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METHOD OF CONSTRUCTING COLD CATHODE GAS DISCHARGE TUBES

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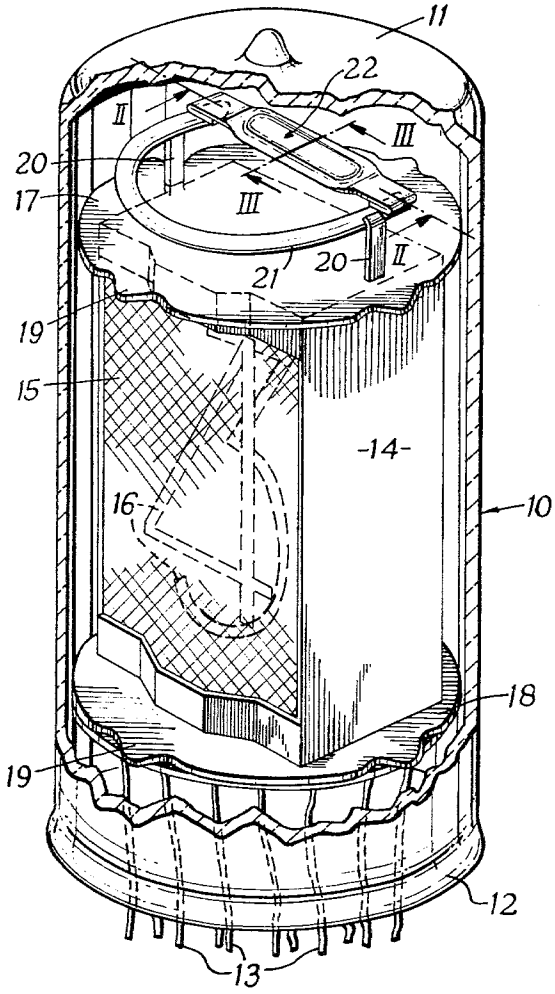


Fig. 1.

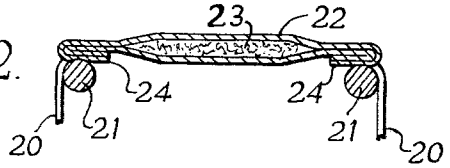


Fig. 2.



Fig. 3.

INVENTOR
CECIL HEDWORTH MAYER
BY
Irvin S. Thompson
ATTORNEY

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METHOD OF CONSTRUCTING COLD CATHODE GAS DISCHARGE TUBES

Cecil Hedworth Mayer, Chesham, England, assignor to Hivac Limited, South Ruislip, Middlesex, England, a British company

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This invention relates to cold-cathode gas discharge tubes and is particularly, although not exclusively, concerned with tubes whose glow discharge provides a visual indication as, for example, in multiple cathode tubes of the digit or other character or symbol display type which comprise a stacked array of differently shaped cathodes disposed in parallel spaced relation within a surrounding anode-forming box.

It is already known to introduce a small quantity of mercury into the gas-filled discharge space with a view to increasing the luminosity and the useful life of the tube by reduction or elimination of cathode sputtering. Hitherto, however, such introduction of mercury has usually been effected either by the distillation of mercury vapour at a late stage of the tube pumping process or by the direct insertion of a droplet of mercury into the tube envelope before the commencement of processing or by the insertion of a sealed capsule of mercury during the tube construction, which capsule is arranged to be broken to release its contents after completion of the pumping process and sealing of the tube.

Such known methods necessitate the handling of liquid mercury at some stage and this is generally undesirable. The first and second mentioned methods have the further disadvantage of contaminating the pumping system with mercury.

It is also known to introduce, into the discharge space of a gas discharge tube, a pill of a mixture of mercury oxide with two separate reducing media, one quick-acting and the other slow-acting. Such pill is disposed on a carrier which is heated after the discharge vessel has been degassed to cause reduction of the mercury oxide to free mercury. Zirconium was suggested as the most suitable quick-acting reducing medium while for the slow-acting reducing medium, which is essential to retard the otherwise explosive character of the thermite reaction which takes place between the mercury oxide and zirconium, either iron or nickel, manganese, chromium or cobalt were proposed.

The present invention represents an improvement on such last-mentioned method of introducing mercury into a discharge vessel by means of which the use of a second slow-acting reducing medium for the purpose of slowing down and thus preventing an otherwise explosive, disadvantageous and possibly dangerous reaction is entirely avoided with consequent simplification and cheapening of the manufacturing process.

The method of the present invention is characterised by the introduction, prior to pumping and sealing of a cold cathode gas discharge tube whose low pressure gas filling is to include mercury, of a quantity of a mixture of suitable oxide of mercury and red or amorphous phosphorus, which mixture is heated after completion of pumping and sealing of the tube to reduce the oxide to free mercury. The preferred oxide of mercury is yellow mercuric oxide and one preferred composition of the mixture

is in the proportion of 4.3 grams HgO (yellow oxide of mercury) to 0.3 gram amorphous phosphorus. Such a mixture provides 20% excess of phosphorus over that required to absorb all the oxygen from the oxide. This excess phosphorus is dispersed and assists in cleaning up any other free oxygen present within the tube.

The measured portion of the mixture is preferably used in the form of a compressed pellet which is either formed in or is placed uopn a recess previously formed in a suitable metal mounting plate.

In order that the nature of the invention may be more readily understood one particular practical embodiment thereof will now be described with reference to the accompanying drawing in which:

FIGURE 1 is a perspective view, with certain parts broken away, illustrating a cold cathode gas discharge tube constructed in accordance with the invention;

FIGURE 2 is a longitudinal sectional detail view, drawn to an enlarged scale, taken approximately along the line II—II of FIGURE 1; while

FIGURE 3 is a transverse cross-sectional detail view, also to an enlarged scale, taken approximately on the line III—III of FIGURE 1.

In the drawing, the invention is shown applied to a cold cathode gas discharge tube of the already known multiple character display type in which any one of a number of differently shaped cathodes, conveniently in the form of numerals or letters, can be caused to glow by selective energisation in conjunction with a common anode. The device as shown comprises a tubular shaped envelope **10** of glass closed at its upper end by a top tubulation end wall **11** and at its lower end by a base seal **12** through which project a number of separate connecting wires **13**, usually one for each of the different character cathodes and one or more for the associated common anode.

Within the sealed interior of the envelope is disposed a box-like anode structure **14** which, in horizontal section, is of rectangular section having imperforate side and rear walls closed by a front wall **15** of foraminated character, e.g. of expanded metal or wire mesh. Within this anode structure, mounted upon suitable horizontal support rods and individually insulated therefrom, are the various character-shaped cathode electrodes as shown at **16**, each cathode being of thin and open wire-like form. The upper and lower ends of the hollow anode structure are closed by mica discs **17**, **18**, each being conveniently provided with a plurality of radially projecting tongues **19** adapted to form a tight frictional fit within the envelope **10** so as to retain the electrode assembly rigidly in position in the already well known manner.

The opposing side walls of the anode are each formed at their respective upper and lower ends with a narrow centrally located and integral projecting tongue which is caused to pass through corresponding slots in the adjacent mica disc **17** or **18** so as to locate and secure the parts together. The upper end tongues, shown at **20**, are arranged to project above the level of the upper mica disc **17** into the substantially enclosed space at the upper end of the envelope.

To the upper end of each of these tongues **20** is secured, in electrically conductive manner as by welding, a C-shaped electrically conductive member **21**, e.g. of solid wire or rod form. The points of attachment of the tongues **20** to such C-shaped member **21** are conveniently located just short of each of the two free ends of such

member and to these free ends, in bridging relation between them, is secured, again in electrically conductive manner as by welding, a capsule **22** containing the pellet or measured quantity of the mercury-introducing mixture. Such capsule is in the form of a length of very thin-walled metal tubing which, although initially of circular section, eventually has a central section of oval or flattened form containing the mixture **23** which is preferably of yellow mercuric oxide and red phosphorus in the proportion of 4.3 grams oxide and 0.3 gram amorphous phosphorus. To retain the mixture in the form of an enclosed pellet, each end of the tube is completely flattened and then bent over and clinched against the main part of the tube as shown at **24** in FIG. 2 prior to the connection, as by spot welding, of each end to the aforesaid free ends of the C-shaped member **21**.

Although the upper part of the envelope **10** within which the capsule **22** and its mounting are disposed is substantially separated from the rest of the space within the envelope, there is free gas interchange between the two regions.

The discharge tube, after assembly, is exhausted in the usual way and after the usual gas cleaning steps, is then filled with an appropriate low pressure gas mixture suitable for providing the required cathode glow when any single cathode and the associated common anode are suitably energised. During the normal cleaning of the tube, it is arranged that the capsule **22** with its mixture pellet and its mounting are not unduly heated but after sealing off of the tube from the pump line the upper end of the tube is placed within the field of an RF heating coil to cause the induction of circulating currents in the conductive metal loop formed by the C-shaped member **21** and the bridging pellet-containing capsule **22** whereby the latter is heated to a sufficiently high temperature to reduce the enclosed mixture with perforation or disruption of the capsule wall. As a result mercury, the amount of which can be accurately controlled from the known composition of the mixture and the amount thereof which is provided for each pellet, is released within the envelope.

Various modifications may be made without departing from the scope of the invention. For example, the mercury-providing mixture may be pre-formed as a compressed pellet which is placed in a suitable receiving recess in a metal mounting plate and then retained therein by a cover plate which is folded over and secured to cover and enclose the pellet. In another alternative form, the mixture may be wrapped in a metal foil strip whose ends are twisted or folded and secured to the other parts of the assembly.

What is claimed is:

1. Method of constructing a cold cathode gas discharge tube having a low pressure gas filling which includes mercury, which method comprises the steps of introducing with the tube envelope prior to pumping and sealing a quantity of a mixture of an oxide of mercury and red phosphorus, evacuating said tube envelope, introducing into said envelope the gaseous filling other than mercury, sealing said tube envelope and then heating said mixture to reduce said oxide to free mercury.

2. Method of constructing a cold cathode gas discharge tube having a low pressure gas filling which includes mercury, which method comprises the steps of introducing within the tube envelope prior to pumping and sealing a quantity of a mixture of yellow mercuric oxide and red phosphorus, evacuating said tube envelope, introducing into said envelope the required gaseous filling other than mercury, sealing said tube envelope and then heating said mixture to reduce said yellow mercuric oxide to free mercury.

3. Method of constructing a cold cathode gas discharge tube having a low pressure gas filling which includes mercury, which method comprises the steps of introducing within the tube envelope prior to pumping and sealing a quantity of a mixture of yellow mercuric oxide and amorphous phosphorus in the proportion of 4.3 grams of oxide to 0.3 gram of phosphorus, evacuating said tube envelope, introducing into said envelope the required gaseous filling other than mercury, sealing said tube envelope and then heating said mixture to reduce said yellow mercuric oxide to free mercury.

4. The method of introducing mercury to form part of the low pressure gas filling of a cold cathode gas discharge tube which consists in forming a solid body of a mixture of an oxide of mercury and red phosphorus, inserting such solid body within the tube envelope, pumping and sealing said tube envelope and then heating said body to reduce said oxide to free mercury.

5. The method of introducing mercury to form part of the low pressure gas filling of a cold cathode gas discharge tube which consists in forming a solid body of a mixture of yellow mercuric oxide and red phosphorus, inserting such solid body within the tube envelope, pumping and sealing said tube envelope and then heating said body to reduce said oxide to free mercury.

6. A process for filling the discharge chamber of a cold cathode gas discharge tube which comprises the steps of supporting within said chamber a thin-walled metal enclosure containing a measured quantity of a mixture of a suitable oxide of mercury and red phosphorus, evacuating said chamber, sealing said chamber and then heating said enclosure by radio frequency induction to raise said mixture to a temperature sufficient to reduce said oxide to free mercury.

7. A process for filling the discharge chamber of a cold cathode gas discharge tube which comprises the steps of supporting whithin said chamber a thin-walled metal enclosure containing a measured quantity of a mixture of yellow mercuric oxide and red phosphorus, evacuating said chamber, sealing said chamber and then heating said enclosure by radio frequency induction to raise said mixture to a temperature sufficient to reduce said oxide to free mercury.

8. A process for filling the discharge chamber of a cold cathode gas discharge tube which comprises the steps of supporting within said chamber a ring-shaped thin-walled metal enclosure containing a measured quantity of a mixture of yellow mercuric oxide and red phosphorus in the proportion of 4.3 grams of oxide to 0.3 gram of phosphorus, evacuating said chamber, sealing said chamber and then heating said enclosure by radio frequency induction to raise said mixture to a temperature sufficient to reduce said oxide to free mercury.

9. The method of constructing a cold cathode gas discharge tube comprising an envelope, a plurality of electrodes within said envelope and a low pressure gas filling said envelope, which method comprises the steps of introducing within said envelope at a position spaced from said electrodes a compressed pellet of a mixture of a suitable oxide of mercury and red phosphorus, evacuating said envelope, introducing the gas filling within said envelope, sealing said envelope and then heating said pellet to a temperature sufficient to reduce said oxide to free mercury.

10. The method of constructing a cold cathode gas discharge tube comprising an envelope, a plurality of electrodes within said envelope, and a low pressure gas filling said envelope, which method comprises the steps of introducing within said envelope at a position spaced from said electrodes a compressed pellet of a mixture of yellow mercuric oxide and red phosphorus confined within a surrounding thin-walled metal enclosure, evacuating said envelope, introducing the required gas filling within said envelope, sealing said envelope and then placing said tube to locate said pellet and enclosure within a radio frequency induction field to heat said mixture to a temperature sufficient to reduce said oxide to free mercury.

11. The method of constructing a cold cathode gas discharge tube comprising an elongated tubular envelope containing a plurality of separate electrodes disposed to-

wards one end of such envelope and a low pressure gas filling, which method comprises the steps of forming a pellet of a mixture of yellow mercuric oxide and amorphous phosphorus, confining said pellet within a thin-walled metal enclosure, securing said pellet and its enclosure within said envelope at a position towards the end of the envelope opposite to said electrodes, evacuating said envelope, introducing said gas filling, sealing said envelope and then placing said tube to locate said pellet and its enclosure within a radio frequency induction field to heat

said mixture to a temperature sufficient to reduce said oxide to free mercury.

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FRANK E. BAILEY, *Primary Examiner.*