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METHOD OF UNITING DISSIMILAR MATERIALS AND THE PRODUCT THEREOF

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Fig. 1.

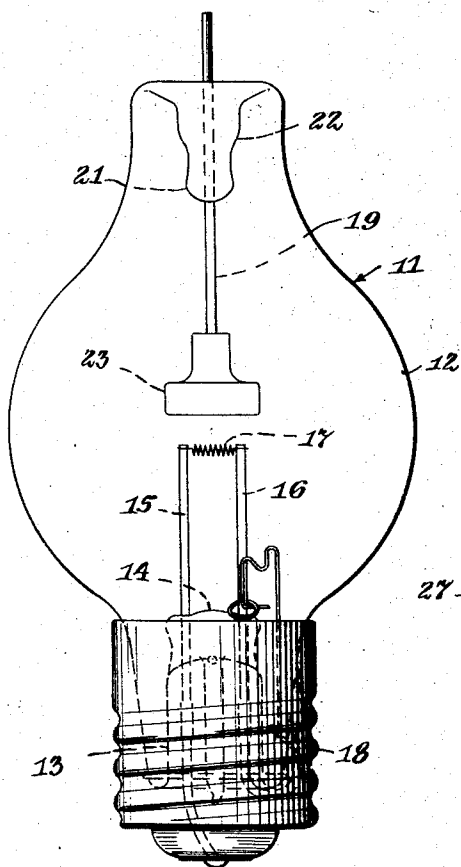


Fig. 2.

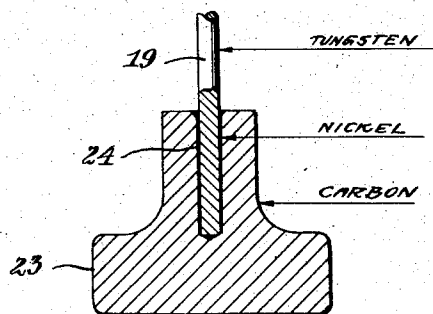
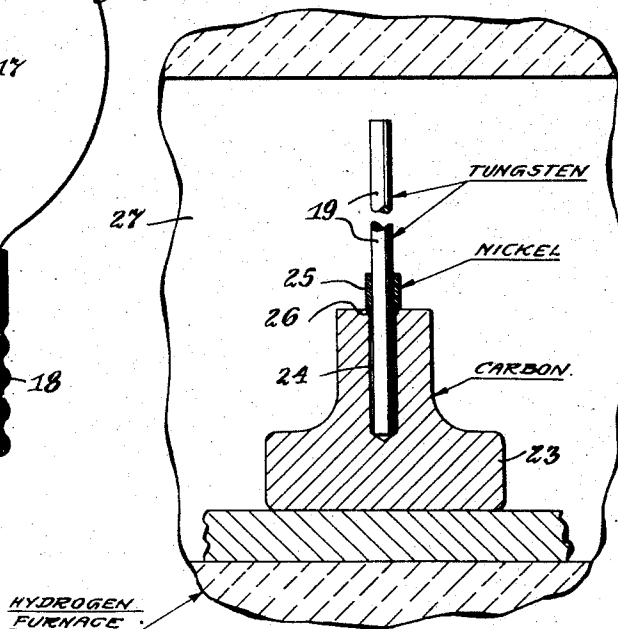


Fig. 3.



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## UNITED STATES PATENT OFFICE

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## METHOD OF UNITING DISSIMILAR MATERIALS AND THE PRODUCT THEREOF

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11 Claims. (Cl. 250—27.5)

This invention relates to a method of uniting dissimilar electrically conducting materials which cannot be conveniently welded together, and the product of such method.

The principal object of my invention, generally considered, is the production of composite articles and especially such which may be employed in electrical discharge devices, and thus capable of withstanding relatively high temperatures by uniting refractory electrode terminal portions to supports or leads by metal which is less refractory than either of the united portions.

Another object of my invention is the uniting of dissimilar electrically conducting materials which cannot be welded or soldered together in a conventional way.

A further object of my invention is the uniting of a metal to a non-metal by a more fusible metal.

A still further object of my invention is to unite a refractory metal to a refractory non-metal by a less refractory metal.

An additional object of my invention is to unite a metal to a refractory material or compound by a more fusible metal.

A specific object of my invention is to unite tungsten to carbon or graphite by nickel or other similar metal.

Another specific object of my invention is to unite an article formed of a refractory material such as boron carbide to a metal article formed of nickel or the like, by a more fusible metal such as copper.

Other objects and advantages of the invention, relating to the particular arrangement and construction of the various parts, will become apparent as the description proceeds.

Referring to the drawing illustrating my invention:

Figure 1 is an elevational view of a "rectigon" having an anode assembly constructed in accordance with my invention.

Figure 2 is a detailed sectional view of the anode assembly shown in Figure 1.

Figure 3 is a sectional view of a hydrogen furnace in which the parts of the anode assembly are disposed for uniting them.

Referring to the drawing in detail, like parts being designated by like reference characters, there is shown a gas-filled rectifier, called a "rectigon," 11, comprising a transparent envelope 12, of glass or similar vitreous material, having a flare tube 13 forming a re-entrant portion provided with a press 14. From the press extend

lead-in conductors 15 and 16, between which is mounted a coil of tungsten wire 17, adapted to form an incandescible cathode. The tube 12 is provided with a screw base 18 of conventional construction.

The other end of the tube 12 has a rod or wire forming a lead-in conductor or electrode support 19 extending through the press 21 of a re-entrant portion 22 thereof. The inner end of the lead 19 has an enlarged member 23 attached thereto, to function as an anode and thereby complete the rectifier assembly.

In the present embodiment the anode member 23 is desirably formed of carbon or graphite and has a cavity 24 formed therein in which the lead-in conductor 19, desirably formed of tungsten, is loosely fitted. The cavity 24 is desirably formed .002" greater in diameter than the tungsten supporting lead 19. This makes the assembly easy while insuring correct alignment.

A preferred method of uniting the tungsten lead 19 to the graphite anode 23 is to fill the space between the tungsten support 19 and the anode 23 with nickel or similar metal which will withstand the relatively high temperatures to which the device is to be subjected in use, said nickel being applied in a molten state in order to fill the pores of the articles to be united and cause a secure mechanical connection, and an electrical union of high conductivity.

The application of the uniting or "soldering" nickel to the assembly, is desirably accomplished by fitting one or two rings 25, of preferably pure nickel, closely about the tungsten lead 19, as shown in Figure 3, and disposing it so that the lower edge 26 either slightly enters or is disposed close to the cavity 24. The assembled parts are then disposed in a hydrogen furnace 27 as shown in Figure 3, and heated to a temperature of about 1500° C. for a period of time long enough to allow the nickel to melt. The nickel or similar metal, upon melting, flows down into the cavity 24, as shown in Figure 2, and causes a tight mechanical and electrical union between the tungsten support 19 and the graphite electrode 23, as shown in Figure 2.

Such an assembly may be used in "rectigons" or other electrical devices which have an operating temperature of not more than 1400° C., for example, between 1050° and 1400° C.

Although I have disclosed, as a preferred embodiment, an electrode assembly comprising a graphite anode held on a tungsten lead or support, it will be understood that the anode or other electrode may be formed of tungsten or other

desired material and the lead formed of a different material.

It will also be understood that I am not limited to the use of nickel for uniting tungsten to carbon or graphite, but may use copper or other metal, provided it does not fuse at the operating temperature of the electrical device with which employed.

It will also be understood that I may use a similar process for uniting a refractory carbide, such as boron carbide with a metal such as nickel, serving to conduct current thereto, as by fitting a rod of boron carbide in a cavity in a nickel lead to mount the same for use as an igniter in a mercury-pool rectifier.

Such a method would consist in placing a rod of boron carbide, or similar igniter material, in a hole drilled in nickel, tungsten, or other metal or graphite stud. A ring (like the ring 25) of copper, nickel or other metal having a lower melting point than that of the stud, is then placed around the boron carbide, or other rod, like the showing in Figure 3, and the assembly then placed in an upright position and heated in a furnace in an atmosphere of hydrogen, nitrogen or other suitable gas, to a temperature above the melting point of the ring material. The ring will then melt and the molten material run into the cavity in the stud, which serves to support the rod, and fill the space around the rod. The molten material, upon cooling, forms a bond between the carbide or the like and the supporting device, with the production of a joint having great mechanical strength and high electrical conductivity.

Although preferred embodiments of my invention have been disclosed, it will be understood that modifications may be made within the spirit and scope of the appended claims.

I claim:

1. The method of making an anode assembly suitable for use in an electrical discharge device, comprising loosely fitting a supporting rod of tungsten into a cavity in a graphite electrode, placing a ring of nickel around said rod adjacent said cavity, and heating the assembly in a protective atmosphere until the ring melts and the nickel flows into the space in the electrode cavity around said rod.

2. The method of uniting a refractory metal to a refractory conductive non-metal to make an electrode assembly suitable for use in an electrical discharge device, comprising forming an upwardly opening cavity in an electrode of said non-metal, fitting a rod of said metal into said cavity, placing a ring of a less refractory metal around said rod adjacent said cavity, said ring comprising metal solid at temperatures prevailing in such a device during operation, and heating the assembly in a protective atmosphere until the ring melts and the metal thereof flows into the space in said cavity around said rod.

3. The method of uniting tungsten and graphite, comprising forming an upwardly opening aperture in a body of one of said materials, loosely fitting a rod of the other material in said aperture, placing a ring of nickel around said rod adjacent said aperture, placing the assembly in a furnace, and heating in a protective atmosphere until the nickel melts and flows into said cavity around the rod portion received therein, whereupon the parts are firmly united upon cooling.

4. A rectifier comprising a transparent gas-filled envelope, an incandescible cathode and an

associated anode, said anode comprising a graphite element having a cavity, a rod of tungsten loosely fitting in said cavity, and nickel fused and filling the space in said cavity around the received end portion of said rod, said rod passing through said envelope as a lead-in conductor and support for the graphite member.

5. The method of uniting tungsten and graphite comprising forming an upwardly opening aperture in a body of graphite, fitting a rod of tungsten in said aperture with a small clearance therebetween, placing a ring of nickel fitting closely around said rod adjacent said aperture, and heating said assembly in a protective atmosphere until the nickel melts and flows into said aperture round said rod.

6. In an electrical discharge device, an exhausted envelope, and a composite electrode assembly therein comprising a graphite element having a cavity, a rod of tungsten fitting in said cavity with a slight clearance, and nickel fused and filling the space in said cavity around said rod and firmly uniting the parts.

7. The method of uniting dissimilar electrically conducting materials, comprising forming an upwardly opening aperture in a body of one of said materials, fitting a rod of the other material in said aperture with a small clearance therebetween, placing a ring of metal having a melting point in the neighborhood of that of nickel, fitting closely around said rod adjacent said aperture, and heating said assembly in a protective atmosphere until the ring melts and the metal thereof flows into the cavity around said rod.

8. An electrical discharge device comprising a transparent envelope from which the air has been exhausted, a pair of electrodes, at least one of said electrodes comprising a graphite element having a cavity, a rod of tungsten loosely fitting in said cavity, and nickel fused and filling the space in said cavity around the received end portion of said rod, said rod passing through said envelope as a lead-in conductor for the graphite member.

9. A discharge device comprising a transparent envelope from which the air has been evacuated, a pair of electrodes, at least one of said electrodes comprising an electrically conductive element having a cavity, a rod of a dissimilar electrically conductive material loosely fitting in said cavity, and metal having a melting point of about the order of that of nickel fused and filling the space in said cavity around the received end portion of said rod, said rod passing through said envelope as a lead-in conductor and a support for the element to which it is connected.

10. The method of uniting metal to boron carbide to make an electrode assembly suitable for use in an electrical discharge device, comprising forming an upwardly opening aperture in a body of one of said materials, fitting a rod of the other material in said aperture with a small clearance therebetween, placing a ring of less refractory metal around said rod adjacent said cavity, said ring comprising metal solid at temperatures prevailing in such a device during operation, and heating the assembly in a protective atmosphere until the ring melts and the metal thereof flows into the space in said cavity around said rod.

11. A discharge device comprising a transparent envelope from which air has been evacuated, a pair of electrodes, at least one of said electrodes comprising an electrically conductive element having a cavity, a rod of a dissimilar elec-

trically conductive material loosely fitting in said cavity, one of said telescoping elements being formed of boron carbide and the other of metal, and another metal less refractory than said first mentioned metal, but solid at temperatures prevailing in such a device during operation, said other metal having been fused and filling the

space in said cavity around the received end portion of said rod, one of said conductive elements passing through said envelope as a lead-in conductor and support for the element to which it is  
5 connected.

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