May 4, 1965 W. A. ROOVERS 3,182,117

SEMICONDUCTOR DEVICE IN COLD-WELDED ENVELOPE

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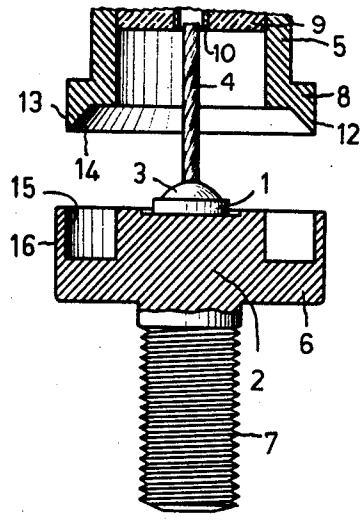

FIG.1

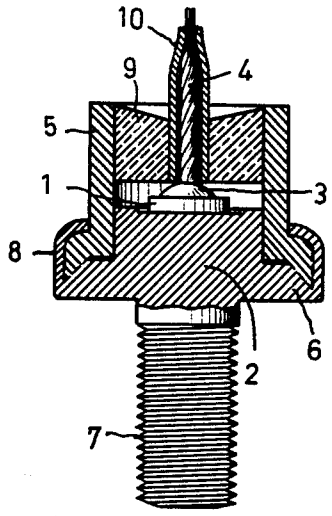

FIG.2

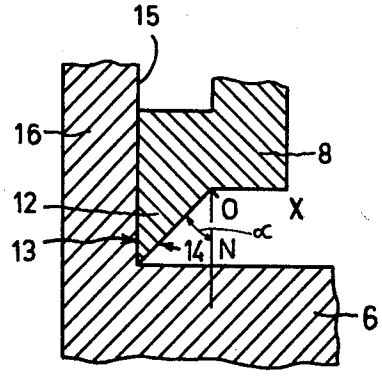

FIG.3

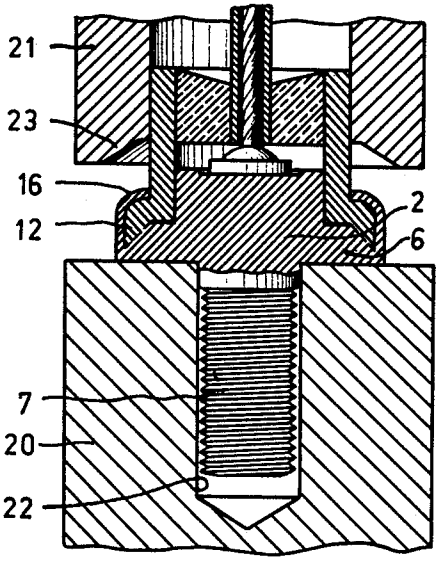

FIG.4

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SEMICONDUCTOR DEVICE IN COLD-WELDED ENVELOPE

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4 Claims. (Cl. 174—52)

This invention relates to semi-conductor devices, such as transistors or crystal diodes, of the type having an envelope consisting of at least two metallic parts which are connected together in a vacuum-tight manner by means of their flanges.

It is known to unite such flanges by means of a so-called cold weld, but this involves the disadvantage of a heavy deformation of the flanges in a direction parallel to their contact surfaces and transverse to the direction of pressing. It has also previously been suggested to unite the flanges by providing them with grooves and pressing into the grooves a ring of soft metal, for example lead, which has been laid between the flanges. This method makes it necessary to work both flanges and to employ a third part, namely the ring.

A known method of relatively sealing two flanges consists in providing one flange with several concentric sharp edges and pressing the two flanges one on the other so that the material of these edges is pressed into that of the opposing flange. This method may likewise give rise to deformation to an extent which is impermissible for the comparatively small envelopes usually employed for semi-conductor devices.

An object of the invention is inter alia to overcome these disadvantages.

According to the invention, one flange is provided at its periphery with a sharp ridge with two flanks directed towards the other flange and pressed into the material thereof, the first flange being embraced by a flange edge of the other flange.

In one advantageous embodiment, the flank directed inwardly is at a larger angle to a perpendicular to the surface of the flange than is the flank directed outwardly.

The outer flank of the ridge preferably engages part of the inner side of the flange edge according to a cylindrical plane.

Such envelopes are usually bodies of revolution, but this is not essential to the invention.

In order that the embodiment may be readily carried into effect, one embodiment thereof will now be described in detail, by way of example, with reference to the accompanying diagrammatic drawing, in which:

FIG. 1 is a cross-sectional view of a diode prior to closure of the envelope;

FIG. 2 is a sectional view of a diode after the flanges have been united;

FIG. 3 is a sectional view of the flanges on a larger scale;

FIG. 4 is a diagrammatic view of a diode and several parts of a press to be used for closing.

The envelope shown in these figures is intended for a crystal diode comprising a semi-conductor body **1**, which is soldered to a base **2**, and a rectifying electrode **3** provided with a supply wire **4**. The composition of this semi-conductor system, which will otherwise not be described, is in general unimportant for the structure of the envelope. What is important for the structure of the envelope, and this applies to the majority of semi-conductor devices and hence not only to crystal diodes, but also to transistors, photo-electric cells and the like, is that the closure is very reliable and vacuum-tight and

that the portion of the base to which the semi-conductor body is secured does not undergo deformation, since its electrical properties are hazarded thereby.

The envelope comprises substantially two metallic parts, that is to say the base **2** and a ring or cap **5**. The base might be made of copper or aluminum, the ring of iron or of an alloy consisting of iron and chromium. The base **2** has a flange **6** and a threaded stud **7** for securing the envelope to a carrier plate. The centre of the base forms as it were a table to which the semi-conductor body **1** is secured. The ring **5** has a tubular portion provided with a flange **8**. A glass insulator **9** having a metallic lead-through tube **10** is sealed into the tubular portion. The assembly comprising the parts **5**, **9** and **10** is usually indicated by "cap" or "bulb."

The flange **8** has a sharp ridge **12** provided with two flanks **13** and **14**. Upon closing the envelope, the ridge **12** is pressed into the material of the other flange **6** and is provided at the periphery of the flange **8** in order that the deformation of the material of the flange **6** which occurs upon pressing-in may substantially be kept away from the centre of the base carrying the body **1**. The diameter of the ridge is, by way of example, 10 mm. in which case the pressing force is about 750 kg. The invention is of course not limited to envelopes of this size; in small envelopes the diameter might be about 5 mm.; in larger envelopes 15 mm. The ridge **12** has an asymmetrical shape, as shown in FIG. 1, and also in FIG. 3, but on a larger scale. The flank **14** directed inwardly is at an angle α of, for example, about 45° to a perpendicular ON dropped to the surface of the flange **8** indicated by the line OX. This perpendicular is parallel, however, to the flank **13** directed outwardly. The object of this step is to prevent the ridge **12** from bending inwardly upon pressing-in, which might also give rise to deformation of the base in the vicinity of the semi-conductor body. In the structure shown in FIG. 3 the outer flank **13** engages, according to a cylindrical plane, the inner wall **15** of a flange edge **16** provided on the flange **6**. It is thus ensured that upon closing by pressing the outer flank **13** is guided in the direction of pressing and neither bent over inwardly, nor outwardly.

Closing by pressing may be effected in the usual manner by means of a press (not shown) comprising two dies **20** and **21**. The lower die **20** carries the base **2** of the envelope and for this purpose has a bore **22** to receive the threaded stud **7**. The upper die **21** has a tubular shape so as to embrace the ring **5**. The underside of the die **21** has an inclined edge **23** which causes the flange edge **16** to bend over and at the same time presses the ridge **12** into the flange **6**. During this process of closing by pressing, it is not necessary for the flanges **6** and **8** to adjoin each other.

It is to be noted that it must be regarded as an advantage that closing by pressing and flanging can take place in a single operation, because one thus avoids the risk that an envelope previously closed by pressing may be deformed by a subsequent flanging operation and made untight.

After the envelope has been pressed and flanged tight, the lead-through tube **10** containing the supply wire **4** is closed in the usual manner by pinching, welding or soldering.

What is claimed is:

1. A semiconductor device comprising a semiconductor element and an envelope hermetically sealing and enclosing the semiconductor element, said envelope comprising base and cap annular metallic members each having annular flanged portions cold-welded together to form a vacuum-tight seal, the cap flanged portion having an upper transverse surface and extending downward from its pe-

riphery outer and inner surfaces intersecting at a point remote from the said flanged portion and defining a sharp edge, the semiconductor element being mounted at a central region of the base member and the base flanged portion having a recess surrounding and spaced from the semiconductor element and an upstanding outer wall portion defining said recess, the cap flanged portion fitting within the said recess with the sharp edge pressed deeply into the material underlying the said recess, the outer wall portion defining the recess being pressed over the said transverse surface of the cap flanged portion and tightly into engagement therewith thereby tightly embracing the cap flanged portion.

2. A device as set forth in claim 1 wherein the downwardly-extending peripheral outer surface of the cap flanged portion is substantially vertical, and the said inner surface extends downward and outward to form with the outer surface the sharp edge.

3. A device as set forth in claim 2 wherein the outer diameter of the cap flanged portion at the outer surface is approximately the same as the inner diameter of the outer wall portion defining the recess and the said outer surface engages the inner surface of the said wall portion.

4. A device as set forth in claim 3 wherein the said outer surface and the inner surface of the said wall portion are cylindrical.

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