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G. S. EVANS

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MERCURY VAPOR TUBE

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Fig. 1.

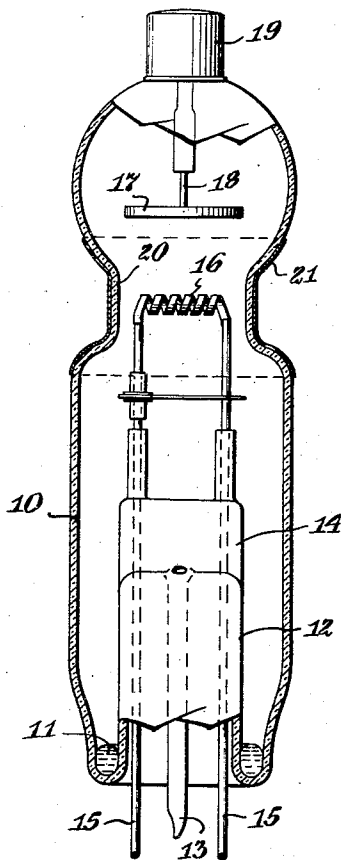


Fig. 4.

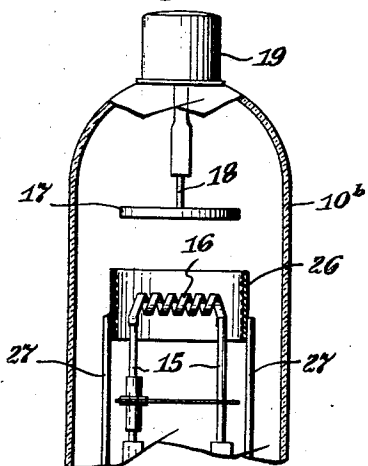


Fig. 2.

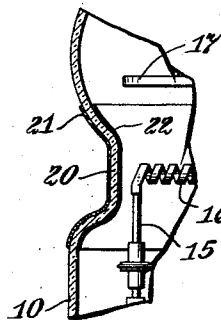


Fig. 3.

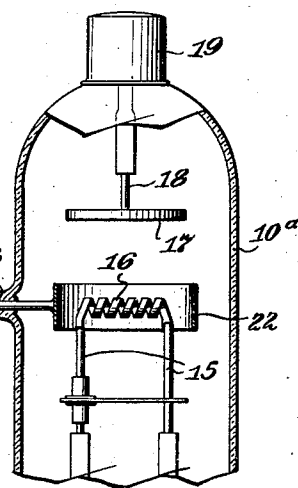
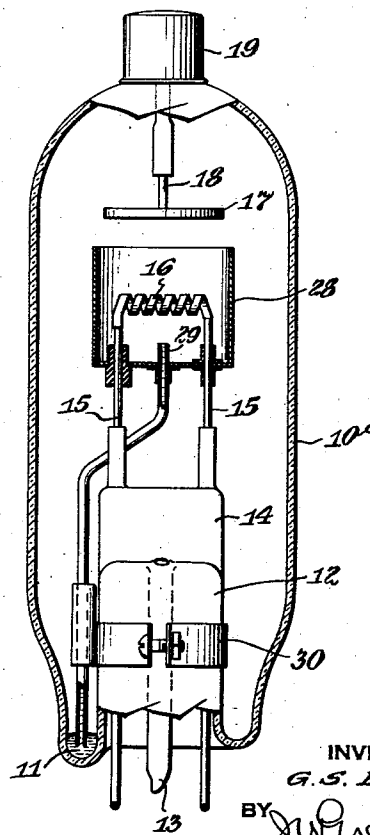


Fig. 5.



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MERCURY VAPOR TUBE

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14 Claims. (Cl. 250—27.5)

1 This invention relates to mercury vapor de-
vices, and more particularly to such devices in
the electronic art wherein mercury or other ma-
terial which is fluid or transient in use consti-
tutes a means for producing a vapor atmosphere
within a sealed envelope.

The effective current capacity of the oxide type
cathodes is greatly dependent on the gas pres-
sure or vapor density of the operating atmos-
phere. An oxide cathode operating in an insuf-
ficient vapor density of mercury or the like is
subject to ion bombardment by ions of destructive
velocity due to the higher voltage tube drop
caused by the insufficient vapor density. This
bombardment tends to destroy the emission and
shorten the cathode life. If the current de-
manded of the cathode becomes too high, a phe-
nomenon known as "sparking" occurs, which
causes irreparable damage to the cathode and
often destroys it completely in a very short time.
The current at which the cathode will spark de-
pends very greatly upon the mercury vapor den-
sity, and the sparking tendency is the greatest at
the lower vapor density conditions.

Normally, such tubes operate at such condi-
tions that a satisfactory equilibrium vapor den-
sity of mercury or the like exists in the tube. At
starting, however, just the opposite condition
prevails. When the filament voltage is applied,
the cathode reaches operating temperature in a
time depending on the system of heating. Directly
heated cathodes reach operating tempera-
ture in approximately half a minute; well
heat-shielded indirectly-heated cathodes some-
times require five minutes. It is not alone suf-
ficient to have the cathode at operating tempera-
ture before the anode voltage is applied however.
Due to the conditions outlined above, there must
also be a vapor density of mercury or the like in the
anode-cathode region sufficient to allow the re-
quired current to be conducted without harming
the cathode. To obtain this required density re-
quires a comparatively long time, since it must
be supplied from the mercury or the like con-
densed on the cooler parts of the tube. These
parts are usually in poor heat-receiving rela-
tion with the cathode. Therefore, the condensed
mercury or other material is heated slowly, and
the vapor density thereof in the anode-cathode
region is built up slowly.

Many applications demand rectifiers or other
electronic devices which have a short heating
time, that is, the time for the tube to become op-
erable after the required cathode voltage is ap-
plied must be small. The cathode must be de-

2 signed to reach operating temperature very
quickly, and this can easily be done. It is not
such a simple matter, however, to supply mercury
vapor density sufficient to permit the tube to
safely pass high currents shortly after the cath-
ode is energized.

An object of the present invention is to pro-
vide for prompt vaporization of the vaporizable
material or portion thereof upon heating the
cathode.

Another object of the present invention is to
obtain condensation of the vaporizable material
in proximity to the cathode.

A further object is to obtain promptly vapor
density sufficient to pass high currents after the
cathode is energized.

Yet further objects of the invention are to
provide simplicity of construction, certainty of
operation, and to assure avoidance of sparking.

Still further objects of the invention will ap-
pear as the description progresses, both by direct
recitation thereof and by implication from the
context.

Referring to the accompanying drawing where-
in like numerals of reference indicate similar
parts throughout the several views:

Figure 1 is a sectional view of an electronic
device embodying my invention; and

Figures 2 to 5, inclusive, are similar sectional
views each of modified constructions embodying
my invention.

In its broad or general aspect, the invention
contemplates employment of a cyclic reversible
or reconstructing material, that is one which va-
porizes upon application of heat and condenses
as it cools and adapted to again vaporize and
condense in recurring cycles. As mercury is an
especially good material for the purpose, and is
most often used, the description will, for the
sake of clarity, refer to mercury by way of ex-
ample but without restricting the invention to
its use only. Accordingly, using mercury as an
acceptable exemplification, the invention pro-
vides for a mercury vapor condensing surface
which is in good heat-receiving relation with the
cathode. When the cathode is heated, the vapor
condenser becomes heated quickly, creating
around it and in the anode-cathode region a
higher density of mercury vapor than that which
would be supplied to the condensed mercury in
the cooler portion of the tube. The construc-
tion contemplates provision of a sufficiently high
vapor density to permit tube operation as soon
as the cathode is at operating temperature.
When the tube is shut down, the mercury vapor

will condense on the portions of the tube which cool most rapidly. The condenser surface should be so designed as to cool rapidly, either by correct positioning or by other means. The invention, then, is to provide high vapor densities at start of tube operation by quickly heating a mercury vapor condenser positioned in such manner that mercury vapor condenses on it when the tube is shut down after operation.

In the specific embodiment of the invention illustrated in said drawing, and referring initially to Figure 1, a sealed envelope 10 is depicted which is preferably evacuated and is supplied with a pool of mercury or other reconstructing vaporizable material 11 therein. The envelope is shown with a stem 12 entering at the bottom of the envelope and provided with appropriate tubulation 13 and a press 14 as commonly employed in connection with electronic devices heretofore on the market. Through the stem and press appropriate lead wires 15 are provided to supply current to a filament 16 located within the envelope. Above the filament 16, which is of emitting character and which accordingly constitutes a cathode, is situated an anode 17 the lead-in 18 for which is shown extending through an appropriate seal to the exterior of the envelope at the top thereof and provided with a metallic cap 19 for suitable external connection. The envelope is shown with a throat 20 so that the throat surface of the envelope near the cathode 16 will be brought into relatively close proximity thereto. The fact that this portion 20 of the envelope is close to the cathode will result in the throat portion 20 becoming quickly heated from the heat emanating from the cathode as soon as the cathode is rendered hot or incandescent. The provision of this throat is likewise such that the other portions of the envelope beyond the throat both toward the top and bottom of the envelope have greater spacing from the cathode than the throat portion and are likewise larger in diameter so as not to be as quickly responsive to temperature changes of the cathode.

It is not only desirable for purposes of the present invention to transmit heat quickly to the portion of the envelope wall nearest the cathode, but is also a purpose to quickly cool that portion of the envelope when the cathode loses its heat. The particular construction shown in Figure 1 for accomplishing this purpose consists in applying an outer surface 21 to the envelope upon the throat portion 20 thereof, said coating having heat radiating properties which will rapidly dissipate heat to the atmosphere either contained within the coating or transmitted thereto through the envelope wall at the throat portion 20. One such material which performs the function very well is graphite in colloidal suspension in alcohol, known in the trade as "Aquadag" and accordingly adapted to be painted on the exterior of the constricted portion of the envelope wall. This material will harden in place and will increase the rapidity of radiation of heat at the region of the envelope in the vicinity of the cathode, so that the envelope wall in this region will rapidly cool when heat is no longer furnished by the cathode. As a result, mercury vapor present in the envelope under conditions of heat and operation of the device, will promptly condense at the throat region as soon as the cathode is no longer heated. The condensed mercury is accordingly obtained on the envelope wall in close proximity to the cathode, and when the cathode is next heated the heat obtains a prompt vaporization of the

mercury and thus ionization and current transmission between the electrodes will occur without delay.

In order to provide for better adhesion of the condensed mercury upon the throat region or area of the envelope, the aforementioned construction of device is again shown in Figure 2 and the parts identified by same reference numerals as in Figure 1. The showing of Figure 2 adds to the interior surface of the throat region 20 the permanent surface 22 on which condensed mercury will more readily adhere than to the glass surface of the envelope. This surface 22 may be of any suitable material and applied in any acceptable manner. According to one mode of manufacture, said coating may be obtained by applying nickel or some other metal to the said throat area, as by a vaporization process, by spraying, or otherwise. The surface 22 thus situated at the throat region not only assists in the retention of condensed mercury vapor at that area, but also acts as a good heat conductor for transmitting the contained heat to the exterior coating and thereby obtain a rapid cooling at the region in the vicinity of the cathode when the cathode ceases to be heated.

If preferred, the envelope itself need not be narrowed into a throat but a construction may be provided around the cathode in some other suitable manner. As illustrated in Figure 3, an envelope 10a is provided containing the usual elements such as filament 16, anode 17, leads 15 and 18 and exterior connection 19 such as described with respect to Figure 1. As before, the envelope contains mercury which is adapted to be vaporized when the device is in operation and which is adapted to condense when the parts cool down. In this instance, a throat 22 is provided around the cathode 16, it being shown as a metal ring open at top and bottom and supported by a metallic bar 23 extending through a suitable seal 24 in the side of the envelope and provided with radiating fins 25 at the outside of the envelope. When the cathode 16 ceases to be heated, heat contained in the metal ring rapidly dissipates through the metallic rod 23 by virtue of the exterior fins 25 and accordingly said ring or throat 22 will cool more rapidly than other parts within the device as the result of which the mercury or other vapor will condense on said ring 22. Then, when the cathode is again heated, by virtue of the proximity of the condensed mercury on the throat 22 adjacent to said cathode, the mercury becomes promptly vaporized.

The showing of Figure 4 is somewhat similar to the showing of Figure 3 in the provision of a ring-like throat 26 within an envelope 10b and associated with other parts as described in connection with the preceding figures to which like numerals of reference are applied. The ring-like throat 26 of Figure 4 is supported by rods 27, mounting of which may be suitably obtained with respect to the stem of the envelope as will be readily understood by those skilled in the art. The throat 26 is preferably of a character which constitutes it an amalgamating agent and located in heat-receiving relation to the cathode, so that when hot the amalgam releases mercury, and when cooled, readily absorbs mercury.

Again, in Figure 5, is shown other means for obtaining proximity of mercury to the cathode such that mercury vapor will be promptly obtained when the cathode is heated. The construction includes substantially the same envelope as described in connection with Figure 4

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and is identified with numeral 10c. The stem, tubulation, press, lead-in wires, cathode, anode, lead-wire from the anode and exterior connection, having substantially the same construction as heretofore described are identified by reference numerals heretofore employed in connection with the corresponding parts. In the figure now being described, a cup-like constriction 28 is provided around the cathode, the lead-in wires 15 passing through the bottom of said cup-like throat and suitably insulated electrically so as to avoid short-circuiting the cathode. Entering at the bottom of this cup-like throat 28 is an open-ended small diameter tube 29 of suitable material such as nickel or iron, the lower end of the tube extending to the bottom of the envelope and dipping in the pool of mercury 11. The said tube is supported by a stem collar 30, and is furthermore of such small interior size that the mercury will maintain the tube filled therewith by capillary action. The construction thus described situates the open end of the tube adjacent to the cathode, and consequently when the cathode is heated the heat will promptly vaporize the adjacent mercury in the end of the tube and such mercury as has condensed on the throat area 28. As mercury is drawn off by vaporization from the open-ended tube 29, additional mercury from the pool replaces that which is drawn off by virtue of the capillary action.

The constructions above described accordingly have in common the provision of throat areas adapted to cool promptly and adapted to present mercury or mercury condensation in close proximity to the cathode whereby heat from the cathode will promptly affect the mercury and obtain quick vaporization when the cathode is excited. Accordingly the reverse cycles of heating and cooling are caused to function promptly and effectively, enabling the device to safely pass high current with minimum time delay after the cathode is energized.

Since the various details of construction as well as the precise relation and functioning of parts are subject to variation and change without departing from the inventive concept or scope of the invention, it is intended that all matter contained in the specification or illustrated in the drawing, shall be interpreted as exemplary and not in a limiting sense. It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein shown and described and all statements of the scope of the invention herein set forth as a matter of language which might be said to fall therebetween.

I claim:

1. An electronic device comprising an anode, an evacuated envelope having a throat region, a cathode within said throat region, means in the vicinity of said throat region for increasing heat dissipation at said throat region, and recurrently vaporizable and condensible material in the envelope deposit whereof is promoted on the throat region as a result of heat dissipation from said region.

2. An electronic device comprising an anode, an evacuated envelope having a throat region, a cathode within said throat region, means at said throat region for increasing heat dissipation, and condensible material in the envelope deposit whereof is promoted on the throat region as a result of heat dissipation from said region, said means comprising a composition of the character

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of colloidal graphite on the exterior of the throat region.

3. An electronic device comprising an anode, an evacuated envelope having a throat region, a cathode within said throat region, means at said throat region for increasing heat dissipation, and condensible material in the envelope deposit whereof is promoted on the throat region as a result of heat dissipation from said region, said means comprising a composition of the character of colloidal graphite on the exterior of the throat region, the interior of said throat region being left clear for condensation of said material directly thereon.

4. An electronic device comprising an anode, an evacuated envelope having a throat region, a cathode within said throat region, means at said throat region for increasing heat dissipation, and condensible material in the envelope deposit whereof is promoted on the throat region as a result of heat dissipation from said region, said means comprising a composition of the character of colloidal graphite on the exterior of the throat region, the interior of said throat region having a metallic face for promoting condensation of said material thereon and for increasing heat dissipation.

5. An electronic device comprising an anode, an evacuated envelope, a cathode therein, vaporizable material in said envelope, and a throat in the vicinity of the cathode for obtaining prompt condensation of the vaporizable material in the vicinity of the cathode, said throat comprising a metallic ring spaced inward from the envelope wall constructed and arranged to present a supply of the condensate of the vaporizable material in the vicinity of the cathode ready for prompt vaporization as the cathode becomes hot.

6. An electronic device comprising an anode, an evacuated envelope, a cathode therein, vaporizable material in said envelope, and a throat in the vicinity of the cathode for obtaining prompt condensation of the vaporizable material in the vicinity of the cathode, said throat comprising a metallic ring spaced inward from the envelope wall and subject to quick heating by the cathode, said ring having a connection therefrom to the exterior of the envelope, and said connection having radiating fins thereon.

7. An electronic device comprising an anode, an evacuated envelope, a cathode therein, vaporizable material in said envelope, and a throat in the vicinity of the cathode for obtaining prompt condensation of the vaporizable material in the vicinity of the cathode, said throat comprising a metallic ring spaced inward from the envelope wall and subject to quick heating by the cathode, said ring comprising essentially an amalgamating agent which when hot releases the vaporizable material and which when cool absorbs the vaporizable material.

8. An electronic device comprising an anode, an evacuated envelope, a cathode therein, vaporizable material in said envelope, and a throat in the vicinity of the cathode for obtaining prompt condensation of the vaporizable material in the vicinity of the cathode, said throat comprising a metallic ring spaced inward from the envelope wall and subject to quick heating by the cathode, said ring having a closed bottom, and an open-ended tube of vaporizable material extending to the vicinity of said cathode within the ring.

9. An electronic device comprising an evacuated envelope having a straight cylindrical main

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portion, a cathode in said envelope, an anode in said envelope spaced longitudinally of the envelope from said cathode, reconstructing vaporizable fluid material in said envelope adapted to be condensed after vaporization in recurring cycles, and means in proximity to the cathode closer to the cathode than the normal wall spacing of the straight cylindrical main portion of the said envelope to the cathode, for presenting condensed fluid thereby proximate to the cathode for prompt vaporization by heat from the cathode.

10. An electronic device comprising an evacuated envelope having a straight cylindrical main portion, a cathode in said envelope, an anode in said envelope spaced longitudinally of the envelope from said cathode, reconstructing vaporizable fluid material in said envelope adapted to be condensed after vaporization in recurring cycles, and a constriction in proximity to the cathode closer to the cathode than the normal wall spacing of the straight cylindrical main portion of the said envelope to the cathode, for presenting condensed fluid thereby proximate to the cathode for prompt vaporization by heat from the cathode.

11. An electronic device comprising an evacuated envelope having a straight cylindrical main portion, a cathode in said envelope, an anode in said envelope spaced longitudinally of the envelope from said cathode, reconstructing vaporizable fluid material in said envelope adapted to be condensed after vaporization in recurring cycles and a throat encircling the cathode and in proximity thereto closer to the cathode than the normal wall spacing of the straight cylindrical main portion of the said envelope to the cathode, for presenting condensed fluid thereby proximate to the cathode for prompt vaporization by heat from the cathode.

12. An electronic device comprising an evacuated envelope having a straight cylindrical main portion, a cathode in said envelope, an anode in said envelope spaced longitudinally of the envelope from said cathode, reconstructing vaporizable fluid material in said envelope adapted to be condensed after vaporization in recurring cycles, and a throat encircling the cathode and in proximity thereto closer to the cathode than the normal wall spacing of the straight cylindrical

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main portion of the said envelope to the cathode, for presenting condensed fluid thereby proximate to the cathode for prompt vaporization by heat from the cathode and means for promoting retention of the condensed material on the throat area.

13. An electronic device comprising an evacuated and generally cylindrical envelope, a cathode in said envelope, a ring-like condensation area provided in said envelope axially longitudinal thereof and around said cathode and of less diameter than side portions of the envelope above and below the cathode, said condensation area extending substantially equal distances above and below said cathode less than the length of the envelope, and an anode in said envelope beyond said condensation area.

14. An electronic device comprising an evacuated and generally cylindrical envelope, a cathode in said envelope, a ring-like condensation area provided in said envelope axially longitudinal thereof and around said cathode and of less diameter than side portions of the envelope above and below the cathode, said condensation area extending substantially equal distances above and below said cathode less than the length of the envelope, and an anode in said envelope beyond said condensation area, said anode having a diameter substantially equal to the said diameter of the condensation area.

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