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DISPERSED GETTER ELEMENT AND METHOD OF MANUFACTURE THEREOF

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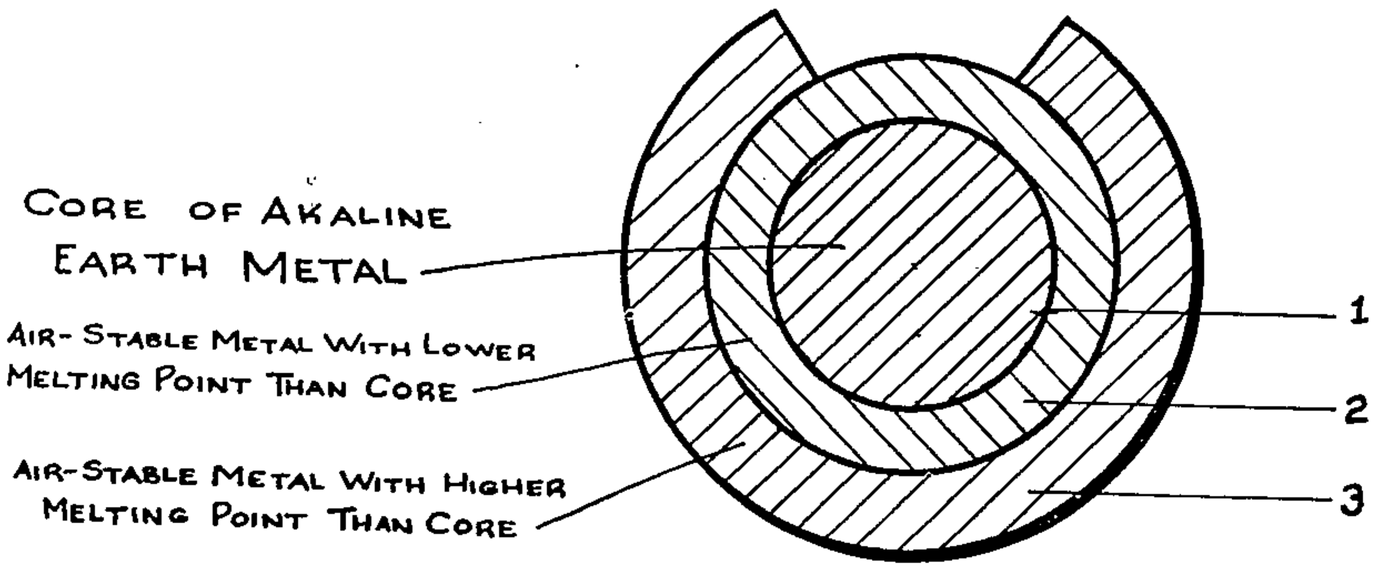

FIG. 1.

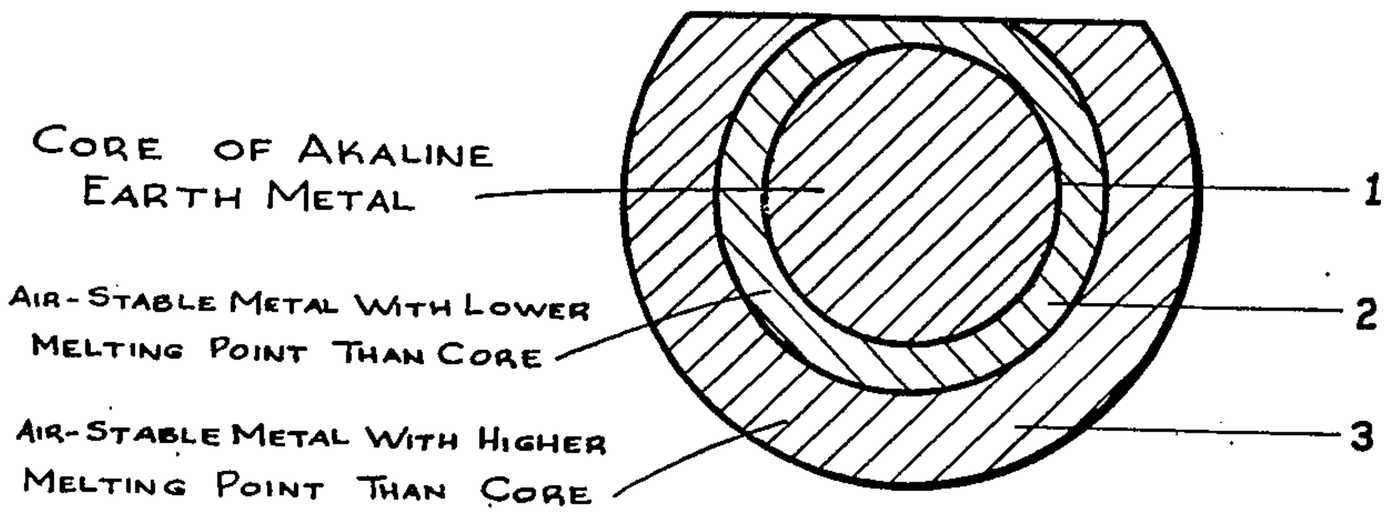

FIG. 2.

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DISPERSED GETTER ELEMENT AND METHOD OF MANUFACTURE THEREOF

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The present invention relates to dispersed getter elements and to methods of manufacture thereof.

Getters are commonly used for assisting in the production of a high vacuum, for example in the envelope of an electric discharge device such as a thermionic valve during the manufacture of the device. Dispersed getter elements consist at least in part of a quantity of getter material which is volatilised inside the envelope after this has been evacuated to a certain degree, the getter material during and after its volatilisation serving to absorb gas residues left in the envelope.

It has previously been proposed to use dispersed getter elements consisting of a length of a compound wire composed of a core of getter material, such as metallic barium, provided with an outer shell or sheath of a metal, such as nickel, which is more inert to dry and moist air at ordinary temperatures and is less volatile in a high vacuum than the core, and has a melting point at least as high as nickel. Such getter elements are not entirely satisfactory however for use in relatively small envelopes, because the amount of getter material required is such that the wire is of very small diameter. The effect of this is that when the getter is fired, usually by eddy-current heating, the getter material has only a very small opening at each end of the wire through which to volatilize. For this reason the getter element must be heated for an appreciable time, and there is a tendency for the getter material most distant from the ends of the element to alloy when molten with the outer shell. Moreover in a small envelope difficulty is experienced in mounting the getter element so that the volatilization from both ends does not result in deposition on electrodes contained in the envelope. To overcome these disadvantages it has been proposed to thin down a portion of the periphery of the outer shell along the length of the getter element, so that the reduced-portion of the outer shell is sufficiently thin for the getter material, when heated, to diffuse through the reduced portion of the shell and volatilize onto the envelope of the device. With this arrangement the end openings in the outer shell are preferably closed during the operations of cutting the wire into suitable lengths or of mounting the getter element, so that the vapour of the getter material will travel in a predetermined general direction upon volatilization, thereby enabling the getter element to be positioned so that the volatilized material is deposited upon a desired area

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of the envelope, and not upon electrodes contained in the envelope.

This last arrangement, however, itself suffers a disadvantage in that the thickness of the reduced portion of the outer shell must be so small that it is difficult in manufacture to maintain this dimension within the necessary tolerances, so that during manufacture the outer shell may be punctured thereby exposing the getter material to the air, or the reduced portion may be left too thick for the getter material to be able to diffuse through the shell.

One object of the present invention is to provide improved dispersed getter elements which are less prone to suffer from the above mentioned disadvantages.

A further object of the present invention is to provide a method of manufacture of such improved getter elements.

According to the present invention a dispersed getter element comprises a core of an alkaline earth metal, an inner sheath surrounding the core, said inner sheath being of a metal which is stable in air and has a lower melting point than the alkaline earth metal, and an outer sheath having an aperture therein and surrounding the inner sheath, said outer sheath being of a metal which is stable in air and has a higher melting point than the alkaline earth metal. Thus in one form the getter element may consist of a portion of wire, the metals comprising the inner and outer sheaths being sufficiently ductile to be capable of being drawn into wire. Preferably the core is of barium, the inner sheath is of aluminium, and the outer sheath is of iron.

According to a feature of the invention, a method of manufacturing dispersed getter elements comprises the steps of enclosing a rod of an alkaline earth metal in a tube of a ductile metal which is stable in air and has a lower melting point than the alkaline earth metal, drawing down the tube and rod into a wire, enclosing the wire in an outer sheath by rolling around the wire a strip of a ductile metal which is stable in air and has a higher melting point than the alkaline earth metal, the width of the strip being such that after the rolling process there is left in the outer sheath a gap which extends substantially parallel to the axis of the wire, and, finally, cutting the sheathed wire into predetermined lengths. If necessary or desirable, the further step of drawing the sheathed wire through a wire-drawing die may be included immediately after the rolling process.

According to a further feature of the inven-

tion, a second method of manufacturing dispersed getter elements comprises the steps of enclosing a rod of an alkaline earth metal in a first tube of a ductile metal which is stable in air and has a lower melting point than the alkaline earth metal, enclosing the first tube in a second tube of a ductile metal which is stable in air and has a higher melting point than the alkaline earth metal, drawing down the tubes and rod into a wire, cutting away a portion of the outer sheath of the wire to leave in the outer sheath a gap which extends substantially parallel to the axis of the wire so that a portion of the inner sheath of the wire is uncovered, and, finally, cutting the wire into predetermined lengths.

It is to be understood that throughout this specification the term "metal" includes an alloy.

The getter is fired by heating to a sufficient temperature to melt the uncovered portion of the inner sheath, so that on further heating the core volatilizes and the vapour produced escapes through the aperture in the outer sheath.

Two embodiments of the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which Figures 1 and 2 show cross-sections of two different dispersed getter elements suitable for use in thermionic valves.

Referring to the drawings, in each embodiment the getter element is constituted by a length of composite wire consisting of a core **1** of metallic barium, an inner sheath **2** of aluminium which surrounds the core **1**, and an outer sheath **3** of iron which surrounds the aluminium sheath **2**. In each case the iron sheath **3** has a longitudinal gap in which a portion of the aluminium sheath **2** is uncovered.

The method of manufacturing the getter element illustrated in Figure 1 is as follows. Barium is first melted in vacuo, is allowed to solidify, and is then extruded at a temperature slightly below its melting point into the interior of a glass tube closed at one end. The extruded rod is then slid into a tube of substantially pure aluminium in which it is a sliding fit, and the tube containing the rod is then drawn down in wire-drawing dies to produce a wire of the desired diameter, which will be determined by the quantity of barium required in a given length of wire.

The cross section of the wire at this stage is the same as that of the core **1** and inner sheath **2** of the final getter element shown in Figure 1. The wire is enclosed in an iron sheath in the following manner. A strip of iron, whose width is somewhat less than the circumference of a cross-section of the aluminium-barium wire, is first pulled through a pass consisting of two rollers, one of which is grooved and the other of which has a convex surface co-operating with the groove in the first roller to deform the strip so that its cross-section is substantially semicircular. The strip is then pulled through a second pass consisting of two grooved rollers mounted with their axes perpendicular to those of the first pair of rollers, the aluminium-barium wire being fed in at this stage from the open side of the deformed strip so that the wire is provided with an iron sheath by rolling the strip round it. Owing to the relationship between the width of the original iron strip and the circumference of a cross-section of the wire, a gap is left in the iron sheath extending substantially parallel to the axis of the wire. If the iron strip is resilient it may be necessary or desirable to draw the sheathed wire through a wire-drawing die after the rolling process to ensure that the iron sheath grips the wire firmly. It will be appreciated that the whole rolling process and any subsequent wire-drawing are preferably carried in one continuous operation. The compound wire finally formed is cut up into predetermined lengths to provide the individual getter elements as shown in Figure 1.

The method of manufacture for the getter element illustrated in Figure 2 is as follows:

Barium is melted in vacuo, allowed to solidify, and extruded at a temperature slightly below its melting point into the interior of a glass tube closed at one end. The extruded rod is then slid into a tube of substantially pure aluminium in which it is a sliding fit, and the tube containing the rod is then drawn down in wire-drawing dies until the rod is firmly gripped by the reduced tube. The combined rod and tube are then slid into an iron tube and the drawing down is continued to obtain a wire of the desired diameter, which will be determined by the quantity of barium required in a given length of wire. The wire is then drawn past a cutting tool which removes a portion of the iron and aluminium sheaths to leave a planar surface on a portion of the periphery of the wire, which surface consists of a longitudinal strip of aluminium flanked on either side by a longitudinal strip of iron. The wire is then cut up into suitable lengths to provide the individual getter elements as shown in Figure 2.

In use the getter elements are spot-welded by their ends to the ends of a wire stirrup, by which they can be supported in a desired position by attaching the stirrup to a supporting member provided in the envelope. The spot-welding preferably serves to close the open ends of the wire. To fire the getter, the getter element and its stirrup which form a closed turn are heated by eddy-current heating. As the temperature of the getter element rises, as a result of the heating, the portion of the aluminium sheath **2** in the longitudinal gap in the iron sheath **3** melts first and alloys with the barium core, so that with further increase in temperature the barium core **1** volatilizes, the vapour escaping through the gap in the iron sheath **3** and being deposited on the desired area of the interior surface of the envelope.

It will be appreciated that when the aluminium in the longitudinal gap melts and alloys with the barium, there is a relatively large opening for the subsequent escape of the vapour, so that the time for which the getter element is maintained at a temperature above the melting point of barium can be relatively small. Moreover the vapour will travel in a predetermined general direction. At the same time getter elements according to the present invention do not have to be manufactured with such small tolerances on the minimum thickness of the sheath as are necessary in the form of getter element previously proposed having a single sheath, for the reason that the exposure of the getter material results from the lower melting point of the inner sheath **2** rather than the fact that a portion of the sheath is thinner. It is however preferred to keep the amount of the low melting point metal in the longitudinal gap to a minimum without making the manufacturing tolerances undesirably small, in order to avoid an excess of the fused metal.

It will be appreciated that while in the above described embodiments it is preferred to use aluminium for the inner sheath 2, other metals or alloys may be used, for example aluminium alloys or tin, provided that they are sufficiently ductile to be drawn down into wire. Moreover other metals or alloys than iron, for example steel, nickel or copper may be used for the outer sheath 3, provided that they are sufficiently ductile to enable the drawing down or rolling process to be successfully carried out as the case may be. The alkaline earth metals strontium and calcium may be used in place of barium for the core 1. It will of course be understood that the materials used for the inner and outer sheaths 2 and 3 should not be such as to cause any adverse effects in the envelope to be evacuated; in particular they should not be such as to affect adversely the operation of the getter itself.

We claim:

1. A dispersed getter element comprising a core of an alkaline earth metal, an inner sheath surrounding the core, said inner sheath being of a metal which is stable in air and has a lower melting point than the alkaline earth metal, and an outer sheath having an aperture therein and surrounding the inner sheath, said outer sheath being of a metal which is stable in air and has a higher melting point than the alkaline earth metal.

2. A dispersed getter element according to claim 1, said getter element being in the form of a compound wire.

3. A dispersed getter element according to claim 1, in which the core is of barium.

4. A dispersed getter element according to claim 1, in which the inner sheath is of aluminium.

5. A dispersed getter element according to claim 1, in which the inner sheath is of an aluminium alloy.

6. A dispersed getter element according to claim 1, in which the inner sheath is of tin.

7. A dispersed getter element according to claim 1, in which the outer sheath is of iron.

8. A dispersed getter element according to claim 1, in which the outer sheath is of steel.

9. A dispersed getter element according to claim 1, in which the outer sheath is of nickel.

10. A dispersed getter element according to claim 1, in which the outer sheath is of copper.

11. A dispersed getter element according to claim 1, in which the core is of barium, the inner sheath is of aluminium, and the outer sheath is of iron.

12. A method of manufacturing dispersed getter elements such as set forth in claim 1 comprising the steps of enclosing a rod of an alkaline earth metal in a tube of a ductile metal which is stable in air and has a lower melting point than the alkaline earth metal, drawing down the tube and rod into a wire, enclosing the wire in an outer sheath by rolling around the wire a strip of a ductile metal which is stable in air and has a higher melting point than the alkaline earth metal, the width of the strip being such that after the rolling process there is left in the outer sheath a gap which extends substantially parallel to the axis of the wire, and, finally, cutting the sheathed wire into predetermined lengths.

13. A method of manufacturing dispersed getter elements according to claim 12, including the step of drawing the sheathed wire through a wire-drawing die immediately after the rolling process.

14. A method of manufacturing dispersed getter elements according to claim 12, in which the rod is of barium, the tube is of aluminium, and the strip is of iron.

15. A method of manufacturing dispersed getter elements such as set forth in claim 1 comprising the steps of enclosing a rod of an alkaline earth metal in a first tube of a ductile metal which is stable in air and has a lower melting point than the alkaline earth metal, enclosing the first tube in a second tube of a ductile metal which is stable in air and has a higher melting point than the alkaline earth metal, drawing down the tubes and rod into a wire, cutting away a portion of the outer sheath of the wire to leave in the outer sheath a gap which extends substantially parallel to the axis of the wire so that a portion of the inner sheath of the wire is uncovered, and, finally, cutting the wire into predetermined lengths.

16. A method of manufacturing dispersed getters according to claim 15, in which the rod is of barium, the first tube is of aluminium, and the second tube is of iron.

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