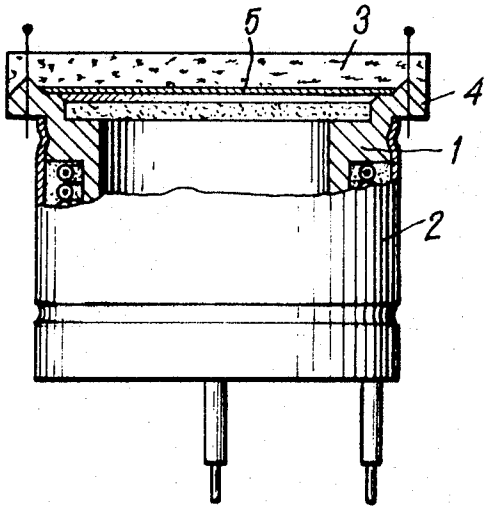
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SUPPLY CATHODE FOR ELECTRICAL DISCHARGE VESSELS AND METHOD FOR ITS PRODUCTION

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SUPPLY CATHODE FOR ELECTRICAL DISCHARGE VESSELS AND METHOD FOR ITS PRODUCTION

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ABSTRACT OF THE DISCLOSURE

The method of producing a dispenser type cathode comprising forming an emission substance supply container and a porous disk that seals the container, applying a layer of a hydroxide that is thermally convertible to a corresponding oxide on a face (which may have portions thereof masked) of the carrier disk, thermally converting the hydroxide to the corresponding oxide, filling the supply container with an emission substance and sintering the carrier disk onto the supply container with the coated inner face thereof adjacent the emission substance.

The invention relates to a method of producing a dispenser type cathode for electrical discharge vessels.

Dispenser type cathodes are known wherein, generally, emission substances travel from a supply of an emission substance through fine apertures of a porous emission substance carrier disk to the cathode surface. Such known cathode structures generally comprise, a means forming a supply chamber having disposed therein a supply of an emission substance (consisting mainly of barium oxide), with the chamber having an opening for admission of the emission supply substance. A porous sintered member composed of a highly melting metal covers the chamber opening and has an inner face adjacent the supply of emission substances coated with a thin layer of aluminum oxide to effect uniform distribution of the emission substances to the cathode surface.

It has been extremely difficult to satisfactorily produce the dispenser type cathode described hereinabove, particularly the satisfactory application of the aluminum oxide powder onto a face of the sintered porous cover member. Aluminum oxide powder is relatively coarsely granulated in comparison with the pore size of the sintered porous cover member. Consequently, insufficient adhesion between the aluminum oxide particles and the porous surface results, especially after the thermal decomposition of the binder utilized to apply such aluminum particles. This phenomenon is further aggravated when, in addition to the decomposition of the binder, interfering decomposition products are also produced. Such interfering decomposition products further reduce the adhesiveness of the aluminum oxide particles.

Further, dispenser cathodes of this type have a relatively small diameter emission carrier disk (i.e. the porous sintered cover member) which must be thermally attached (as by welding or soldering) to various elements after the disk has been positioned on top of the supply container. The relatively high heat necessary to attach such various elements to the positioned disk causes at least a portion of the aluminum oxide layer on the inner face thereof to melt, causing highly unsatisfactory operation of the cathode.

In accordance with the principles of the present invention, the above described disadvantages and difficulties are overcome by utilization of a higher melting oxide layer on the inner face of the emission disk and/or by utilization of an especially fine substance that can easily be applied as a tightly adherent layer on the inner face of the emission disk and thermally converted to form a coating of extremely fine granulated oxide particles firmly adhering to the inner face.

The single figure on the drawing is an elevational view, parts broken away for sake of clarity, of a preferred embodiment of the dispenser cathode constructed in accordance with the principles of the invention.

Generally, the invention provides a hydroxide coating material for the inner face of an emission carrier disk of a dispenser type cathode (as previously described) which thermally convertible into fine sized corresponding oxide particles. Sintered or melted and pulverized particles, of for example aluminum oxide, (such as utilized for heat insulation) have a particle size distribution of 1 to 30μ, with the average size being about 7μ and about 5% being above 15μ. The best commercially available particles have an average particle size of about 2μ. In contrast to this, the pores of a sintered emission disk (composed of for example tungsten) have a maximum diameter of about 1μ and an average diameter of about 0.25μ.

Hydroxides, for example aluminum hydroxide, are generally colloidal gels and have minute particles whose size is usually below about 0.01μ. As will be appreciated, such coloidal gel particles may conglomerate into more or less mucilaginous flake-like particles, which retain a substantial degree of plasticity. These gel particles and conglomerates thereof easily penetrate at least the pores on the peripheral surface of the emission carrier disk and clog or fill the same. As a result of this limited penetration by the hydroxide particles into the pores at or directly below the peripheral surface of the emission disk, no further or deeper penetration of the hydroxide particles takes place. Such deeper penetration would completely clog the emission disk pores throughout its cross-section. The penetration achieved with the hydroxide particles is generally to a depth of about 1μ. The relatively voluminous hydroxide gel particles are thermally converted, after penetration into the relatively large emission disk pores, into extremely fine sized particles of the corresponding oxide. In this manner, the relatively large emission disk pores are subdivided into smaller pores that are approximately of a homogeneous size. This unique manner of effectively equalizing the pore size of the emission disk effectively regulates the emission substance (for example, barium) evaporation during the operation of the cathode.

Further, it has now been discovered that an additional advantage of impregnating pores with microporous particles resides in the surface properties of such microporous particles. Apparently, these microporous particles, because of their rough surface structure, exhibit a repelling effect on liquid metals and are therefore not wetted by solder metals thereby effectively preventing the penetration of such liquid solder metals into the emission disk. In other words, during the soldering process, the wetting action only occurs at the edges of the surface pores and at the partition walls of the emission disk.

It is therefore advantageous to apply the hydroxide layer to the emission disks before soldering the disk to the supply chamber container and before thermally decomposing or sintering the hydroxide layer on the disk. The hydroxide layer, which is applied as a coating on a surface or face of the emission carrier disk, simultaneously functions as a means of regulating emission substance (i.e. barium) evaporation and as a protective means preventing impregnation of liquid solder into the pores of the emission disk during the soldering process. Alternatively, the preselected portion of the porous emission carrier disk which are to be soldered may be covered with a correspondingly shaped mask or an easily removed

layer of, for example, nitrocellulose, polyacrylic ester, silicon polymer or a similarly easily de-polymerizable (or decomposable) plastic. However, in instances where a hydroxide layer is utilized as a protective means, it can easily be mechanically removed from the preselected portion of the porous emission carrier disk so that the hydroxide remaining in the interior of the pores functions to prevent penetration of the solder material.

In order to more fully exemplify dispenser cathodes produced in accordance with the principles of the invention, the figure in the drawing illustrates a preferred form of a dispenser cathode. The dispenser cathode comprises a pot-shaped supply container **1** which is encased and surrounded by a cathode shell **2**. The supply container **1** has an upwardly disposed opening covered by an emission or carrier disk **3** which is composed of a sintered porous high-melting metal, such as tungsten. The carrier disk **3** is tightly joined to the supply container **1** at matching flanges **4**. The inner face of the carrier disk **3** is covered with a thin layer **5** of an oxide which has been thermally produced from its corresponding hydroxide as explained hereinbefore.

As indicated hereinbefore, in known dispenser cathodes of the type described, the soldering of the emission disk to the supply container is effected after placement of the emission supply substance in a supply container and penetration of the solder occurs in the pores of the emission disk. This penetration apparently results because the heat generated by the soldering process cannot be dissipated fast enough and the melting point of the aluminum oxide is attained, causing it to melt and allow the penetration to take place. In accordance with the principles of th invention, layers of oxides having higher melting points are utilized to coat the inner face of an emission disk. Such oxides include BeO, MgO, ZrO_2, HfO_2 and the like. These higher melting substances are applied as hydroxides and are thermally converted into the corresponding oxides and sintered as indicated hereinbefore. The behavior of these higher melting oxides in respect to the emission substance, i.e. barium, is substantially analogous to that of aluminum oxide, so that during the operation of such a cathode structure, a solid-state reaction occurs at the emission disk coating to produce materials corresponding to the aluminates. As a consequence of the effective equalization of the pore diameters of the emission disk (which are coated with hydroxides of such higher melting materials, and then thermally converted to the corresponding oxides) effective regulation of emission substance evaporation is also achieved.

Alternatively, cathodes operating at low temperatures and not utilizing high melting solder metals may also be provided in accordance with the principles of the invention. These cathodes generally comprise, for example, thin layer oxide cathodes with an emission substance (barium) supply behind the emission disk such as in a MK-cathode with a barely visible emission substance supply (i.e. barium oxide) layer on the emission disk. The aluminum oxide layer on these emission disks can be advantageously replaced with oxides having a lower melting point, such as TiO_2, ThO_2, V_2O_4, Nb_2O_3, Nb_2O_5, etc. Of course, these lower melting oxides are applied in their hydroxide form and are thermally converted into their corresponding oxide. The lower melting oxide layers also regulate the emission substance (i.e. barium) evaporation. As will be appreciated, the hydroxide layer of such lower melting oxides can only be utilized as impregnating protective means against correspondingly low melting soldering metals. Further, in these low operating temperature cathodes, it is also feasible to use combinations of alkaline earth metals, such as for example alkaline earth tungstates, molybdates, titanates, silicates and the like. Thus, as will be appreciated the principles of the invention are applicable to hydroxides of a material selected from the group consisting essentially of Al, Be, Mg, Zr, Hf, Ti, Th, V, Nb, etc. since such hydroxides are readily convertible into their corresponding oxides, which effectively regulate the evaporation of the emission substance.

The method of producing the coating layer on an emission disk is selected from conventional procedures for applying fluid-type (i.e. suspensions, gels, etc.) materials. As will be appreciated, the heretofore known procedures for applying oxide powders to emission disks necessarily required the use of conventional binders. Binders are, of course, not necessary when hydroxide coatings are utilized. A particular hydroxide, for example $Al(OH)_3$ is precipitated as a very voluminous colloid (gel) from a salt thereof, i.e. aluminum nitrate. The easily entrapped interfering materials (i.e. the salts formed during the precipitation of the hydroxide) are removed in a conventional manner with known means. The relatively watery or fluid-like hydroxide suspensions generally only impregnate the outwardly open pores of the emission disk and the major portion of such hydroxide suspension remains on the disk surface per se. The hydroxide suspension is applied by spraying, brushing, troweling, etc. Both the hydroxide layer and the thermally produced oxide layer are much better anchored within the pores of the emission disk and have better adhesion therewith than a directly applied oxide layer.

To attain satisfactory equalization of pore size and thereby satisfactory regulation of emission substance evaporation, the amount of the resulting oxide layer, for example Al_2O_3, is preferably not more than about 6 mg./cm.^{2}. If no protective means, such as a mask, is utilized during the hydroxide coating procedure, then the hydroxide must be superficially removed from the soldering areas. Generally, the hydroxide layer is thermally converted into the corresponding oxide layer and subjected to sintering conditions in a protective gas or under vacuum prior to the soldering process. However, as will be appreciated, the thermal conversion, the sintering and the soldering can all be combined into a single operation.

One method of producing an exceptionally adherent and uniformly distributed hydroxide layer consists of applying reduced pressure, i.e. vacuum, to one side of an emission disk while immersing the other side of the disk into a hydroxide suspension or pressing the other side into a damp hydroxide gel film (such as obtained by filtration). This may be readily accomplished by supporting one side of the emission disk at one end of a tube or hose having about the same diameter as the disk, connecting the other end of the tube to a reduced pressure source and immersing or pressing the exposed face of the emission disk into the hydroxide material. The pressure differential on opposite faces of the disk causes the plastic-like hydroxide gel to penetrate only into the first pore layers below the disk surface per se.

Another method of attaining limited (or superficial) impregnation by the hydroxide into the emission disk involves the conversion of a suitable alkyl metal in a hydroxide thermally convertible to a corresponding oxide. In accordance with this method, a face or side of the emission disk is suitably moistened (as by liquid or vaporized water) and exposed to a vaporized alkyl metal. The alkyl metal reacts to water to produce a thin tightly adherent layer of a corresponding hydroxide within the surface pores of the disk, which is then thermally converted into an oxide. The areas of the disk face which are not to be impregnated with the hydroxide are covered with a mask or a layer of de-polymerizable plastic as indicated hereinbefore, which can be readily removed for soldering and the like. For example, a disk face is moistened with steam and exposed to vaporized tri-isobutyl aluminum (although alkyls of the materials having higher and lower melting points described hereinbefore can also be utilized) to form aluminum hydroxide. The aluminum hydroxide penetrates only into the surface or upper layers of pores since the conversion reaction takes place at the surface of the disk and immediately clogs the surface pores. As long as the reaction is not allowed to continue for too long a

period, a thin coating of a firmly adhering aluminum hydroxide is formed on the disk surface.

After impregnation of a disk surface in accordance with one of the hereinbefore described methods, any excess hydroxide material or excess water in the pores is immediately removed as by washing with a methanol solution and drying the disk. Finally, the hydroxide layer adhering to the disk surface is thermally converted by exposure to a calcination (sintering) process wherein a dry stream of heated (for example around 1200° to 1300° C. for aluminum hydroxide) hydrogen gas converts the hydroxide into its corresponding oxide. In addition, this calcination process also reduces any existing tungsten oxide in the emission disk and substantially simultaneously removes any mask or masking layer of de-polymerizable plastic which may have been previously applied.

It will be understood that modifications and variations may be effected without departing from the spirit and scope of the novel concepts of the present invention.

We claim:

1. The method of producing a dispenser type cathode for an electrical discharge vessel comprising the steps of (1) forming a porous carrier disk composed of a porously sintered high melting metal, (2) forming an emission substance supply container having an opening for admission of a supply emission substances and adapted to receive said carrier disk as a closure therefor, (3) applying a layer of a hydroxide gel thermally convertible to the corresponding oxide onto a face of said carrier disk, (4) thermally converting said hydroxide to the corresponding oxide to produce an oxide coated face, (5) adding an emission supply substance into said supply container, and (6) sintering said carrier disk onto said supply container with the oxide coated face being adjacent the emission substance.

2. The method as defined in claim 1, wherein the hydroxide is applied in the form of a precipitated gel and is a hydroxide of a material selected from the group consisting essentially of Al, Be, Mg, Zr, Hf, Ti, Th, V and Nb.

3. The method as defined in claim 1, wherein step (3) comprises (a) applying reduced pressure to a face of said container disk, (b) immersing the opposite face of said carrier disk into the hydroxide whereby said hydroxide penetrates into the outer pore layers of said opposite face of the carrier disk, and (c) removing excess hydroxide from said opposite face.

4. The method as defined in claim 1, wherein step (3) comprises (a) moistening a face of the container disk with water, and (b) exposing said moistened face to a vaporized alkyl metal reacting with water to produce a hydroxide thermally convertible to a corresponding oxide.

5. The method as defined in claim 1, wherein preselect portions of the face of the disk carrier coated with the hydroxide are covered with a correspondingly shaped mask prior to the application of the hydroxide.

6. The method as defined in claim 1, wherein preselect portions of the face of the disk carrier coated with the hydroxide are covered with an easily removable layer of a material selected from the class consisting essentially of nitrocellulose, a polyacrylic ester, a silicon polymer and a de-polymerizable polymer.

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313—337