

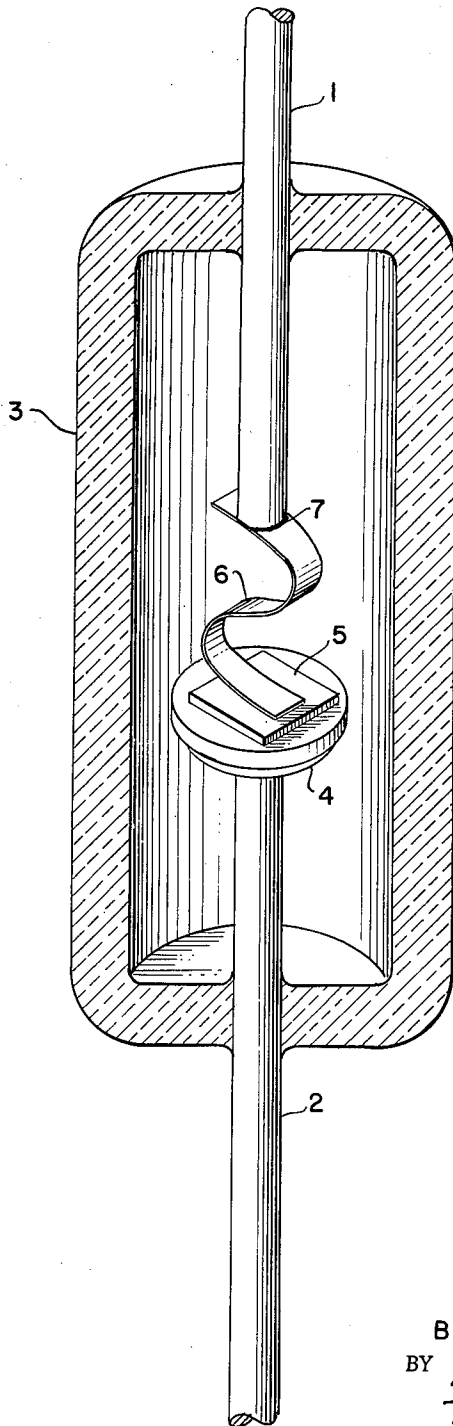
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SPRING CONTACT ELEMENT FOR SEMICONDUCTOR DIODES

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SPRING CONTACT ELEMENT FOR SEMI-
CONDUCTOR DIODES

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This invention relates to the art of electric or mechanical contacts and, more particularly, to an improved spring contact element that is adapted to be advantageously employed with semiconductor diodes.

There are various known types and forms of semiconductor diodes, such as glass-sealed silicon diodes. Accordingly and for the purposes of this application, the ensuing discussion and description and the accompanying drawing are directed to a diode of this type.

A typical silicon diode includes a glass envelope, a pair of electric leads or electrodes, namely a first electrode and a second electrode, which extend into the interior of the envelope, and a suitable silicon wafer or chip within the envelope, a first face of the silicon wafer being secured to the first electrode, usually by soldering. The diode also includes an electrically-conductive spring contact element which is positioned within the envelope intermediate the electrodes. One end of the spring contact element is affixed, preferably by welding, to the second electrode and the other end bears against and exerts pressure on a second face of the silicon wafer so as to form intimate contact with the silicon wafer.

The requirements for the spring contact element employed in a semiconductor diode include that it be resistant to corrosion and possess requisite stiffness and resiliency. Also, it is important that the temper of the spring contact element shall not be materially decreased and that the material of that element shall not oxidize appreciably in the course of fabricating the diode, including the step of subjecting its glass envelope to relatively high temperatures to effect fusion of the glass and sealing of the same to the electrodes.

Present day spring contact elements of the character mentioned above are usually made of a suitable platinum alloy. Among such alloys are an iridium-platinum alloy containing about 10% iridium and 90% platinum and a tungsten-platinum alloy containing about 8% tungsten and 92% platinum. While spring contact elements made of these alloys are generally satisfactory, they are quite expensive.

I have discovered that spring contact elements made of alloys consisting of certain proportions of palladium and one or more of the metals of group 6B of the periodic table of the elements, i.e. tungsten, molybdenum and chromium, are well suited for use in lieu of conventional spring contact elements made of alloys of iridium-platinum and tungsten-platinum in semiconductor diodes and other environments in which the latter compositions are now being used. Such tungsten-palladium, molybdenum-palladium and chromium-palladium alloys, and mixtures thereof possess requisite physical and electrical properties and characteristics which are essential for use as contact elements of the type indicated. Moreover, spring contact elements made of these alloys cost only about one third as much as corresponding contact elements made of the referred-to platinum base alloys. This is a very important factor as it materially reduces the total cost of a semiconductor diode as compared to that of a like diode employing a platinum base alloy as the material of its spring contact element.

Alloys of palladium with tungsten, molybdenum and/or chromium and certain properties and uses of such alloys are known in general. This is exemplified by

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K. Ruthardt et al. Patent No. 2,890,114, dated June 9, 1959, which discloses the use of such alloys as resistance elements of potentiometers. On the other hand, it has not heretofore been known that these alloys are suitable for use as spring contact elements and, as a consequence, result in substantial cost economies when so used.

I have ascertained that spring contact elements are entirely satisfactory for the indicated purposes when composed of an alloy of a metal selected from the group consisting, on a weight basis, of tungsten in the amount of 1% to 10%, molybdenum in the amount of 1% to 20% and chromium in the amount of 1% to 12%, the balance being palladium, and mixtures of these alloys. Such spring contact elements, when used in semiconductor diodes possess desired electric characteristics and physical properties including requisite stiffness and resiliency, despite being heated to a relatively high temperature in the course of being sealed within the glass envelope.

For best results, spring contact elements of this invention are preferably composed of an alloy of a metal selected from the group consisting, on a weight basis, of tungsten in the amount of 3% to 6%, molybdenum in the amount of 8% to 12% and chromium in the amount of 4% to 7%, the balance being palladium, and mixtures of these alloys.

It is within the purview of this invention to replace part of the palladium component of the above identified tungsten-palladium, molybdenum-palladium and chromium-palladium alloys and mixtures thereof with platinum in an amount up to about 50% of the indicated palladium content. Thus the spring contact element may be composed of an alloy of a metal selected from the group consisting, on a weight basis, of tungsten in the amount of 1% to 10%, molybdenum in the amount of 1% to 20% and chromium in the amount of 1% to 12%, the balance being palladium and platinum, the platinum component of this balance being in an amount up to about 50% of the total weight of the balance, and mixtures of these alloys.

Spring contact elements of this invention which contain both palladium and platinum are preferably composed of an alloy of a metal selected from the group consisting, on a weight basis, of tungsten in the amount of 3% to 6%, molybdenum in the amount of 8% to 12% and chromium in the amount of 4% to 7%, the balance being palladium and platinum, the platinum component of this balance being in an amount up to about 50% of the total weight of the balance, and mixtures of these alloys.

My spring contact elements, made of alloys of tungsten-palladium-platinum, molybdenum-palladium-platinum, and chromium-palladium-platinum, and mixtures thereof, also possess requisite physical and electrical properties and characteristics. Their only disadvantage, as compared to spring contact elements of corresponding alloys which are devoid of platinum, is that they are more costly, the increase in cost depending on the amount of platinum in a particular composition. On the other hand, these spring contact elements have the advantage of being considerably less expensive than spring contact elements which are made of the earlier referred-to tungsten-platinum and iridium-platinum alloys.

Accordingly, it is an important object of this invention to provide a spring contact element having requisite electrical and physical characteristics and properties for use in semiconductor diodes and the like, which contact element is made of an alloy that is considerably less expensive than present day alloys that are employed for the same or similar purposes. Another object of the invention is to provide an improved spring contact element of the character indicated that is reasonable in material and manufacturing costs and that is capable of performing

its intended functions in a dependable manner over an extended time period.

Certain aspects of the invention will be readily understood by persons trained in the art from the following: detailed description taken in conjunction with the accompanying drawing wherein a semiconductor diode, including a spring contact element of this invention, is shown in perspective and partly in cross section.

Referring to the drawing, the semiconductor diode illustrated therein comprises a pair of aligned and spaced electrodes, namely an upper electrode 1 and a lower electrode 2. The electrodes are made of suitable metal compositions, such as those which are presently available under the trade names "Dumet" and "Kovar." Both electrodes extend into and are hermetically sealed to a glass envelope 3 in the usual manner. The upper end of electrode 2 includes a platform or support 4 to which a semiconductor wafer or chip 5 is affixed, preferably by soldering. The semiconductor wafer is preferably made of silicon but may consist of any other suitable semiconductor material known to the art.

An electrically conductive spring contact element 6 is interposed between the lower end of electrode 1 and the upper face of silicon wafer 5 and is composed of a palladium base alloy earlier described. The spring contact element is of S-configuration and is made from a ribbon of at least one of the indicated palladium-containing alloys. The thickness and width of such ribbon depends on its intended specific use. For example, the spring contact element may be made from a ribbon of the selected alloy that is .003" in thickness by .018" in width for certain silicon diodes.

The upper end portion of spring contact element 6 is welded to the lower end of electrode 1, as indicated at 7. The parts are so constructed and arranged at the time of assembly that the lower end portion of the spring contact element bears against and exerts requisite pressure against the upper face of the silicon wafer so as to obtain desired yielding intimate contact between the contact element and the wafer.

From the foregoing, it is believed that the objects, advantages and utility of my present invention will be readily comprehended by persons skilled in the art without further description. While a specific embodiment of the invention has been shown and described to illustrate the application of the invention principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

I claim:

1. In a semiconductor diode, an electrically non-conductive envelope, first and second electrodes extending into the envelope, a member comprising a semiconductor material within the envelope, the first electrode being connected to a first face of the member, and a spring contact element within the envelope and composed of an alloy of a metal selected from the group consisting of tungsten in the amount of 1% to 10%, molybdenum in the amount of 1% to 20% and chromium in the amount of 1% to 12%, said amounts being on a weight basis, the balance of the alloy being palladium, one end portion of the contact element being secured to the second electrode, the other end portion of the contact element bearing against a second face of the member.

2. A semiconductor diode constructed as defined in claim 1 wherein the material of the spring contact element is a composite of at least two palladium alloys according to claim 1.

3. In a semiconductor diode, an electrically non-conductive envelope, first and second electrodes extending into the envelope, a member comprising a semiconductor material within the envelope, the first electrode being connected to a first face of the member, and a spring contact element within the envelope and composed of an alloy of a metal selected from the group consisting of tungsten in the amount of 3% to 6%, molybdenum in the amount of 8% to 12% and chromium in the amount of 4% to 7%, said amounts being on a weight basis, the balance of the alloy being palladium, one end portion of the contact element being secured to the second electrode, the other end portion of the contact element bearing against a second face of the member.

4. A semiconductor diode constructed as defined in claim 3 wherein the material of the spring contact element is a composite of at least two palladium alloys according to claim 3.

5. In a semiconductor diode, an electrically non-conductive envelope, first and second electrodes extending into the envelope, a member comprising a semiconductor material within the envelope, the first electrode being connected to a first face of the member, and a spring contact element within the envelope and composed of an alloy of a metal selected from the group consisting of tungsten in the amount of 1% to 10%, molybdenum in the amount of 1% to 20% and chromium in the amount of 1% to 12%, said amounts being on a weight basis, the balance of the alloy being palladium and platinum, the platinum component of the balance being in an amount up to about 50% of the total weight of the balance, one end portion of the contact element being secured to the second electrode, the other end portion of the contact element bearing against a second face of the member.

6. A semiconductor diode constructed as defined in claim 5 wherein the material of the spring contact element is a composite of at least two palladium platinum alloys according to claim 5.

7. In a semiconductor diode, an electrically non-conductive envelope, first and second electrodes extending into the envelope, a member comprising a semiconductor material within the envelope, the first electrode being connected to a first face of the member, and a spring contact element within the envelope and composed of an alloy of a metal selected from the group consisting of tungsten in the amount of 3% to 6%, molybdenum in the amount of 8% to 12% and chromium in the amount of 4% to 7%, said amounts being on a weight basis, the balance of the alloy being palladium and platinum, the platinum component of the balance being in an amount up to about 50% of the total weight of the balance, one end portion of the contact element being secured to the second electrode, the other end portion of the contact element bearing against a second face of the member.

8. A semiconductor diode constructed as defined in claim 7 wherein the material of the spring contact element is a composite of at least two palladium platinum alloys according to claim 7.

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