March 6, 1962 H. C. NIJHUIS ET AL 3,024,299

COLD PRESS BONDED SEMI-CONDUCTOR HOUSING JOINT

Filed March 26, 1958

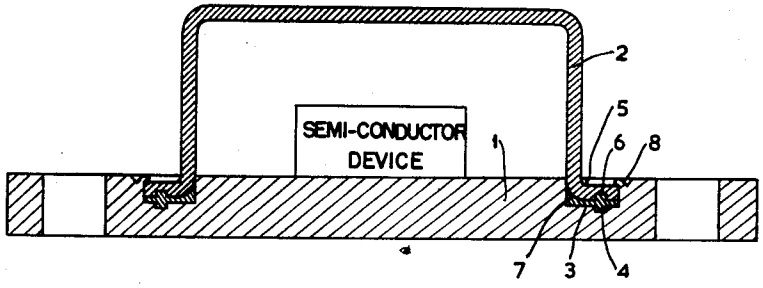

FIG.1

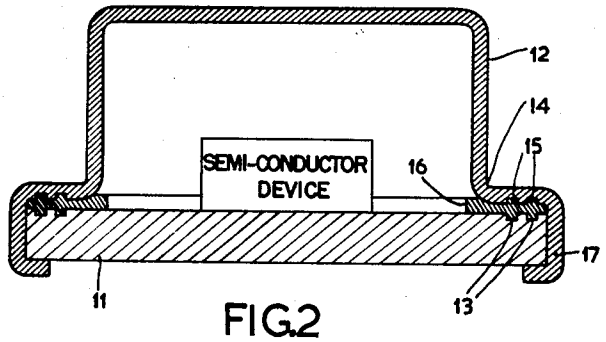

FIG.2

INVENTOR
HERMAN CORNELIS NIJHUIS
WILHELMUS ANTONIUS ROOVERS
BY Frank R. Trifari
AGENT

United States Patent Office 3,024,299 Patented Mar. 6, 1962

3,024,299
COLD PRESS BONDED SEMI-CONDUCTOR HOUSING JOINT

Herman Cornelis Nijhuis and Wilhelmus Antonius Roovers, Mollenhutseweg, Nijmegen, Netherlands, assignors to North American Philips Company, Inc., New York, N.Y., a corporation of Delaware

Filed Mar. 26, 1958, Ser. No. 725,774
Claims priority, application Netherlands Apr. 16, 1957
6 Claims. (Cl. 174—50.5)

This invention relates to a semi-conductor electrode system or device, for example a transistor or a crystal diode, provided with a vacuum-tight envelope made substantially of metal.

It has already been proposed for such an envelope to be constituted by at least two parts, facing surfaces of these parts being united together by pressure. In this device, one press surface consisted of a comparatively hard metal and another engaging press surface consisted of a comparatively soft metal, the surface made of the harder metal being provided with at least one groove the lateral walls of which were at substantially right angles to the said surface, while this groove or these grooves was or were filled with the softer metal.

These suggestions referred substantially to combinations of parts the softer of which consisted of metals such as copper and aluminum and the harder of iron and steel. In many semi-conductor electrode systems the heat dissipation is important and in this respect envelope parts made of iron or steel have a limitation in that they have a comparatively high thermal resistance.

It is an object of the present invention to provide a construction in which the envelope can be made substantially entirely from soft metals of good thermal conductivity, such as copper and aluminum.

According to the invention, the envelope comprises at least two parts provided with facing press surfaces, grooves being formed in these surfaces the walls of which are substantially at right angles to the said surfaces, while between these surfaces there is interposed a layer of very soft metal which fills the grooves, one of the said two parts having a flanged rim which embraces the other part and presses and keeps the parts together. The term "very soft metal" is to be understood to mean a metal the hardness of which is less than 25 V.P.N. (Vicker's Pyramidal Number). In a preferred embodiment, the press surface of one part lies in a recess of the other part, a rim of this recess being designed as a flanged rim.

In order that the invention may readily be carried out, two embodiments thereof will now be described by way of example, with reference to the accompanying drawings, the two figures of which each are cross-sectional views of a transistor or a crystal diode, the semi-conductor bodies with the electrodes and the lead-in conductors being shown in block form for the sake of simplicity.

The envelope shown in FIG. 1 comprises a base **1** and a cover **2**. The base **1** is provided with a press surface located in a recess **3** in its rim constituting a flanged portion; in this recess, there is formed a groove **4** having substantially vertical walls. The cover **2** is provided with a flange **5** the lower side of which forms a press surface in which a groove **6** is formed. Between the two press surfaces there is interposed in the recess **3** a layer **7** consisting of a very soft metal, such as lead, tin or indium, for example in the shape of a ring. The layer may also be produced by melting a soft metal in the recess so that it spreads. Subsequently, the base **1** is laid on a table, there being arranged on the flange **5** of the cover a ram by which the press surfaces are pressed together with such pressure that the grooves **4** and **6** are entirely filled with the soft metal. Furthermore,

preferably during the application of this pressure, a flanged rim **8** made from the rim of the recess **3** is pressed over the flange **5** so that the parts **1** and **2** are hermetically joined together.

The envelope shown in FIG. 2 comprises a base **11** and a cover **12**. Two grooves **13** are formed along the rim of the base **11**. The cover **12** has a flange **14** in which two grooves **15** have also been formed. The parts of base and cover in which these grooves are formed again constitute the press surfaces between which a layer **16** of a very soft metal is interposed. These press surfaces have again been pressed together with a high pressure, a flanged rim **17** of the cover **12** being subsequently folded over the base **11**.

These constructions have the advantage that the layers of soft metal **7** and **16** may consist of a metal having a very slight mechanical strength; this layer ensures the vacuum-tight seal but the flanged rims **8** and **17** ensure the mechanical closure of the envelope.

An attendant advantage consists in that the base **1** or **11** and the cover **2** or **12** may be made of substantially any metal which otherwise fulfills the requirements to be satisfied by such envelopes. Both iron and copper or brass have proved highly suitable.

The provisions of the grooves **4**, **6** and **13**, **15** respectively has proved necessary for ensuring a vacuum-tight seal.

What is claimed is:

1. A semi-conductor device comprising a semi-conductive element, and a vacuum-tight, cold-pressed, metal envelope enclosing said element, said envelope comprising two metal members having outwardly-extending flanged portions with facing surface portions, each of said surface portions containing a groove whose walls are substantially at right angles to their respective surface portion, a separate layer of a very soft metal disposed completely between and cold-press-bonded to both of the facing surface portions and filling both grooves in the surface portions and forming a vacuum-tight bond to and between the metal members, said metal members at the facing surface portions being substantially undeformed by the bonding operation, and a further flanged portion of and integral with one of said metal members embracing a portion of the other member and permanently mechanically joining and holding them together.

2. A device as set forth in claim 1 wherein one of the metal members is flat, and the other is cup-shaped with a flanged bottom.

3. A semi-conductor device comprising a semi-conductive element, and a vacuum-tight, cold-pressed, metal envelope enclosing said element, said envelope comprising two thermally-conductive metal members, one of said metal members comprising a flat base member having an annular recess along its rim, the other metal member comprising a cup-shaped member with a flanged bottom portion seated in the recess and defining with the bottom wall thereof facing surface portions, each of said surface portions containing a groove, which opposes the groove in the other surface portion, whose walls are substantially at right angles to their respective surface portion, a separate annular layer of a very soft metal disposed in the recess completely between and cold-press-bonded to both of the facing surface portions and filling both grooves in the surface portions and forming a vacuum-tight bond to and between the metal members, said metal members at the facing surface portions being substantially undeformed by the bonding operation, and a further flanged portion of and integral with one of said metal members embracing a portion of the other member and permanently mechanically joining and holding them together.

4. A device as set forth in claim 3 wherein a corner portion defining the recess in the base member is flanged-

over and embraces the flanged bottom of the cup-shaped member.

5. A semi-conductor device comprising a semi-conductive element, and a vacuum-tight, cold-pressed, metal envelope enclosing said element, said envelope comprising two metal members having outwardly-extending flanged portions with facing surface portions, said metal members being of soft thermally-conductive metal, each of said surface portions containing a groove whose walls are substantially at right angles to their respective surface portion, said grooves being opposed to one another, a separate layer of a very soft metal disposed completely between and cold-press-bonded to both of the facing surface portions and filling both grooves in the surface portions and forming a vacuum-tight bond to and between the metal members, said metal members at the facing surface portions being substantially undeformed by the bonding operation, and a further flanged portion of and integral with one of the said members embracing a portion of the other member and permanently mechanically joining and holding them together.

6. A device as set forth in claim 5 wherein both metal members are of copper.

References Cited in the file of this patent

FOREIGN PATENTS

1,512,298	Mueller	Oct. 21, 1924
1,783,791	Hughes	Dec. 2, 1930
2,342,422	Morehead et al.	Feb. 27, 1944
2,701,483	Foxon et al.	Feb. 8, 1955
2,754,065	Hawley	July 10, 1956
2,763,708	Brennan	Sept. 18, 1956
2,777,974	Brattain et al.	Jan. 15, 1957
2,808,543	Cooper	Oct. 1, 1957
2,825,014	Willemse	Feb. 25, 1958
2,852,722	Noon	Sept. 16, 1958
2,932,684	Hales et al.	Apr. 12, 1960

FOREIGN PATENTS

243,668	Switzerland	Jan. 16, 1947