Dec. 27, 1938. C. EDDISON 2,141,644

MANUFACTURE OF EVACUATED METAL ENVELOPES

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Fig. 1

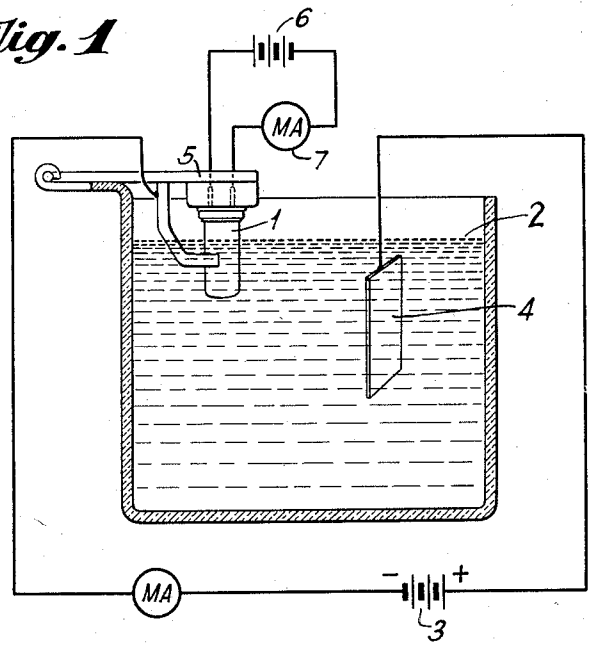
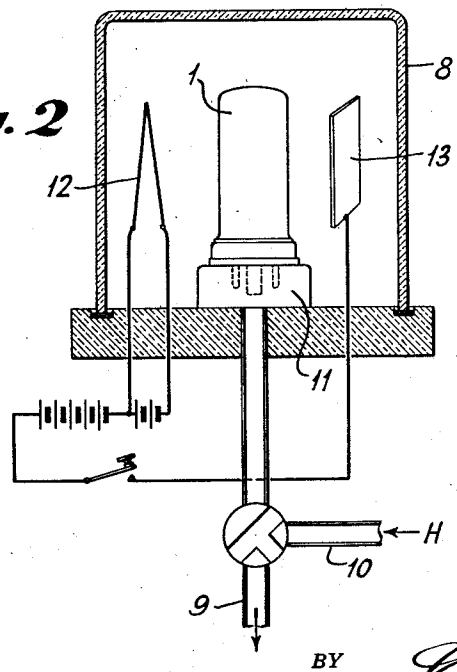


Fig. 2



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MANUFACTURE OF EVACUATED METAL ENVELOPES

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5 Claims. (Cl. 250—27.5)

My invention relates to the manufacture of evacuated metal envelopes, particularly methods of and means for reducing the amount of residual gas in sealed metal envelopes of electron discharge devices and similar articles.

In manufacturing metal envelope radio tubes in the usual way the electrodes are mounted upon a header or stem, the stem welded or sealed to the rim of the envelope, and all parts heated while the envelope is mechanically evacuated through an exhaust tube connected to pumps. The reasonably good vacuum obtained with the pumps is improved by vaporizing or flashing a chemically active getter such as barium, which forms a film or coating on the inner wall of the envelope, and the exhaust tube is then sealed off. In spite of carefully controlled exhaust schedules a number of the finished tubes may contain sufficient residual gases to decrease electron emission from the cathode and in various ways render the tube defective. The presence of the residual gases may be detected by the usual gas test in which gas current flow between the cathode and one or more of the cold electrodes in the tube is measured.

The principal object of my invention is to reduce in a simple and convenient way the residual gas pressure in a finished radio tube made and exhausted in the usual way and having an iron or steel envelope.

Another object of my invention is to provide a simple and convenient way of introducing into a sealed vacuum device, having an envelope with an iron or steel wall, a reactive agent for reducing gas pressure within the envelope.

According to my invention an evacuated sealed envelope of metal permeable to hydrogen is immersed in an environment capable of yielding ionizable hydrogen. The hydrogen is ionized for a predetermined time in the presence of the envelope and then a gas test is made, usually by measuring the gas discharge current between electrodes, to determine the degree of evacuation in the envelope. Reduction in gas pressure in the envelope produced by its treatment in the hydrogen may be accelerated by heat applied to the envelope during or after the treatment. Reduction of gas pressure may also be aided by applying rated voltages to the electrodes in the envelope during or after the treatment in hydrogen. The ionized hydrogen upon the surface of the envelope appears to diffuse through the wall to the inside where it either chemically or mechanically combines with the residual gases in the envelope to reduce the residual gas pressure

According to one embodiment of my invention a sealed iron envelope is immersed in an acid electrolyte and when a current is passed through the electrolyte with the sealed metal envelope connected as a cathode, ionized hydrogen generated in the electrolyte diffuses through the wall of the envelope. According to another embodiment of my invention the necessary ionized hydrogen is diffused through the wall of the envelope by placing the envelope between a plate and a tungsten filament in a chamber filled with hydrogen. A glow discharge between the plate and filament ionizes the hydrogen and readily diffuses it into the metal envelope where a substantial reduction in gas pressure is effected.

A more complete understanding of my invention may be obtained in the following specification and in the accompanying drawing in which—

Figure 1 shows an evacuated metal envelope treated in accordance with my invention in a hydrogen bearing electrolyte, and

Figure 2 shows a metal envelope placed in a glow discharge for treatment according to my invention.

The metal envelope shown by way of example as a radio tube with an iron shell is shown at 1, Figure 1, immersed in an electrolytic solution 2, containing a dilute hydrogen bearing acid or salt. The voltage of a source of current 3 connected on the one hand to the metal envelope 1 and on the other hand to an anode electrode 4 may be adjusted to pass a current through the electrolyte sufficient to decompose the hydrogen bearing compound in the solution and ionize the freed hydrogen. With the metal envelope connected as the cathode in the electrolyte, ionized hydrogen rapidly accumulates at the envelope and diffuses through the wall and into the envelope.

A bracket 5 to hold the envelope is shown hinged to the edge of the electrolyte container to facilitate immersion of a large portion of the envelope without wetting the electrode connections in the base of the envelope. Battery 6 and current meter 7 are provided for measuring the gas discharge current between electrodes in the envelope.

Radio tubes commercially known as 6K7 containing conventional barium-strontium getters and with considerable gas have been successfully degassed and rendered operative by immersing the clean unpainted envelope in a .05 N. solution of potassium bisulfate $KHSO_4$ and passing a current of about 3 milliamperes for

ten minutes through the electrolyte between an iron anode and the sealed envelope, connected as the cathode and having a drawn iron envelope of about .03 inch in thickness. I have found that heat applied to the tube immediately after treatment in the electrolyte accelerates the "clean-up" of the gases in the envelope. Alternatively the gas clean-up may be accelerated by connecting the electrodes in a gas testing circuit ordinarily used for testing tubes in radio tube manufacture. In the case of the 6K7 a cathode bias of zero and rated voltages on the grids and plate were found to be effective in accelerating the rate of clean-up. A direct indication of the gas content in the tube is easily obtained by measuring with a current meter the gaseous discharge between the cathode and the other electrodes in the envelope. Tubes of the 6K7 type with a gas current reading of 12 microamperes are readily cleaned up when treated according to my invention.

While it is not known just what electrical or chemical phenomena takes place in a sealed metal envelope treated in accordance with my invention, I believe that the ionized hydrogen accumulated at the surface of the envelope, diffuses through the metal wall, and combines with the residual gases in the envelope. It is quite probable that the active hydrogen combines with oxygen to produce water vapor at a much reduced pressure which can be absorbed by the getter, or the hydrogen may combine with nitrogen to give compounds of low pressure. An excess of hydrogen however, must not be introduced to the envelope. If the metal envelope is held in the hydrogen bearing environment too long, the gas current reading of meter 7 is found to increase. The optimum time of treatment is determined by such factors as current density in the electrolyte, envelope wall thickness, temperature and surface cleanliness of the envelope.

The ionized hydrogen may, if desired, be provided at the wall of a metal envelope by holding the envelope in a hydrogen atmosphere in which a glow discharge is maintained. Metal envelope 1 containing considerable gas has been cleaned up according to my invention by supporting the envelope as in Figure 2 in a sealed chamber or belljar 8 connected to an exhaust pump through conduit 9 and a source of hydrogen 10. The tube is mounted upon a bracket 11 between a tungsten filament 12 and a metal anode 13. The air in the belljar is replaced by hydrogen and a glow discharge initiated between the anode and filament to ionize the hydrogen in the jar. Tubes of the type commercially known as the 6K7 treated in a gaseous discharge of hydrogen for about ten minutes have been freed of practically all gas. The ionized hydrogen accumulated at the surface of the metal envelope in the gaseous discharge appears to diffuse much in the same manner as in the tube in the electrolyte described in connection with Figure 1.

It will be obvious to those skilled in the art that there are many methods of generating ionized hydrogen at the surface of a sealed metal envelope and that such methods may be employed in practicing my invention. It is accordingly desired that my invention be limited only by the prior art and the appended claims. According to my invention improperly evacuated sealed metal envelopes containing undesired gases may be more completely and easily degassed and the method and means of practicing my invention are easy to follow and are highly useful in salvaging gassy tubes.

I claim:

1. The method of reducing gas pressure in an exhausted and gettered sealed envelope permeable to hydrogen, comprising ionizing hydrogen in the presence of said envelope, and diffusing a predetermined amount of said hydrogen through the wall of said envelope.

2. The method of reducing gas in an exhausted and sealed metal envelope of a radio tube containing a getter of active metals, comprising immersing said envelope in an environment capable of yielding ionizable hydrogen, ionizing said hydrogen, diffusing a predetermined amount of said hydrogen through the wall of said envelope, and then heating said envelope.

3. The method of reducing gas in the sealed metal envelope of a radio tube containing a getter of active metals, comprising immersing said envelope in an environment capable of yielding ionizable hydrogen, ionizing said hydrogen, diffusing a predetermined amount of said hydrogen through the wall of said envelope, and then applying voltages to the electrodes in said tube.

4. The method of reducing gas in a substantially evacuated metal envelope, comprising immersing the envelope in an electrolytic solution containing a hydrogen bearing compound, passing a current through said electrolyte between the envelope connected as a cathode and an anode to liberate and ionize some of the hydrogen in said compound, diffusing the hydrogen through the envelope wall to reduce the gas pressure, and applying voltages to the electrodes in said envelope.

5. The method of reducing the residual gas in the exhausted, gettered and sealed metal envelope of a radio tube, comprising supporting the envelope in a hydrogen filled chamber containing a filament and an anode, initiating a gaseous discharge between the cathode and anode, and continuing the discharge until the residual gas pressure in said envelope is reduced to a minimum.

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