Nov. 30, 1937. H. J. MILLER ET AL 2,100,746

GETTERING VACUUM TUBE

Filed Nov. 7, 1935

Fig. 1

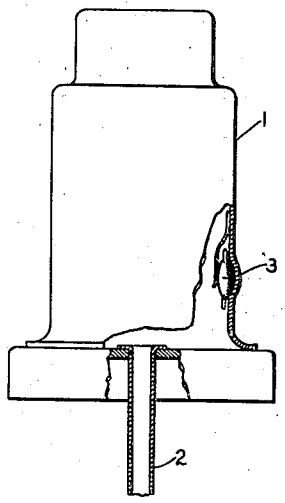


Fig. 3

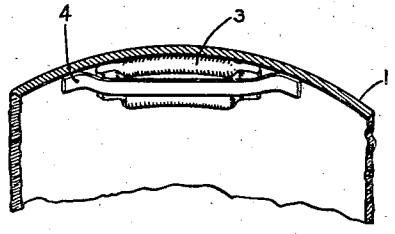


Fig. 4

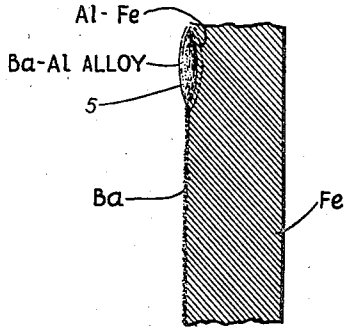


Fig. 2

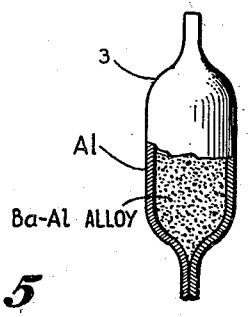
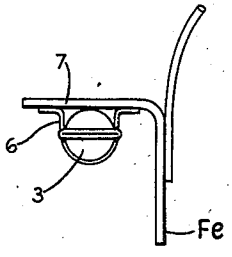


Fig. 5



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Patented Nov. 30, 1937 2,100,746

UNITED STATES PATENT OFFICE

2,100,746

GETTERING VACUUM TUBE

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Application November 7, 1935, Serial No. 48,658

7 Claims. (Cl. 250—27.5)

This invention relates to the manufacture of vacuum tubes such as electron discharge devices and the like, and more particularly to the evacuation of such devices by the aid of chemically active vaporizable clean-up agents or getters which are vaporized or flashed during exhaust to reduce the pressure of the residual gases and vapors left in the device by mechanical pumping.

It is the usual practice to use as a getter or clean-up agent an active metal, such as an alkaline earth metal, and to introduce the agent into the device in the form of compounds of the metal from which the metal may be liberated by heating and decomposing the compound after the tube is evacuated by the pumps. Extensive use has been made of alloys of the active alkaline earth metals such as alloys of barium and aluminum or magnesium and aluminum or of all three metals. In these alloys the aluminum protects the active alkaline earth metals against oxidation until the alloy is decomposed in the discharge tube by heating. Usually these alloys to be introduced into the discharge tube are shaped into pellets and fixed to a getter carrier or getter tab which is then heated at the proper stage of exhaust by high frequency induction heating.

The conventional methods of using these getters have given good results in electron discharge devices having glass envelopes, but the results obtained with them have not been so favorable in the metal tubes in which the envelope consists of iron or a mild steel. The commercial procedure in exhausting a metal tube involves the heating of the shell or envelope of the metal tube by gas flames to a red heat during exhaust and dispenses with the use of the high frequency heating generally used in connection with the glass envelope tubes. It has been found difficult to obtain and to maintain in the metal tubes as good a vacuum as is desired, due apparently to the liberation of gases from the metal parts of the tube during exhaust and during normal operation.

One object of this invention is to provide an improved getter of the alkaline earth metal type in which a more profuse and rapid evolution of the active metal takes place than with the conventional getters heretofore used.

Another object of this invention is to provide an improved method of gettering which is useful for all types of vacuum devices, particularly in tubes with envelopes of metal, such as iron.

Still another object of this invention is to modify and improve the gettering of a metal tube in such a way as to have and to maintain throughout its useful life a better vacuum than is possible with the conventional methods of exhaust now in use.

Further objects and advantages of this invention will appear from the following specification and detailed description.

In accordance with this invention an alloy of barium and aluminum is intimately associated with free aluminum preferably by placing the alloy in a casing or tube of aluminum or in a container of sheet aluminum or foil. The barium aluminum alloy which we prefer to use is friable and is preferably powdered and enclosed in the aluminum container, thus forming a getter capsule. This getter capsule is then mounted on and preferably in close thermal contact with the wall of the iron envelope of the metal tube and at the proper time during the exhaust of the tube is heated to the temperature at which the getter flashes, preferably by means of a pointed flame directed against the outside of the metal envelope at the point where the getter is mounted.

The novel characteristics of this invention may be more fully understood by reading the following specification in connection with the accompanying drawing in which:

Figure 1 shows an electron discharge device with a metal envelope and a getter capsule made in accordance with this invention;

Figure 2 shows a getter capsule constructed in accordance with this invention;

Figure 3 is a detailed view of one method of mounting this getter capsule on a curved metal wall;

Figure 4 is a cross sectional view on an enlarged scale of the wall of an iron envelope which has been gettered according to this invention; and

Figure 5 shows a modified getter support for our novel getter capsule.

In the specific embodiment of this invention illustrated in Figure 1, which shows an application of this invention to metal tubes, we have shown a metal tube comprising an envelope 1 having an exhaust tube 2. The getter capsule 3, consisting of a short piece of aluminum tubing containing the powdered alloy and pinched at the ends, is according to this invention located in any desired position on the side wall or in the top or dome of the envelope. The getter which we prefer to use and with which we have obtained good results is an alloy of approximately equal parts of barium and aluminum powdered to pass through a 200 mesh screen and preferably formed

into 20 to 30 mg. pellets wrapped in foil of metallic aluminum to form a getter capsule. One convenient way of making such getter capsules is to pour the powdered alloy into a long cylinder or tube of aluminum with an outside diameter of about .09 of an inch and a wall thickness of about .01 of an inch, and to tamp the powder firmly in the tube by a ramrod. The tube is then pinched off in short sections to form capsules filled with the alloy and of lengths of about one-half of one inch as shown in Figure 2. The getter capsule may be attached to the side wall of the envelope by any retaining means such as a strap welded to the wall. These capsules may be flattened by rolling to an outside thickness of .04 to .05 inch and curved to the inner wall of the metal envelope as indicated in Figure 3 to provide good thermal contact between the envelope and the capsule, and may be held in place in the envelope by any desired securing means such as by spring steel strap 4 placed over the getter capsule and welded at each end to the iron wall.

The metal tube containing our novel getter capsule may be exhausted on the conventional exhaust machine in which the pumps remove the greater portion of the air in the tube and produce a partial vacuum. During pumping, the envelope of the tube, which may conveniently be of .025 inch drawn steel, is heated to a bright red heat by gas flames to drive out the occluded gases from the envelope and also to heat the electrodes inside the envelope to degas them. A few seconds after the gas flames have been removed, and while the tube is still at or slightly below a dull red heat, the getter of this invention is flashed by directing against the wall of the tube at the spot where the getter is secured a pointed gas flame which raises the temperature of a spot about one half inch in diameter on the wall of the tube to near white heat. We prefer to attain the temperature in about four or five seconds, which can be done by supplying oxygen to the gas flame. This localized heating of the envelope at the point where the getter is secured seems to initiate a reaction in the getter which is apparently exothermic, as the hot spot on the tube quickly increases in brightness, and often attains a temperature which as near as we have been able to determine is about 1400° C. This sudden and marked increase in temperature of the hot spot indicates that the getter has flashed. The reaction between the elements of the getter may sometimes be made more pronounced by the inclusion in the capsule of some oxygen as in some cases better results are obtained by heating the getter capsule in air before use.

It has been found that metal tubes exhausted and gettered as above described are remarkably free from gas compared with similar tubes gettered with barium-aluminum alloy flashed in the conventional way on a nickel tab. A tube gettered as above described, when opened shows a bright surface or lining on the inside as indicated in Figure 4, which after exposure to the atmosphere, changes color characteristic of barium, and when chemically tested appears to be predominantly metallic barium. This extended area of active barium on the inner wall of the envelope apparently acts as a "keeper" to maintain the envelope gas free throughout normal operating life.

There is also found on the inner wall of the iron envelope evacuated in accordance with this invention, at the getter location (5), Figure 4, a closely adherent hard mass of barium aluminum alloy with considerable aluminum, part of which is combined with the iron of the envelope to produce a hard film which appears under a microscope to be analogous to the film on calorized iron articles. The temperature and pressure to which the getter is subjected makes the evaporation of aluminum probable, and the appearance of the wall indicates aluminum is deposited throughout the inner surface of the envelope. Further, it has been found that fresh barium may, after aging of the vacuum tube, be liberated from the coated spot of the getter location merely by heating the envelope at said location to a red heat, since residual gases accumulated in the tube after the sealing off may be cleaned up by reheating the getter. When, with a current meter in the anode-cathode circuit of the tube, the envelope is reheated, a momentary increase in gas discharge current through the tube is observed indicating the evaporation of additional getter material, followed by a decrease in gas current to practically zero, indicating a clean up of the residual gases.

The fact that the barium of the alloy of our improved getter is shielded to a certain extent against contamination by moisture or gas by the protective covering of aluminum, may account for the greater amounts of available barium, and hence the improved gas cleaning-up action of our getter.

The advantages of our improved getter and improved method of gettering tubes may be obtained in the exhaust of glass tubes by securing our getter capsule as by a strap 6 to an iron getter tab 7, Figure 5, and mounting the tab in the tube, which is then heated to the flashing temperature of the getter by means of high frequency induction heating.

We claim:

1. A clean up agent adapted for use in producing high vacua which comprises an alloy of aluminum and barium, free aluminum in contact with said alloy, and iron in contact with said free aluminum.

2. A getter composite comprising a getter of powdered alloy of barium and aluminum, a metal getter support, and a metal adapted to react exothermically with said support interposed between and in close contact with said getter support and said getter.

3. An evacuated electrical device comprising a sealed iron envelope enclosing cooperating electrodes, said iron envelope having on an area of its inner wall an adherent coating of aluminum combined with the iron and a coating of at least equal area with a surface which is predominantly barium.

4. Process of producing high vacua in an iron envelope which comprises placing in good thermal conductive relation to a portion of the wall a powdered friable alloy of barium and aluminum in intimate contact with a layer of aluminum interposed between said alloy and said wall and in good contact with said portion of said wall, mechanically evacuating said envelope, calorizing the iron with aluminum of said layer, and heating said alloy to liberate free barium from said alloy.

5. Process of producing a high vacuum in an envelope which comprises introducing into the envelope a clean-up agent consisting of metallic aluminum and an alloy of aluminum and a clean-up material, the metallic aluminum and aluminum of said alloy being physically separable and held in contact with iron; mechanically evacuating said envelope; and alloying the metallic alu-

minum with said alloy and with the iron, and heating to volatilize at least part of the clean-up material in said agent.

6. Process of producing a high vacuum in an envelope with a getter capsule, of aluminum containing an alloy of aluminum and barium, held in contact with iron comprising, mechanically evacuating said envelope, heating said capsule to combine part of the aluminum with the iron and volatilizing at least part of the alloy by the combined heating action of said iron and the exothermic reaction between the elements of the capsule and said iron.

7. Process of producing a high vacuum which comprises introducing into an envelope a clean-up agent consisting of two metals in mutual contact, one being composed predominantly of free aluminum in contact with iron, and the other being an alloy of aluminum and barium, mechanically evacuating said envelope; and alloying the free aluminum with the aluminum of the alloy and with the iron, and heating to volatilize at least part of the clean-up material in said agent.

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