United States Patent [19]

Staffa et al.

[11] **3,719,855**

[45] **March 6, 1973**

[54] **MULTIPLE CATHODE**

[75] Inventors: **Alois Staffa; Erwin Huebner,** both of Munich, Germany

[73] Assignee: **Siemens Aktiengesellschaft,** Berlin, Germany

[22] Filed: **Jan. 27, 1972**

[21] Appl. No.: **221,163**

[30] **Foreign Application Priority Data**

Feb. 12, 1971 Germany.....P 21 06 745.8

[52] **U.S. Cl.**.....**313/338,** 313/243, 313/346 R

[51] **Int. Cl.**.....**H01j 1/20,** H01j 1/92, H01j 1/14

[58] **Field of Search**.....313/337, 338, 243, 346

[56] **References Cited**

UNITED STATES PATENTS

3,614,514 10/1971 Katz et al.....313/346 R

Primary Examiner—David Schonberg
Assistant Examiner—Paul A. Sacher
Attorney—Carlton Hill et al.

[57] **ABSTRACT**

A cathode which allows simple and easy variance in the amount of emission and is constructed of a minimum number of different parts comprises first and second generally concentric cylinders of different diameters such that the cylinders have a space therebetween, which space may receive a heating unit therein. Each of the first and second cylinders have radially extending overlapping flanges joined to each other and one of the cylinders has a lower flange generally below and generally parallel to the upper flanges. At least three hollow tubular emission carriers are positioned between the upper and lower flanges and evenly distributed around the cylinders. The method of making the cathode and particularly the emission carriers comprises the steps of applying a thick layer of tungsten suspended in a liquid coating to the outer surface of a form, pre-sintering the coating to rigidify it, removing the rigidified coating from the form and finally sintering the coating to form a shell for the tubular emission carrier. Upper and lower plugs close opposite ends of the shell whereby it serves as a container or carrier for the cathode emission material. Three or more of the emission material carriers are inserted into aligned holes in flanges of a cylindrically shaped support unit. A cylindrically shaped member of a thin or foil material is connected to the support unit to the dispenser cathode to the tube envelope.

6 Claims, 2 Drawing Figures

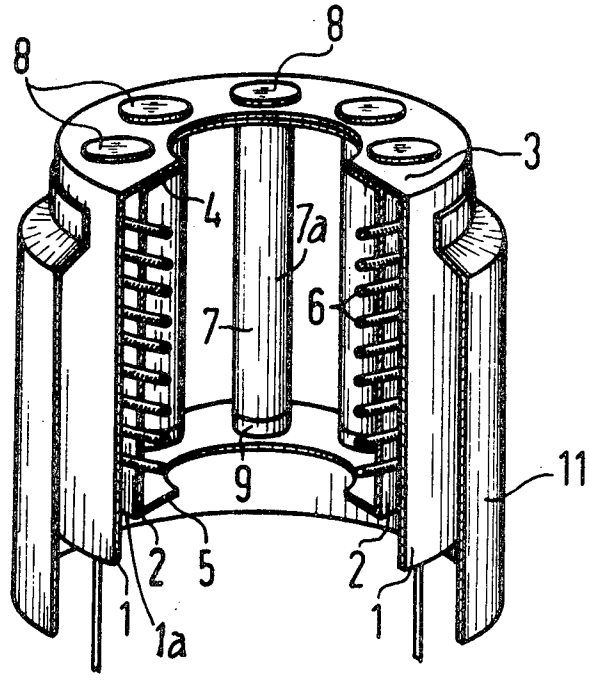


Fig.1

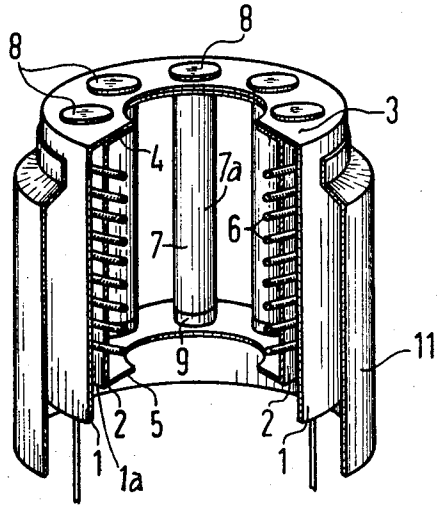
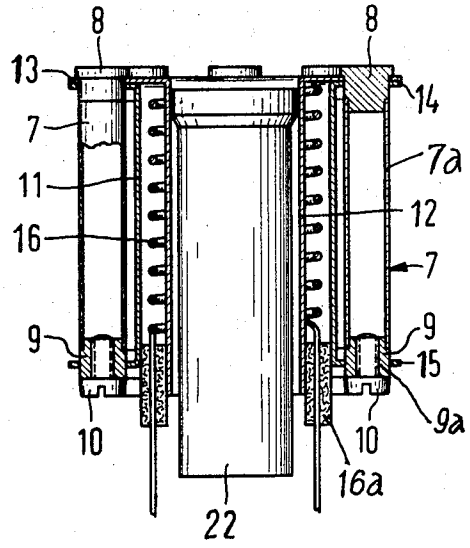


Fig.2



MULTIPLE CATHODE

BACKGROUND OF THE INVENTION

This invention generally relates to a dispenser cathode and more particularly concerns a multi-purpose cathode used for electric discharge tubes wherein the cathode includes a variable number of emission carriers. A pair of generally concentric cylinders of different diameters are connected together by means of overlapping upper flanges to form the basic support structure for the emission carriers. The apparatus and particularly the emission carrier tubular shell members may be made by a method of applying a liquid coating of tungsten to the outer surface of a form, pre-sintering the coating to rigidify the coating, removing the coating from the form and finally sintering the coating to provide a shell for the tubular emission carriers.

The invention herein is especially useful in high capacity discharge tubes requiring large and variable amounts of emission as for example, electronic beam tubes whose cathode ray current is particularly large and must obtain a high energy density such that the beam may be utilized for processing material.

Presently in the prior art dispenser cathodes for high energy equipment such as lasers usually have a fixed emission level and are fabricated in a complex and expensive manner. Moreover, the methods of making these prior art cathodes are involved and costly.

SUMMARY OF THE INVENTION

According to the invention herein we have provided a dispenser cathode for high energy density electronic beam tubes which allow the emission to be simply, accurately and inexpensively changed from a small amount to a larger amount by simply adding one or more emission carrier units to a basic, easily constructed support unit. Furthermore, the same emission carrier units may be inserted in either a support unit of the hollow cathode type or a support unit of what is referred to as the cylinder cathode type.

The above noted advantages and many others are obtained from a multiple purpose cathode comprising first and second generally concentric cylinders each of which cylinders have different diameters such that a space is provided between the cylinders which space may receive a generally spiral shaped heater coil to provide indirect heat for the cathodes. Each of the first and second cylinders has an upper, radially extending flange which is arranged to overlap the other and to be mechanically joined. One of the cylinders has a lower flange generally below and generally parallel to the upper flanges. At least three hollow tubular cathode emission carriers are positioned between the upper flanges and the lower flange and are advantageously evenly distributed about the flanges. A foil mounting structure may be provided and attached to at least one of the cylinders.

Each of the tubular emission carriers comprises a generally cylindrical shell made of a porous tungsten which shell has an upper plug and a lower plug to form a container for the cathode emission material. The upper plug has an outwardly extending flange whereby when the emission carriers are inserted through holes in the upper flange of the support unit the flange will come to bear against the upper flange and provide stable support for the emission carrier. The upper and

lower plugs may be made of a molybdenum material, for example, and may be attached to the shell by means of soldering, for example. The lower plug may have a central bore to allow insertion and removal of the material. A screw means serves as a cap.

It is a particular advantage of our invention that the support unit may be of a "hollow" type wherein the flanges of the concentric cylinders are directed radially inwardly and the foil mounting member is attached outside the outer cylinder. In this case a lower flange extending inwardly from the inner cylinder cooperates with the upper flange to support the carrier members inside the cylinders.

In another "cylinder" type embodiment the first cylinder is inside the second cylinder and the upper and lower flanges extend radially outwardly from the first and second cylinders to support the emission carrier members outside the cylinders. The foil mounting cylinder is mounted within the inner first cylinder and attached thereto adjacent its upper end.

The method of making the multi-purpose cathode comprises the steps of applying a thick coating of liquid having tungsten suspended therein to the outer surface of a form, which form may be cylindrical, pre-sintering the coating to rigidify the coating on the form, removing the rigidified coating generally intact from the form, again sintering the coating to form a porous tungsten shell, adding the upper and lower plugs and affixing them securely to the upper and lower ends of the tubular shell, fabricating the supporting units by overlapping the flanges of the first and second generally concentric cylinders, adding a foil mounting member, providing holes in the upper and lower flanges adding the necessary cathodic material to the tubular emission carrier cathodes and placing three or more of emission carriers evenly distributed about the flanges. It is contemplated that the number of individual emission carrier elements distributed about the flanges may go up to **12, 16** or more so that a very wide range in the amount of emission may be quickly and economically obtained. Moreover, the fact that the same cathodic emission carriers may be provided in either a hollow or cylindrical type of supporting units lends a great versatility and economy of design and construction to the cathode.

In the method of making the dispenser cathode a sufficiently thick coating of tungsten in suspension may be applied on a ceramic rod or tube which rod or tube may be made of aluminum oxide or molybdenum. A pre-sintering at about 1,600° centigrade solidifies the coating to the point where it may be removed such as by twisting it off the form after which it may be finally sintered at about 2,200° to form the tough, porous tungsten shell.

BRIEF DESCRIPTION OF THE DRAWING

Other objects, features and advantages of the invention will be readily apparent from the following description of certain preferred embodiments thereof, taken in conjunction with the accompanying drawings, although variations and modifications may be effected without departing from the spirit and scope of the novel concepts of the disclosure and in which:

FIG. 1 is a schematic representation of a hollow type multiple purpose indirectly heated dispenser cathode with a portion cut-away for purposes of showing the interior, and,

FIG. 2 is a schematic representation taken generally in cross sectional elevation of a cylindrical type multiple purpose indirectly heated, dispenser cathode employing the same cathodic emission carrier members as shown in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the hollow type multiple purpose dispenser cathode shown in FIG. 1 it may be seen that a pair of generally concentric cylinders 1 and 2 are of different diameters such that they include a space 1a between them which space may receive a spirally shaped heating coil 6 therein. The concentrically aligned cylinders 1 and 2 are provided at their upper end with inwardly, radially extending flanges 3 and 4, respectively, which flanges may partially overlap each other and be mechanically connected with each other by conventional joining means such as welding or soldering whereby the cylinders 1 and 2 are held in fixed relation to each other. As shown in FIG. 1 the inner cylinder 2 has another flange 5 radially extending inwardly from its lower end. The flanges 3, 4 and 5 advantageously surround a central opening.

Both the upper flanges 3, 4 and the lower flange 5 are provided with a number of aligned holes into which there may be inserted an individual cathodic emission carrier 7. Each of the individual emission carriers 7 comprise relatively small cylindrical porous tungsten shell members 7*a* as shown in cross section in FIG. 2. The upper end of the shell 7*a* is closed with an upper plug means 8 which advantageously is made of a molybdenum material that is affixed to the shell 7*a* by means such as soldering or welding for example. The lower end of the shell 7*a* is closed with a lower plug means 9 which also may be of a molybdenum material and similarly attached to the shell 7*a*. According to our invention the emission carrier means 7 is retained in position by the cooperation of the upper and lower flanges 3, 4 and 5 as shown in FIG. 1. Each of the emission carriers 7 is positioned by inserting the lower end including the lower plug 9 through the hole in the upper flanges and into a hole in the lower flanges until an outwardly extending portion of the upper plug means 8, which is of a size which will not pass through the upper holes, prevents further movement of the emission carriers 7. While the emission carriers are shown in a vertical position held by gravity it will be understood that suitable means for retaining the emission carrier 7 against movement may be provided. The individual emission carrier means 7 may have an opening 9*a* as may be best seen in FIG. 2 which opening will be closed or controlled by a screw means 10. By this means a cathodic emission material, not shown, may be inserted into the emission carrier 7 at any time. Advantageously barium oxide may be used as the cathodic material depending upon the application of the apparatus and may be protected or held in position by a paraffin closure. Alternatively, the material may be contained in a small molybdenum container which is inserted into the emission carrier 7. It is further contemplated that the material may be barium carbonate. The construction features of the multiple purpose cathode according to the invention may also be applied to oxide-matrix cathodes or impregnated cathodes. The cathode as shown in FIG. 1 is mounted by means of a tantalum foil cylinder 11 which is attached at one end to the upper edge of the outer cylinder 1 and attaches at the other end to the tube envelope by way of its tube base, not shown.

Referring to the "cylinder" type dispenser cathode in FIG. 2 it will be seen that a pair of generally concentric cylinders 11, 12 are connected together in fixed relationship by means of their partially overlapping, radially outwardly extending flanges 13 and 14 at their upper end. These flanges are suitably attached together by means such as soldering or welding. As before the cylinders 11, 12 are of different diameters such that a space is created between the inside of the outer cylinder 11 and the outside of the inner cylinder 12. The thus created space receives a spirally wound electrically insulated heating means 16 whereby indirect heating of the emission material carriers 7 is provided. The heating means 16 may be suitably cemented in position in electrically insulated relationship by means of the insulating member 16a. The heating means 6 and 16 shown in FIGS. 1 and 2, respectively, are similar and function in a similar manner to produce the same result. It is possible that when a free, thus not cemented, heater is applied, the outer cylinder 1 as shown in FIG. 1 may be eliminated and, in the case of the embodiment referring to FIG. 2, the inner cylinder 12 may be eliminated.

The emission carrier 7 as described in detail with respect to FIG. 1 may also be used as shown in FIG. 2 in greater cross sectional detail.

The cathode shown in FIG. 2 is mounted in position by means of a cylinder 22 made of tantalum foil. The cylinder 22 is attached at one end to the upper portion of the inner cylinder 12 and is attached at its other end to the tube envelope base not shown.

The method of making the multiple purpose dispenser cathode comprises the steps of applying a coating of a generally liquid material having tungsten suspended therein to the outer surface of a form, which form may be a ceramic rod or tube made of aluminum oxide, for example. The thus coated form is then presintered at about 1,600° centigrade to solidify it after which it may be removed from the form as for example, by twisting and is then finally sintered at about 2,200° centigrade. With the shell 7*a* thus formed of porous tungsten the molybdenum plugs 8 and 9 as shown best in FIG. 2 in cross section, may be attached thereto by secure means such as soldering or welding. The lower plug 9 has an opening 9a therein which allows the insertion of materials into the formed emission carrier means 7. With the material in position the closure member 10 may be inserted in the hole 9*a*.

The units supporting the emission carrier means is readily fabricated from a pair of generally concentrically aligned cylinders of different diameter, each of which cylinders has a flange that overlaps the flange of the other cylinder whereby the cylinders may be readily fastened together by suitable means such as welding or soldering. The cylinders are preferably made of molybdenum. Because of the different diameters a space remains between the cylinders and the indirect heating means of the cathode are provided by extending the spiral heating member 6 or 16 therein and maintaining it in electrically insulated relationship. For this purpose the heating means is cemented in, as shown for exam-

ple, in FIG. 2 by the means 16*a*. The flanges of the cathode have holes drilled therein which holes in the upper and lower flanges are aligned so that the emission carrier means 7 may be inserted through the hole in the upper flange and engage the hole in the lower flange. A greater number of holes up to 12, 16 or more may be provided in the flanges so that the emission capability of the cathode may be varied by varying the number of emission carrier means 7 which are put in place in the cathode. To provide an even distribution of the emission about the circumference of the cathode it is important that the holes in the emission carrier means be evenly distributed.

The thus constructed cathode is then mounted in position in the tube envelope by means of a foil cylinder such as shown at 11 in FIG. 1 for the hollow cathode or the cylinder 12 as shown in FIG. 2 with the cylindrical cathode.

From the foregoing description of the invention it may be seen that we have provided a dispenser cathode for high energy density electronic beam tubes which allow the amount of emission of the cathode to be simply, accurately and very inexpensively varied by simply adding or substracting emission carrier means to a basic, easily constructed supporting unit. In this construction the emission carrier means may be of a standard size that will work equally as well in a hollow or cylindrical type cathode.

Although minor modifications might be suggested by those versed in the art, it should be understood that we wish to embody within the scope of the patent warranted hereon all such modifications as might reasonably and properly come within the scope of our contribution to the art.

We claim:

1. A multiple purpose dispenser cathode comprising first and second generally concentric cylinders of different diameters such that said cylinders have a space therebetween, each of said first and second cylinders having upper and peripheral partially overlapping flanges joined to each other, one of said cylinders having a lower flange generally below and generally parallel to said upper flanges, at least three hollow tubular emission carriers positioned between said upper flanges and said lower flange and evenly distributed about said flanges wherein said space between said first and second cylinders receives a heater therebetween which heater coil provides indirect heat for said cathode.

2. A multiple purpose cathode according to claim 1 wherein said tubular emission carriers are closed off at their opposite ends by upper and lower plugs respectively, said upper plug having a portion thereof extending outwardly beyond said tubular emission carrier, said upper and lower flanges having openings therein of a size generally conforming to the cross section of said emission carriers, said portion of said upper plug being of a size larger than said opening, said lower plug being of a size generally conforming to said cross section of said tubular emission carrier and having a bore therein, said bore being closed with a screw.

3. A multiple purpose cathode according to claim 1 wherein said upper and lower flanges extend radially outwardly from said first and second cylinders, said first cylinder being inside and said second cylinder, said first cylinder having a foil mounting cylinder therein and attached thereto adjacent its upper end.

4. A multiple purpose cathode according to claim 1 wherein said upper and lower flanges extend radially inwardly from said first and second cylinders, said second cylinder being outside of and generally surrounding said first cylinder, a foil mounting cylinder outside of and generally surrounding said second cylinder, said foil mounting cylinder being attached to said second cylinder adjacent its upper end.

5. A multiple purpose cathode according to claim 1 wherein said tubular emission carriers form containers which contain supply substances.

6. A multiple purpose cathode according to claim 5 wherein said supply substance a material selected from the group consisting of barium oxide and BaC_3.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,719,855 Dated March 6, 1973

Inventor(s) Alois Staffa and Erwin Huebner

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the patent, claim 6, last line "BaC_3" should read

-- $Ba\ Co_3$ --.

Signed and sealed this 25th day of December 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—364-334