is a maximum operating temperature at which the transistor may be operated without its characteristics changing. It follows that for given maximum operating and ambient temperatures the lower the thermal resistance the higher the permissible wattage rating of the transistor.

What I claim is:

1. A sealed transistor comprising a metal cap, a metal eyelet sealed to said cap to form an enclosure, said eyelet having sealed therein vitreous material, a transistor wafer and associated supporting conductors, said wafer being supported within said enclosure and spaced apart from the inner wall of said cap by said supporting conductors which pass through and are sealed to said vitreous material in spaced relation to each other, and a refractory electrically insulating insert of anodised aluminium within said cap preventing said transistor wafer and said supporting conductors from coming into contact with said inner wall of said cap.

2. A sealed transistor comprising a metal cap, a flanged metal eyelet sealed to said cap to form an enclosure, said eyelet having a glass bead sealed therein, a transistor wafer and associated supporting conductors, said wafer being supported within said enclosure and spaced apart from the inner wall of said cap by said supporting conductors which pass through and are sealed to said glass bead in spaced relation to each other, and a refractory electrically insulating sleeve of anodised aluminium within said cap, the internal diameter of said sleeve being sufficient to accommodate said transistor wafer and said

supporting conductors preventing said wafer and said supporting conductors from coming into contact with said inner wall of said cap.

3. A sealed transistor comprising a hollow cylindrical metal cap having a closed end and an open end provided with a peripheral flange, an annular metal eyelet also provided with a peripheral flange, said cap and said eyelet being sealed in axial alignment to each other at said flanges to form an enclosure, a glass bead sealed within said annular eyelet, a transistor wafer and associated supporting conductors arranged within said enclosure in the form of a cruciform, said supporting conductors passing through and sealed to said glass bead in spaced relation to each other, and a solid refractory electrical insulating cylinder within said cap, said insulating cylinder having two slots substantially at right angles to each other cut into one end, the dimensions of said slots being sufficient to accommodate said transistor wafer and said supporting conductors, to prevent them from coming into contact with the inner wall of said cap.

4. A sealed transistor as claimed in claim 3, in which the refractory electrical insulating cylinder is of anodised aluminium

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