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SEMICONDUCTOR ASSEMBLING APPARATUS

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Fig. 1.

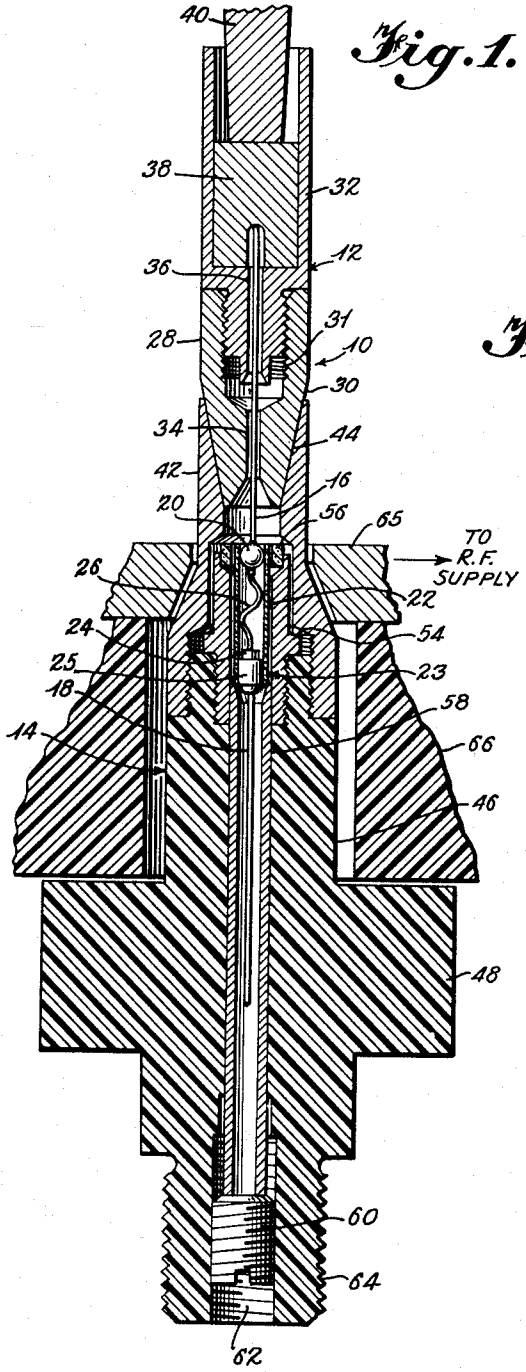
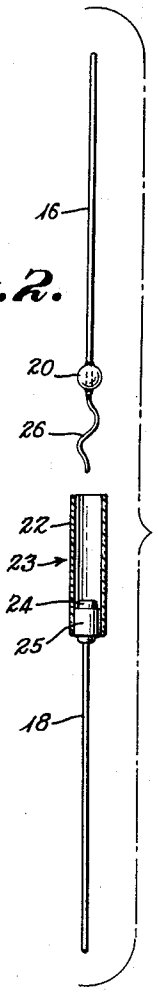


Fig. 2.



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SEMICONDUCTOR ASSEMBLING APPARATUS

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10 Claims. (Cl. 219—9.5)

This invention relates to improvements in semiconductor assembling apparatus and more specifically relates to a separable holder for holding a contact element and a semiconductor element and correctly positioning these elements relative to one another and to an apparatus for sealing the elements together.

In the manufacture of diodes and other semiconductor translators, it is common to mount one of the pair of elements, usually a semiconductor wafer, within a tubular glass envelope and locate a glass bead on the other element, usually the point contact element. The whisker element is adapted to fit within the end of the tubular glass member. It is usually the practice then to heat seal the edges of the bead within the tube by fusing after the elements have been assembled in proper relationship. This heating is customarily accomplished by indirect means, such as high frequency induction devices, although resistance heating is sometimes used. For RF heating, it is known to provide a conductive member adjacent the area of the glass envelope that is to be sealed. This member is heated to a high temperature by currents induced therein by the induction coil and transfers its heat to the glass envelope essentially by conduction to seal the bead within the glass envelope and thereby hermetically seal the semiconductor device.

In one known device for assembling semiconductors as described above, there is provided a graphite ring as the heat concentrating member within the field of the induction coil. Graphite is especially suitable for this purpose as it is highly conductive and will not adhere to the fused glass. The use of a graphite ring poses problems when it is subjected to air during use. Graphite quickly deteriorates from oxidation under these circumstances and, hence, the ring physically decays in a short time to the point where it is no longer usable. Moreover, the deterioration of the graphite ring, sometimes referred to as "flaking," has caused temperature control problems because it produces a decreased size of the radiating heating means with a proportional reduction of heat delivered. This necessitates a change in the time the RF energy is applied on nearly each diode assembly made. The present manner of coping with this problem is to increase both the size of the graphite ring and the distance between the graphite ring and the glass envelope. Thus, a decrease in the physical size by flaking will not produce as large a percentage change in the heat delivered to the glass envelope as when the graphite ring more closely surrounds the glass envelope. Thus greater stability is achieved in the time setting for applying the RF energy. However, in order to do this, the graphite ring must be larger and the amount of heat delivered therefrom must be greater. Thus, the problem of protecting the semiconductor wafer is much greater because the heating is not so well localized.

The present invention overcomes this difficulty by substantially reducing the flaking of the graphite ring thereby permitting the graphite ring to be much smaller and closer to the glass envelope. Hence, the heat delivered

is much more localized and the semiconductor wafer is not adversely affected. Stability in the time setting for the application of RF energy is also achieved.

This invention provides a means for prolonging the sealing life of the heating ring by providing a novel enclosing holder therefor. It was discovered that by enclosing the graphite ring within a holder, the ring will last through approximately two and a half times as many heating cycles as a ring which is not so enclosed.

Accordingly, it is a principal object of this invention to provide a separate holder for assembling semiconductors having an induction-heated heating ring, completely enclosed when the holder is assembled, for heating and fusing the glass areas of the envelope and bead to be joined.

A further object of this invention is to provide a separable holder having mating portions which provide a reference for positioning of the whisker and semiconductor element of a diode.

It is another object of this invention to provide an improved separable holder to aid in assembling and sealing a semiconductor assembly to produce a glass encapsulated semiconductive device wherein the holder has improved means for holding both the semiconductor element and the contact element.

It is an additional object of this invention to provide a separable holder having a surface which may be used as a reference point to position the holder correctly with respect to a high frequency induction coil and thus position an enclosed graphite ring directly adjacent the coil.

Other objects and advantages of this invention will be apparent from the following detailed description taken in connection with the accompanying drawing which discloses, by way of example, the principle of this invention and the best mode which has been contemplated of applying that principle.

In the drawing:

Figure 1 is a sectional elevation view of the holder of this invention shown assembled; and

Figure 2 is an exploded view partially in section of the semiconductor elements before they are assembled and sealed by the apparatus of Figure 1.

Referring to the drawing, the improved apparatus for assembling and sealing the diodes comprises a holder generally indicated by reference numeral **10** which is separable into an upper portion **12** and a lower portion **14**. The portion **12** is adapted to hold lead **16**, the assembly consisting of contact element **26**, and glass bead **20**, while the portion **14** is adapted to hold a subassembly indicated at **23** and consisting of lead **18**, semiconductor element **24** mounted on a molybdenum plug **25** which has previously been sealed within an envelope **22** as shown in Figure 2.

Also shown in Figure 2, the contact element or whisker **26** of the diode is connected to the end of a lead **16** on which is located a glass bead **20**. The assembly including the semiconductor element **24** includes glass tube **22** surrounding the semiconductor element **24** and a lead **18** attached to the plug **25**. The envelope is illustrated and described as being made of "glass" as a matter of convenience, but other equivalent materials may be substituted for the glass. The end of whisker **26** is correctly positioned by the holder of this invention in engagement with the top of the semiconductor element **24**.

The upper portion **12** of the holder **10** includes a mating section **28** having a tapered mating surface **30** and a threaded bore **31** into which is threaded a tube **32** constructed preferably of brass since it is noncorrosive and easy to machine. However, copper or steel may also be used. The tube **32** and the element **28** preferably have aligned axial holes **34** and **36** therein to allow the lead wire **16** of the contact element to extend there-

through. This wire 16 of the contact element is held by a suitable magnet 38 which is slidably mounted within the tube 32. A plunger or weight 40 or any other suitable biasing means may be utilized to assure that the magnet 38 is at the bottom of the tubular element 32 when the device is to be sealed. This assures the proper pressure being applied to element 26.

The lower portion 14 of the holder 10 has a mating element 42 with a tapered surface 44 adapted to mate with tapered surface 30 of the upper portion 12 of the holder and correctly positions the bottom and top portions 12 and 14 of the holder 10 with respect to each other. The mating elements 28 and 42 are preferably constructed of boron nitride or any other suitable material capable of withstanding a high thermal shock in the order of 2000° C. or more. Another suitable material for the mating elements 28 and 42 is a material known under the trademark of "Diamonite" which is made by Diamonite Products Manufacturing Co. of Canton, Ohio, a Division of United States Ceramic Tile Co. Another suitable material for the mating elements is "Mylar" which is a highly durable polyethylene terephthalate resin and which is a registered trademark of E. I. Du Pont de Nemours & Company of Wilmington, Delaware. Still another material which may be used for the mating surfaces is an alumina oxide ceramic material sold by American Lava Corporation of Chattanooga, Tennessee. All of these materials are characterized by the property of withstanding high thermal shock.

The mating element 42 is threadedly attached to a body element 46 which has a flange 48 thereon. Also threadedly attached within a bore in the upper end of body element 46 is an induction ring holder 54. This holder is generally tubular in shape and has an upper portion shaped to support an induction ring 56. This ring is preferably constructed of graphite although any conductive material that would concentrate the radio-frequency electrical energy and transfer the same to the glass without adhering thereto may be used. A tubular support 58 constructed of brass, copper or like material possessing high thermal conductivity is axially positioned within the body member 46 and has a threaded plug 60 on the lower end thereof for cooperating with a threaded bore 62 in the body element 46. By this means the tube 58 may be adjusted to position it axially with respect to the body. The glass tube of the semiconductor element of the diode is supported on the top of this tube as shown in Figure 1. The lower end of the body element 46 may have a threaded portion 64 on the periphery thereof for suitable cooperation in any desired type of support means.

A coil 65 connected to a suitable source of radio-frequency electrical energy is adapted to be positioned as shown in Figure 1 adjacent the graphite ring 56 and surrounding the holder. The coil 65 may be supported on body 66, and the flange 48 of the body member 46 may be utilized to position the holder 10 and the ring 56 carried therein with reference to the stationary coil after the holder has been assembled as shown in Figure 1.

It is believed that the operation of the device will be apparent from the foregoing description, however, a brief summary of the operation will now be given. With the members 12 and 14 separated, the lead wire 16 of the contact element is positioned within the upper portion 12 of the separable holder 10 and is held therein by the magnet 38. The subassembly 23 is positioned within the lower portion of the holder 14 while the portions of the holder 10 are separated. The holder portions 12 and 14 are then assembled and the mating surfaces 44 and 30 will correctly position the glass bead 20 within the top of the glass tube 22 with the whisker 26 in contact with the semiconductor element 24. As shown in Figure 1, the graphite ring 56 will be adjacent the area of the envelope to be sealed, i.e., the top of glass tube 22 and the glass bead 20. If it is desired to move the glass tube 22 this may be accomplished by adjusting the nut 60 within the threaded bore 62. The plunger 40 insures that the magnet 38 is resting against the bottom of the tube 32. Any suitable jig or clamping fixture may be used to insure that the holder portions are securely assembled. The holder is positioned such that the induction coil 65 surrounds the holder adjacent the induction ring 56. This may be accomplished by positioning the holder until top surface of flange 48 abuts a suitable mating surface on body 66.

After the holder has been correctly positioned, R.F. energy is applied to the coil 65 and this in turn heats the graphite ring by induction heating. The graphite ring becomes heated to a temperature of 2000–2500° C. and transfers its heat to the glass without sealing itself thereto. Furthermore, the envelope is only heated to a fusing temperature in the sealing region and the heat generated will not adversely affect the semiconductor material which is remote from the sealing region. The unusual result obtainable with the above disclosed holder is that by enclosing the heat concentrating ring within the holder and excluding air flow around the graphite ring, the average life of the ring has been extended from approximately 40 seals per ring to around 100 sealing operations per ring. Also the holder may be automatically loaded with the subassembly parts of the diode shown in Figure 2 thereby permitting mass production of the diodes.

The embodiment of the invention disclosed above is for the purposes of illustration only. It will be understood that the invention is susceptible to modifications, substitutions, and changes in form and details by one skilled in the art without departing from the spirit of the invention. Therefore, this invention is limited only by the scope of the appended claims wherein applicant is entitled to a reasonable range of equivalents.

What is claimed is:

1. An apparatus for assembling a semiconductor element and a contact element in proper engaging relationship and for enclosing same in an envelope, comprising a holder having a pair of separable portions, one of said portions adapted to hold a semiconductor element and part of an envelope and the other of said portions adapted to hold a contact element and the remaining part of the envelope, said portions provided with mating surfaces such that when assembled they will position the semiconductor element and contact element in proper engaging relationship and said portions will be engaged to enclose substantially the semiconductor element, contact element and envelope, an electrical coil adapted to supply high frequency electrical energy to said holder positioned around said holder adjacent the area of the joint between the envelope parts to be fused, and a heating member carried by one of said elements of said holder in a position adjacent the area of the joint between the envelope parts to be fused, said heating member being totally enclosed within said holder when the elements of said holder are assembled to accomplish the sealing operation.

2. An apparatus as defined in claim 1 wherein said heating member is a ring constructed of graphite.

3. A device as defined in claim 1 wherein the mating surfaces of said holder portions are tapered.

4. A device as defined in claim 3 wherein the holder portion adapted to hold the contact element carries a magnet for holding said element.

5. A device as defined in claim 4 wherein the holder portion adapted to hold the semiconductor element includes an adjustable support therein for adjustably positioning the semiconductor element within the holder portion.

6. A holder for holding the elements of a semiconductor diode and the parts of an encapsulating envelope and correctly positioning same in proper engagement, said holder comprising a pair of holder portions, said holder portions having mating elements such that when the ele-

ments of the diode and the parts of the envelope are held therein and the holder portions are assembled, the elements and parts will be positioned in proper engagement and the holder portions will be engaged to enclose substantially the diode and encapsulating envelope, and an annular heating member positioned within the holder adjacent the parts of the envelope at the area thereof to be fused, said annular member being constructed of a material adapted to be heated by induced RF currents and to transfer its heat to the envelope thereby sealing said envelope.

7. A device as defined in claim 6 wherein said holder has a reference surface for correctly positioning an RF induction coil adjacent the annular member.

8. A device as defined in claim 7 wherein said annular member is constructed of graphite and said mating elements of said holder portions are constructed of boron nitride and further wherein a magnet holding device is located in one of said holder portions.

9. A device as defined in claim 7 wherein said annular member is constructed of graphite and said mating elements of said holder portions are constructed of Mylar and further wherein a magnet holding device is located in one of said holder portions.

10. A device as defined in claim 7 wherein said annular member is constructed of graphite and said mating elements of said holder portions are constructed of an alumina oxide ceramic material and further wherein a magnet holding device is located in one of said holder portions.

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