May 4, 1954 W. R. BAKER ET AL 2,677,778

LINEAR CATHODE

Filed March 31, 1952

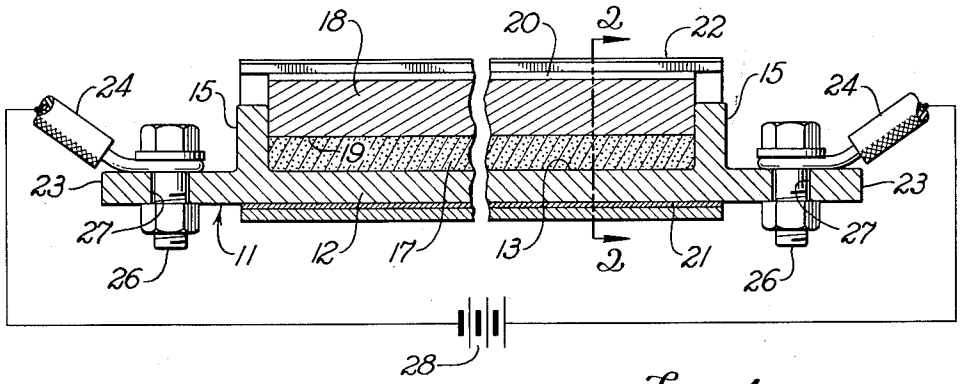

Fig. 1.

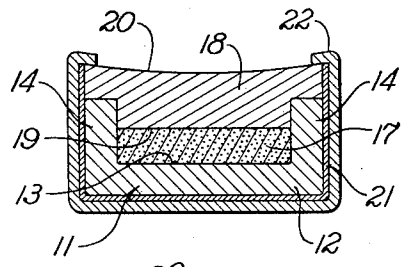

Fig. 2.

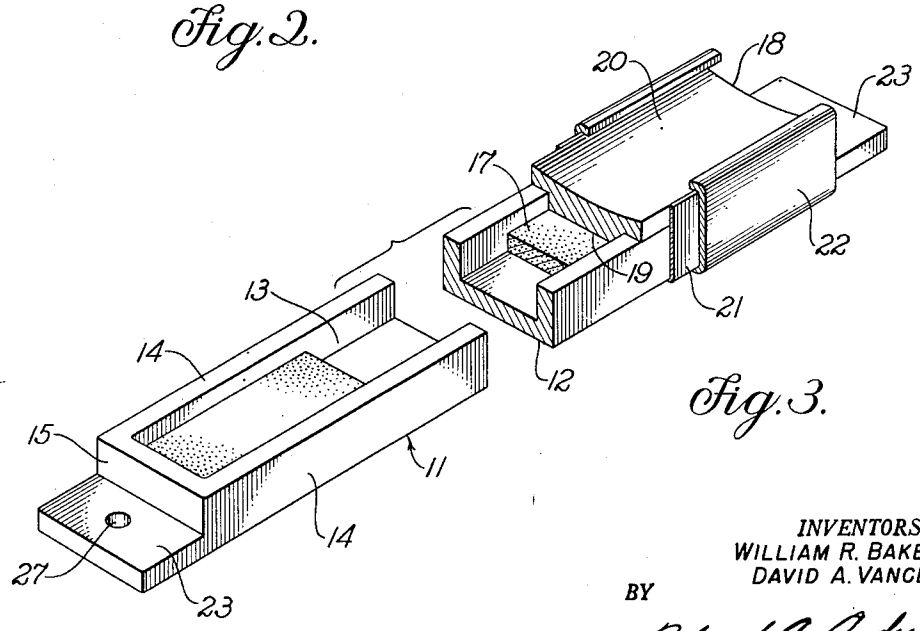

Fig. 3.

INVENTORS.
WILLIAM R. BAKER
DAVID A. VANCE

BY

Roland A. Anderson

ATTORNEY.

Patented May 4, 1954

2,677,778

UNITED STATES PATENT OFFICE

2,677,778

LINEAR CATHODE

William R. Baker, Berkeley, and David A. Vance, Lafayette, Calif., assignors to the United States of America as represented by the United States Atomic Energy Commission

Application March 31, 1952, Serial No. 279,544

3 Claims. (Cl. 313—38)

1

The present invention relates to improvements in dispenser type thermionic cathodes and in particular to a simple, economical and readily replaceable cathode and method of making same.

Dispenser type cathodes commonly comprise a porous metal either impregnated with or surrounding an activating material which slowly volatilizes when heated and escapes to the surface of the metal to reduce the work function thereof and provide a very advantageous electron emission surface. Extensive research within recent years has shown that numerous metals may be employed in combination with a variety of activating materials to provide good emission surfaces and there are a large number of issued patents covering the results of this research. There remains, however, for this rather basic knowledge to be put to a practical advantage by the provision of a simple and economically feasible cathode of the dispenser type, for although undoubtedly the dispenser type cathodes illustrated in the art are operable, few are designed for economy of manufacture, ease of construction, simplicity, or replaceability, which of course is of major importance when considering large scale use and standardization.

It is therefore an object of the present invention to provide an improved dispenser type cathode which is rugged and efficient yet simple and easily constructed.

It is a further object of this invention to provide an improved method of manufacture of dispenser type cathodes.

It is another object of the present invention to provide an improved directly heated dispenser type cathode which is easily disassembled.

Many other objects and advantages of the invention will become apparent to those skilled in the art from the following description of the invention taken together with the accompanying drawing wherein:

Figure 1 is a longitudinal cross sectional view of a preferred embodiment of the invention taken on the center line thereof;

Fig. 2 is a cross sectional view of the embodiment taken at line 2—2 on Fig. 1; and

Fig. 3 is a perspective view of the base element partially in section.

Considering one preferred embodiment of the invention as illustrated in the drawing and referring thereto, it will be seen that there is provided an elongated base member 11 which is preferably formed of an electrically conducting material, such as for example tantalum. Base member 11 includes an elongated rectangular plate portion 12 and a number of upright portions extending from the surface thereof to form a rectangular trough 13. These upright portions may consist of sides 14 and ends 15 which may either be integrally formed with plate portion 12, as shown, or may comprise separate elements joined together and to plate portion 12 to form therewith a substantially rectangular open-sided box extending less than the length of plate 12 and at a distance from each end thereof.

2

Within trough 13 there is disposed a quantity of activating material 17 which is disposed evenly along the bottom of trough 13. Atop trough 13 and in closing relation thereto is a trough cover or bar 18 formed of sintered tungsten or other porous metal which reacts with activating material 17 to form a good electron emitting surface. Bar 18 has the same length as the internal length of trough 13 and the same width as the external width of trough 13, and has a boss 19 upon one face thereof of the same dimensions as the interior length and width of trough 13. Bar 18 is assembled with base element 11 by slipping boss 19 into trough 13 from the top thereof which entirely closes trough 13 and, as boss 19 has a lesser depth than trough 13, there remains a closed chamber or reservoir within trough 13 which contains the above-noted activating material 17.

Bar 18 preferably has the opposite face 20 thereof from boss 19 formed with a slight concavity, with the curvature being transversely of bar 18. The concave surface 20 of bar 18 is the electron emitting surface of the cathode and by virtue of this curvature the electrons emitted therefrom are substantially focused in a line parallel to the surface 20 and at a distance dependent upon the radius of curvature thereof, as noted in more detail below.

The assembly of base element 11 and bar 18 is surrounded in part by a thin sheet or foil of material 21 which has substantially the same length as trough 13 and which extends across the bottom of base element 11 and along the sides of trough 13 and bar 18 up to and flush with the top surface 20 of bar 18. Sheet 21 may be formed of an insulating material to confine electrical currents upon base element 11 or may alternatively be formed of a metal, such as molybdenum; and acts as a heat shield to contain heat within trough 13. Exterior to sheet or shield 21 there is provided a second shield or cover 22 which like shield 21 has substantially the same length as trough 13 and which covers shield 21 in con-

tiguous relation thereto. In addition to extending around the bottom and sides of trough 13 and the sides of bar 18, cover 22 has its edges disposed upon the edges of surface 20 of bar 18 in clamping relation thereto whereby base element 11, bar 18 and shield 21 are held together in assembled relation.

As noted above, plate portion 12 of base element 11 extends beyond trough 13 at both ends thereof and these extensions 23 may be employed as connecting lugs for the connection of electrical leads 24 to the cathode. Joinder of electrical leads 24 to lugs 23 may be accomplished by any suitable means such as soldering or by bolts 26 extending through holes 27 in lugs 23 and engaging nuts on the bottom thereof, as shown, to force electrical leads 24 into good electrical contact with lugs 23. A further function of lugs 23 may be in the mechanical mounting of the cathode in a tube or discharge device and lugs 23 may be formed into desired configuration to facilitate such use.

There has been described above the major elements of one embodiment of the invention and a brief description of the operation thereof now follows. A power supply 28 is connected between electrical leads 24 and which contact opposite ends of base element 11 at lugs 23 thereof to cause a heating current to flow directly through base element 11. This current flow causes base element 11, bar 18 and enclosed activating material 17 to heat up and to thereby vaporize activating material 17. The heating current is controlled so that the temperature of activating material 17 is raised to the point where it very slowly vaporizes. This vapor is contained by the bottom, sides and ends of trough 13 but escapes by migrating through the porous structure of bar 18. A continual movement of vapor through bar 18 is maintained and there is consequently produced upon surface 20 of bar 18 a monoatomic layer of activating material which is being continually replaced. This monoatomic layer of activating material 17, such as for example barium or strontium or both, upon the surface of bar 18, formed of sintered tungsten for example, materially lowers the work function of the surface and there is consequently formed an electron emissive surface having very good emission properties.

Shield 21 acts to prevent heat transfer away from trough 13 and bar 18 and may have a polished inner surface to facilitate the accomplishment of this function. Outer shield or cover 22 also reflects heat back into trough 13 and bar 18 and, in addition, serves to clamp the assembly together. Cover 22 may have the further function of defining or limiting the extent of the electron emissive surface and for this purpose may be formed in whole or in part of a metal which does not have its electron emission properties materially affected by activating material. By this construction the leak or flow of vaporized activating material upon the portion of cover 22 contacting surface 20 does not extend the electron emission surface beyond the exposed portion of surface 20 of bar 18. While numerous materials are suitable for use as cover 22, it has been found that molybdenum is particularly adaptable in this respect. It will, of course, be appreciated that various materials may be used in the above-described embodiment of the invention and that the examples are in no way limiting, and it should also be noted at this point that the inclusion of shield 21 is optional and is not absolutely necessary, although advantageous. It is further noted that the described cathode is adapted to be employed in combination with means to remove or attract electrons from the electron emission surface thereof and in this respect potential supply means may be connected between the cathode and one or more other electrodes as of a vacuum tube or other device employing thermionic cathodes.

There has been set forth above the details of a single preferred embodiment of the invention and attention is invited to the ease of assembly and disassembly thereof. In fabrication of the cathode, base element 11 is formed either from a single plate of stock with trough 13 milled therein or may be built up of plates joined together by suitable means. Bar 18 likewise may be milled from one piece, or boss 19 may be separately formed and joined thereto. In assembly trough 13 is filled to a predetermined level with activating material which may be in powdered form, and bar 18 is placed upon trough 13 with boss 19 thereon mating with trough 13 and extending into trough 13 to contact activating material 17. Shield 21, which may be precut and folded, is then slipped on to the trough-bar combination; or alternatively a sheet of material may be folded about the trough-bar combination to form shield 21 and such may be either pre-cut or cut-off after assembly. The final step consists of placing cover 22 upon the combination and this may be accomplished by pre-cutting and preforming cover 22 and slipping it onto the combination from the end and then pressing the turned edges and back of cover 22 into close contact with base element 11 and bar 18 to clamp same together; or may alternatively be accomplished by folding a sheet of cover material about trough 13 and bar 18, cutting off the ends thereof above surface 20 and then crimping these ends over the edges of surface 20 to tighten cover 22 about the combination and hold same in assembled relation. It will be appreciated from the foregoing that assembly and disassembly of the cathode structure is a simple operation accomplished with a minimum of equipment and time, and therefore very advantageous economically. Furthermore, the elements of the invention are relatively few, quite simple and rugged, and comparatively inexpensive, all of which results in a practical dispenser type cathode readily adapted for use in a variety of tubes and devices.

The particular embodiment illustrated is adapted for use in multiple about the circumference of a circle with a plurality of elongated anodes disposed one adjacent each cathode, and as electrons leave the electron emissive surface substantially normal thereto the radius of curvature of the surface is calculated to focus the electrons at the adjacent anode, or alternatively it may be considered that the electrostatic field about the cathode surface converges away from the surface and thereby draws the emitted electrons together at a focus some distance from the surface as determined by the radius of curvature thereof. The use of a curved cathode surface is not limited to this suggested application and, in fact, the entire invention is not to be limited by the illustrative examples set out above, and thus attention is directed to the following claims for a delineation of the true scope of the invention.

What is claimed is:

1. A dispenser type cathode comprising a metal trough having electrical connections extending from the ends thereof and adapted to be connected across a current supply whereby current flows through said trough heating same, a trough cover mating with said trough in sealing relation thereto and defining an enclosed reservoir therein, said trough cover being formed of a porous metal to admit vapor flow therethrough, volatile activating material disposed in the enclosed reservoir in said trough to be vaporized by the heat from said trough to pass through said trough cover, a heat shield disposed about said trough, and a cover sheet disposed about said trough and a portion of said trough cover in clamping relation thereto whereby said trough, cover, and heat shield are maintained in position.

2. A dispenser type cathode comprising a metallic trough having an open top and a bottom member extending beyond the ends thereof forming electrical connectors, a current source connected across said connectors whereby an electrical current flows through said trough and heats it, a bar of porous metal having a boss thereon mating with said trough opening and in assembly with said trough defining an enclosed reservoir therein, a volatile activating material disposed within said enclosed trough reservoir to be vaporized by the heat of said trough to pass through said porous metal bar, a metal foil disposed about and contiguous with said trough to reflect heat

from said trough back into said trough, and a cover disposed about said trough and bar in clamping relation thereto holding said trough and bar together, said cover extending over less than the entire outer surface of said bar defining an electron emissive surface thereon, the outer surface of said porous bar with the vaporized activating material forming an electron emissive surface and said cover formed of a material substantially unaffected by vaporized activating material.

3. A dispenser type cathode as defined in claim 2 further defined by said trough being formed of tantalum, said porous bar being formed of sintered tungsten, said activating material comprising barium and strontium carbonate and said metal foil and cover being formed of molybdenum.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,121,589	Espe	June 21, 1938
2,131,204	Waldschmidt	Sept. 27, 1938
2,459,841	Rouse	Jan. 25, 1949
2,488,716	Elenbaas	Nov. 22, 1949
2,543,728	Lemmens et al.	Feb. 27, 1951
2,640,949	Cook	June 2, 1953

OTHER REFERENCES

Philips Technical Review, vol. 11, No. 12, pp. 341–350, June 1950. See Fig. 1(b).