Jan. 21, 1941. C. M. SCHWARTZ 2,229,138

VAPORIZING MATERIAL

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Fig. 1.

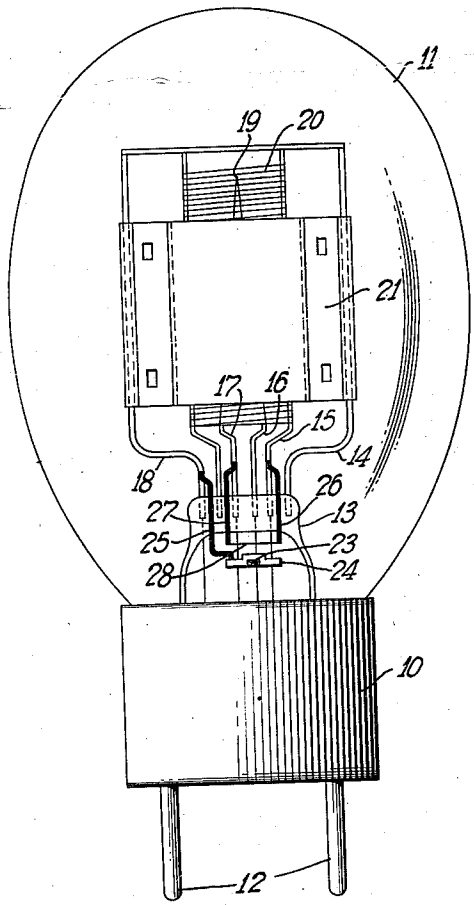


Fig. 2.

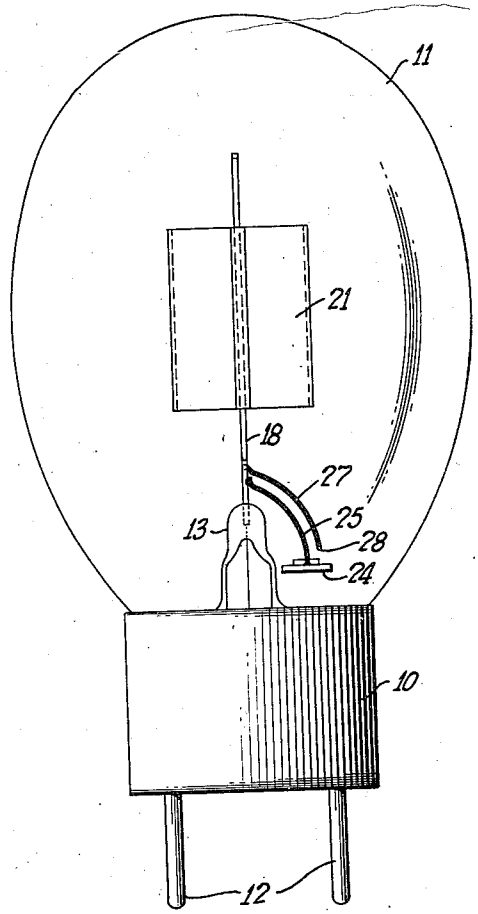
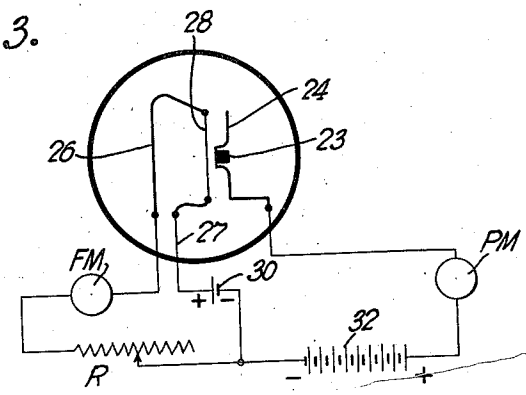


Fig. 3.



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UNITED STATES PATENT OFFICE

2,229,138

VAPORIZING MATERIAL

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1 Claim. (Cl. 250—27.5)

This invention relates to a method of flashing or vaporizing materials in an enclosed chamber, as for example vaporizing caesium in the making of a photocell or the flashing of a clean-up chemical, generally referred to as a getter, in the making of various types of vacuum apparatus.

The invention will be herein described more particularly as applied to a radio vacuum tube, but from that description its application for other uses will be evident.

In the construction of vacuum tubes, the final clean-up of the residual gases remaining after the mechanical exhaustion is completed, is obtained by vaporizing or burning within the inclosure some chemical, such as magnesium, which is capable of chemically uniting with the residual gases to render them inert. These getters may commonly take the form of a small pellet or particle held within the inclosure from some support which remains itself inert until after the tube is sealed off and then is rendered active by being heated to a high temperature until it vaporizes or burns. Several methods of heating have been attempted but each has had serious limitations. In the making of vacuum tubes with a glass envelope the tubes have been placed in a high frequency field which heats the metal parts within the tube to a high temperature by the induction currents produced. Such a procedure, however, heats all of the metallic elements within the field and this in itself may produce disadvantageous effects, as for example it may drive from the heated metal included or occluded gases, which in part overcome the effects of flashing. This procedure also has the limitation that it cannot be effectively applied to tubes with a metal envelope because the envelope itself shields the internal parts from the high frequency current and itself becomes overheated.

In the making of metal tubes a different method has been attempted. The getter is thus attached to the inner wall of the envelope itself, opposite a point marked on the outside, then after the tube is sealed off the localized point on the envelope is highly heated until the getter flashes. This procedure cannot be relied upon to flash the getter all of the time, and thus it gives no assurance that the getter has been flashed, so that tubes produced by this method cannot be relied upon to give uniform service.

It will be readily understood that, by reason of the fact that the envelope is of metal, there is no possible indication from the outside, as to whether the getter has been flashed or not, moreover, the localized heating of the envelope tends to make the envelope at that point porous so that it may either transmit into the interior of the tube or drive off into the tube from the interior of the metal, residual gases which in part counteract the effect of the flashing.

In the making of photocells methods of flashing involving general heating are not satisfactory, since many of these photocells rely, as their active material, upon chemicals such as caesium or silver oxide, the activity of which is impaired or destroyed by heating, so that, to the extent that the flashing overheats the active material, the functioning of the device is impaired.

It is an object of this invention to provide a method and apparatus by which the various troubles may be overcome and the proper heating, flashing or burning of the chemicals may be produced without in any way adversely affecting any of the other parts of the device.

It is a further object to provide a method of flashing which will indicate in the act of flashing that the flashing has in fact taken place so that even though the envelope of the device may be a metal or other opaque material the operator may be certain that the tube so flashed will be reliable in operation.

It is a further object to provide a method which will function satisfactorily within a metal envelope so that the flashing may be conducted satisfactorily regardless of the type of envelope used.

It is a further object to provide a method by which the getter or material may be heated as much as desired for as long a period as desired within the capacity of the device without overheating the active elements.

The invention accordingly comprises the several steps and the relation and order of one or more of such steps with respect to each of the others, and the apparatus embodying features of construction, combinations of elements and arrangement of parts which are adapted to effect such steps, all as exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claim.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description, taken in connection with the accompanying drawing, in which:

Figure 1 is a front elevation of a tube embodying this invention, the active elements of the invention being indicated in heavy lines.

Figure 2 is a side elevaton of the same.

Figure 3 is a circuit diagram illustrating the flashing operation.

In the drawing the numeral 10 designates a base supporting the envelope 11 and having the usual contact prongs 12. Within the envelope there is the usual press 13 carrying the various support wires 14 or lead-in wires 15, 16, 17 and 18. All of these parts of the tube are diagrammatically shown, all representing a typical radio tube which may have a filament 19, grid 20 and plate 21.

In accordance with this invention, the getter material 23 may be supported on a small nickel plate 24 carried by a wire 25 attached to one of the lead-in wires 18. Two more special wires 26 and 27 are welded to two of the lead-in wires which are normally insulated from each other and from the lead-in wires 18 and support at their lower ends a filament 28 preferably in close proximity to the getter material 23; as this filament does not need to be capable of long life it may be made of relatively less expensive material such as molybdenum. A tube embodying this invention may be otherwise built in accordance with any standard specifications.

As will be seen from the drawing, the getter is preferably in a recess depressed upwardly in the plate 24 opening downwardly; this getter assembly is preferably disposed far below the active elements of the tube so that the gettering effect may be obtained without undue deposit of the getter material on the active elements of the tube.

After the tube has been exhausted and sealed off an electric current sufficient to heat the filament 28 to incandescence is applied to the lead-in wires 15 and 17 to which the filament 28 is connected, and a positive potential is applied to the lead-in wire 18.

In accordance with the well known Edison effect if a positive potential is placed adjacent to a heated cathode it will attract electrons discharged from the cathode, the impact of which will tend to heat the anode. The degree of heating is in part determined by the potential applied to the anode, and this principle is made use of in this invention. The temperature of the filament 28 and the potential on the getter 24, serving as an anode, are so chosen that the getter plate itself is quickly heated to the desired temperature by reason of this Edison effect.

The current passing between the cathode and the anode is greatly augmented by the presence of the residual gases in the tube so that the getter is quickly flashed. As soon, however, as the flashing takes place and the residual gases are cleaned up by the getter, the gas pressure within the tube drops to a small fraction of what it formerly was, with the result that the current passing between anode and cathode drops off correspondingly. As soon as the getter has been flashed an excess voltage may be applied between lead-in wires 15 and 17 to burn out the filament 28, leaving the tube in normal operating condition.

Thus it will be seen that the getter is flashed without heating any of the active elements of the tube and that a definite and positive indication is obtained as to when the getter is flashed and as to whether the flashing has been effective in removing the residual gases.

In the form of the invention here disclosed the wire 26 is shown connected to the grid lead-in wire 15 while the wire 27 is shown connected to the filament lead-in wire 17. This makes it easy to heat the filament 28 and to burn it out when desired.

Where tubes are desired for excessively short waves or where for any other reason the presence of the dependent wire 26 from the grid lead-in is found undesirable, the same effect may be obtained by connecting the filament 28 in multiple with the filament 19 of the tube, if it be made for a very much lower voltage. For example, if the filament 19 be adapted to operate on 3½ volts, the filament 28 may be adapted to burn out at two volts.

In Figure 3 there is illustrated a circuit diagram showing only the filament 28 and the getter material 23 within the tube but indicating the flashing operation. In that view the numeral 30 represents a small battery connected on its positive side to the dependent wire 27 and on its negative side through a control resistance R and a filament meter FM, to the wire 26 so that by control of the resistance R, the heating of the filaments may be controlled. The numeral 32 represents a battery for imposing a positive potential upon the anode, this battery being illustrated as having its negative terminal connected to the negative terminal of the battery 30 and its positive terminal connected through the meter PM to the anode 24. With the circuit thus arranged, when the filament circuit has been properly adjusted the plate meter will indicate the amount of space current flowing.

As soon, however, as the flashing takes place this space current will fall off to a very small fraction of what it formerly was and this falling off is an indication not only that the flashing is taking place but also that the flashing has been effective.

In the use of this invention, some of its advantages may be obtained regardless of the getter employed. I have found, however, that the presence of the residual gases during the flashing is helpful in producing the final effect. For example where this method is used with a getter composed of barium alone an initial space current may be produced with low voltage. As soon as the barium starts to warm up, however, it itself begins to absorb the gases and if the anode potential remains constant, the space current may drop off so much that the anode will not be adequately heated. If the invention is used with pure barium, therefore, it will be necessary to increase the anode potential to more than 300 volts in order to maintain a space current sufficient to heat the anode.

Such voltage will not be required, however, if alloy getters are employed and for example if the getter be in the form of an imbedded alloy I have found it much easier to maintain the space current up to the flashing point with low voltage.

Whenever it is desirable to have a pure barium deposit within the tube, this can be obtained event at low voltages by the use of an alloy imbedded getter, as for example an alloy of 50% barium and 50% aluminum. Such an alloy tends to maintain its space current quite readily at relatively low voltages, less than 300 volts, while nevertheless producing a complete and effective clean up with a barium deposit.

As an illustration of the practical dimensions of the parts of this invention as applied to a standard thermionic valve the cathode 28 may consist of a ¾ inch section of .005 inch molybdenum wire.

The getter 24 may be a required quantity of a barium alloy imbedded in a ½ inch square sheet of nickel of .005 inch in thickness.

The position of the cathode relative to the

getter assembly is not critical. In practice in order to conserve space the distance between them may be as close as 2 mm. The getter assembly should be placed pointing away from the interelectrode space, that is pointing away from the filament, so that the high concentration of metallic vapor produced on flashing does not cause an arc to strike between the electrodes. The ½ inch square nickel flag in which the getter material is imbedded prevents the back-flashing of the getter, and directs it in the proper way.

With parts of the dimensions given and 2½ amperes flowing through the filament 28 with 300 volts positive upon the anode there results a blue glow due to the gas ionization. The space current rises steadily to a maximum of 0.2 ampere until the getter flashes after about a minute. The space current thereupon drops immediately.

Since certain changes in carrying out the above process and in the constructions set forth, which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claim is intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention, which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent, is:

The method of vaporizing a getter within a vacuum tube having operating elements therein and at least three lead-in wires leading to said elements which comprises connecting a separate cathode across two of said lead-in wires and a getter assembly to another of said wires adjacent to said cathode and then after sealing and evacuating the tube, heating said cathode to the point of electron emission and imposing a positive potential upon said getter assembly to cause the passage of a current between said cathode and said getter assembly until said getter is flashed and then destroying said separate cathode.

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