

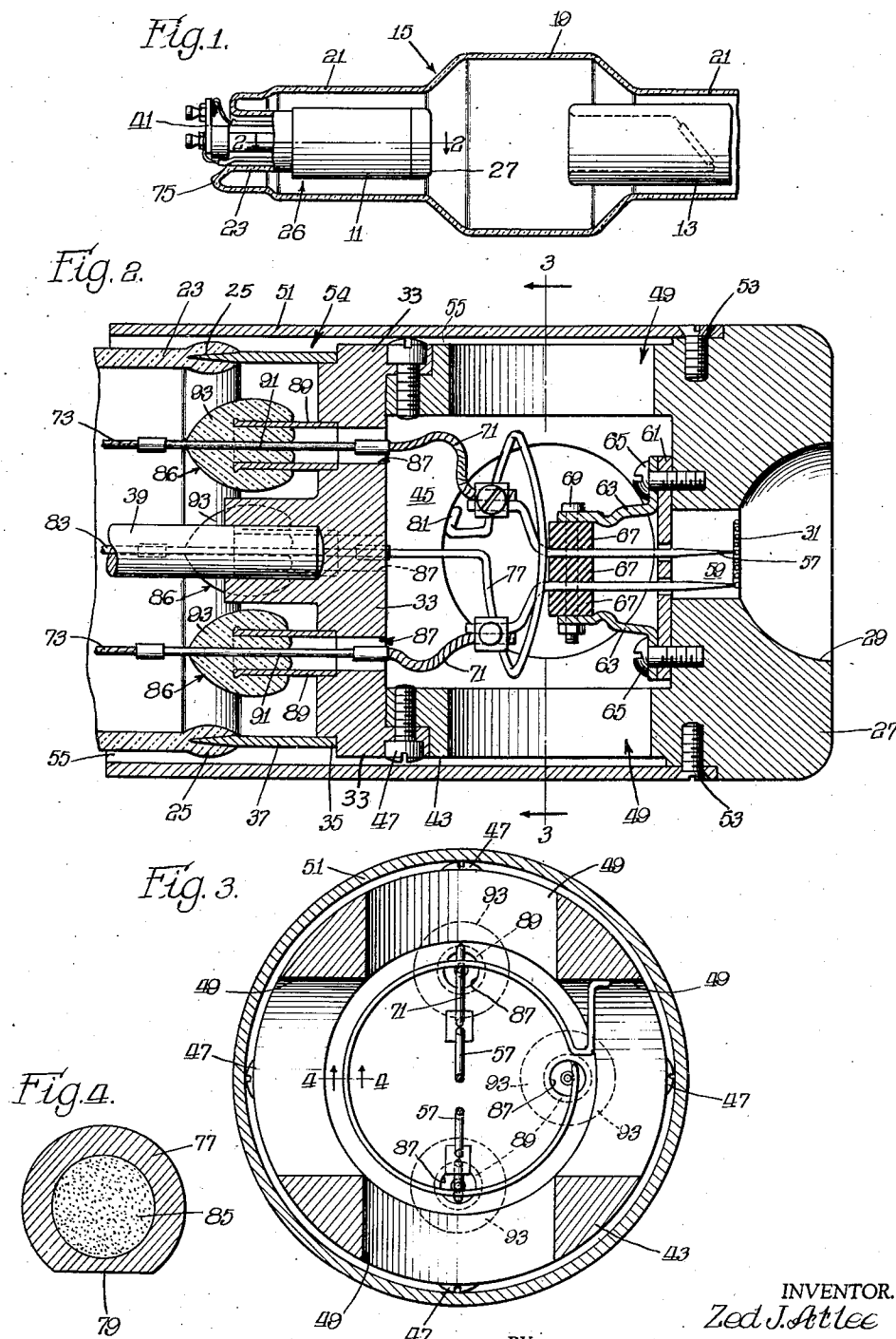
Oct. 28, 1941.

Z. J. ATLEE

2,260,927

GETTER

Filed Sept. 9, 1940



INVENTOR.

Zed J. Atlee

BY

Spencer, Mayall, Johnston & Cook,
ATTYS.

UNITED STATES PATENT OFFICE

2,260,927

GETTER

Zed J. Atlee, Elmhurst, Ill., assignor to General Electric X-Ray Corporation, Chicago, Ill., a corporation of New York

Application September 9, 1940, Serial No. 355,984

5 Claims. (Cl. 250—142)

My invention relates in general to electronics and has more particular reference to X-ray generators.

An important object of the invention is to provide improved gettering means for conditioning the generator for operation after the same has been fabricated.

Another important object is to provide an electronic device, such as an X-ray generator, comprising co-operating anode and cathode electrodes enclosed in a sealed envelope, and to arrange the gettering means as a part of one of the electrodes and enclosed therein, whereby the end products of the gettering operation may not deposit upon and thus contaminate or impair the active portions of the anode or cathode electrodes.

Another important object is to form and arrange the gettering means within an enclosed chamber formed within one of the electrodes of the electron discharge device, the chamber being in open communication with the interior of the electrode-enclosing envelope through a somewhat tortuous and restricted opening, whereby the end products of the gettering operation may be confined within the chamber.

Another important object is to provide, in a device of the character mentioned, an electrode formed with an active or working head, and means on the head forming an internal pocket opening remotely from said head, and to position gettering means in the pocket and to partially close the open end of the pocket so that end products of the gettering operation may be substantially confined within the pocket; a further object being to form the electrode with a dependent skirt on said head and to mount the head on a support forming a glass-to-metal seal with re-entrant envelope portions within the skirt, so that the skirt defines, with said support and re-entrant envelope portions, a restricted annular channel communicating the chamber within the electrode with the interior of the envelope outwardly of the electrode.

Another important object is to mount the gettering means within a chamber formed in the cathode element of the electron discharge device.

These and numerous other important objects, advantages and inherent functions of the invention will become apparent as the same is more fully understood from the following description, which, taken in connection with the accompanying drawing, discloses a preferred embodiment of the invention.

Referring to the drawing:

Figure 1 is a sectional view taken through an X-ray generator;

Figure 2 is an enlarged sectional view taken substantially along the line 2—2 of Figure 1;

Figure 3 is a sectional view taken substantially along the line 3—3 in Figure 2; and

Figure 4 is an enlarged sectional view taken substantially along the line 4—4 in Figure 3.

To illustrate my invention, I have shown on the drawing an X-ray generator comprising a cathode 11 and an anode 13 in spaced-apart relationship in position to co-operate to cause the anode to function as a source of X-rays when energized by the electronic action set up by the operation of the cathode. The anode and the cathode are enclosed in a preferably glass envelope 15, being sealed in the envelope at the opposite ends thereof. The envelope, as shown in the drawing, comprises a central enlarged portion 19 formed at its opposite ends with sleeve-like envelope extensions 21. The outer ends of the extensions may be turned inwardly to form re-entrant sleeve portions 23, and the active electrode elements of the X-ray generator are preferably mounted on said re-entrant sleeve portions and sealed thereto, as at 25. Although in Figure 1 I have shown only the cathode seal, it will be understood that the anode likewise may be sealed in the opposite end of the envelope in like or other suitable or preferred fashion.

The cathode 11, as shown, comprises a head 27 formed with a cup-shaped cavity 29 facing toward the anode, Fig. 2. In the bottom of this cavity is positioned an electron emitting element comprising the filament 31. The head 27 is supported on a mounting 33 comprising a plate or disk, the edges of which are sealingly secured, as at 35, to a sleeve-like member 37 having a rim 40 forming the glass-to-metal seal 25 with the re-entrant envelope portions 23. The plate 33 preferably carries a rod or stem 39 secured thereto extending axially therefrom within the re-entrant portions 23 of the envelope. This stem terminates outwardly of the end of the envelope and provides support for a terminal board 41. The cathode head 27 may, of course, be secured on the mounting plate 33 in any suitable or preferred fashion, but, as shown, the head is formed with a cylindrical wall 43 defining a chamber 45 within the annular wall immediately behind the head 27. The circular edge of the wall 43 remote from the head is secured on the mounting plate 33 as by means of the fastening screws 47. Lateral openings 49 are formed in the walls 43. A

cylindrical, sleeve-like skirt 51 is secured at one end on the head 27 as by means of the fastening members 53, said skirt enclosing the walls 43, the mounting plate 33, the seal ring 39, and portions of the re-entrant envelope portions 23, including the glass-to-metal seal 25. The end of the skirt 51 terminates within the annular space 26 defined between the re-entrant portions 23 and the envelope extension 21 and, it will be noted, provides a restricted annular space 54 which opens, as at 55, into the space 26 and thus connects the chamber 45 with the interior of the envelope 15 outwardly of the electrode through a tortuous restricted channel comprising the openings 49 and the space 54.

The element 31 comprises a filament accurately positioned in the bottom of the depression 29 on stems 57 which extend through an opening 59 formed in the head between the bottom of the depression 29 and the internal cavity 45. The stems 57 extend through openings in a plate 61 which covers the end of the cavity 59, and the stems 57 extend through the cover plate 61 and into the chamber 45. The stems are supported within the chamber 45 by means of a clamp comprising a pair of bracket members 63 having portions adapted to be secured upon the under side of the head 27 as by means of the screws 65, which also serve to hold the plate 61 in place. The spaced brackets receive clamping blocks 67 of suitable insulating material, such as magnesium silicate, which are arranged to clampingly secure the filament support stems 57 therebetween, the blocks 67 being maintained in clamped relationship by means of clamping screws 69. The stems 57 preferably comprise relatively rigid wires forming conductors, the ends of which are spread apart adjacent the clamping blocks 67 in order to facilitate connection with conductor means 71 extending through and sealed in openings formed in the support plate 33 and by means of which the insulated filament supporting stems may be connected with an external power source through the cables 73 which extend within the re-entrant envelope portion 23 to the terminal board 41 for connection with the power source.

In conditioning an X-ray generator for operation, it is necessary to remove all gas that is present within the envelope, and also any gas occluded in the electrodes and in the material of the envelope itself. If such occluded gases are not substantially entirely removed, they will gradually be released within the envelope and impair the exhausted condition at which the device is designed to operate.

Removal of gases from the envelope is accomplished by baking or otherwise heat treating the entire device at a temperature short of the softening point of the glass, while keeping the exhaust means in operation, and also by heating the electrodes to a high temperature, either by electron bombardment or by placing the electrodes in a magnetic field fluctuating at frequencies of the order of radio frequency.

After all gas including occluded gases and other impurities have thus been removed from the envelope, the exhaust connection may be sealed off, as at 75, and as a final step, a suitable gettering material may be volatilized within the envelope, in order to form end products of the gettering material, and any trace of gas or other impurities remaining in the envelope, such end products being inert and innocuous and remaining within the envelope during the service life of the device in the form of a film-like deposit

on such surfaces of the device on which the volatilized gettering material may condense as a result of the gettering operation.

Any suitable gettering material may, of course, be employed, and I prefer to use barium and/or magnesium and preferably a mixture of the named metals. In any event, the gettering material has a high melting point and is characterized by a tendency to remain immobilized after being volatilized and condensed as a film as aforesaid. In electron flow apparatus, and particularly in X-ray generators, it is important that the gettering operation be accomplished in a fashion preventing deposit of the gettering material on the outer or active surfaces of the electrodes, and I provide means for accomplishing the gettering operation within the envelope 15 while eliminating the possibility of the deposit of gettering end products on the external surfaces of the electrodes.

I accomplish this desirable result by vaporizing the gettering material within a gettering chamber formed within an electrode, which chamber is in open communication with the interior of the envelope outwardly of the electrode through a tortuous channel, whereby volatilization of the gettering material within the confined chamber will nevertheless exert a gettering effect throughout the envelope while preventing the escape of vaporized gettering material into the envelope outwardly of the electrode. To this end, I provide means for vaporizing the gettering material within the chamber 45, and while I have illustrated the invention by means of structure in which the gettering is accomplished within an enclosed chamber formed in the cathode element, it will be apparent that the anode also may be formed with an internal chamber within which to carry out the gettering operation, and my present invention is not necessarily confined to gettering facilities enclosed within the cathode structure.

In the illustrated embodiment, however, the gettering apparatus comprises a tubular wire 77 of electrical conducting material, one side of which is of reduced section as at 79. This wire is arranged in the form of a loop within the chamber 45 with the portion of reduced section facing toward the mounting plate 33. One end of the wire is electrically connected, as at 81, upon the wall 43 preferably on the surface defining one of the openings 49. Since the wall 43 is electrically connected with the plate 33, it is also electrically connected with the stem 39 which extends outwardly of the envelope. The other end of the member 77 extends through and is sealed in an opening in the wall 33, by means of which the wire 77 may be connected with an external power source through the conductor 83 which extends within the re-entrant envelope portion 23 to the terminal plate 41 for connection with a power source, the other side of which may be electrically connected with the stem 39 in order to vaporize the gettering material 85 which is disposed within the hollow wire 77. By delivering electrical current through the wire 77, the same may be heated to a temperature sufficient to vaporize the material 85 within the wire, the vapor thus generated being expelled outwardly through the walls of the hollow wire at the section 79 of reduced thickness. The volatilized gettering material thus expelled will be directed upon the facing surface of the support member 33 and will condense and form a deposit of the gettering material on said wall.

Any trace of gas or other impurities remaining in the envelope after the completion of the exhausting operation will be attracted into the chamber 45 through the space 54 and the openings 49 and will combine with the gettering material and be thus rendered innocuous.

The foregoing arrangement of the gettering apparatus 77 within the confined chamber 75 effectively prevents the escape of any gettering end products and insures against the formation of deposit upon the active surfaces of the electrodes. All of the metallic vapor produced during the gettering operation impinges upon the surface of the plate 33 and the inner surfaces of the walls 43. Some deposit may occur on the surfaces of the channels 49 and upon the inner surfaces of the skirt opposite said channels. The vaporized gettering material becomes deposited upon such surfaces substantially immediately upon impinging thereon, so that little, if any, vapor may escape from within the skirt 51 during the gettering operation, and if any vapor should escape, it must do so through the annular opening 55 in the envelope pocket 26 remote from the active electrode surfaces, and any vapor thus escaping through the opening 55 will impinge upon and adhere to the relatively cool surfaces of the envelope.

By mounting the gettering material 85 on a conductor and evaporating the same by heating the conductor electrically, I am able to control the amount of gettering vapor produced at any time, and I may provide a suitable excess of gettering material so that after initially conditioning the tube for operation by evaporating only a portion of the gettering material 85 by controlling the current permitted to flow through the conductor 77, the remaining unused portion of the gettering material will be retained and may be used at a later date in the event that it should become necessary, during the service life of the tube, to recondition the same by evaporating additional quantities of the gettering material. I can, in fact, perform several successive gettering operations at intervals during the service life of the tube.

The flexible connectors 71 and the wire 77 are connected with the cables 73 and 83 through glass-to-metal seals 86 mounted on the plate 33. To this end, the plate 33 is formed with openings 87 therethrough, in which openings sleeves 89 of Fernico are sealed. Stems 91 of Fernico are mounted within the sleeves 89 and are sealed in said sleeves in position insulated therefrom and from the support plate 33 by glass sealing globules 93, so that the stems 91 have opposite ends extending outwardly of and inwardly of the mounting plate 33. The outwardly extending ends of the stems 91 are connected with the conductors 73 and 83, while the inner ends are connected with the cables 71 and with the gettering wire 77.

It is thought that the invention and its numerous attendant advantages will be fully understood from the foregoing description, and it is obvious that numerous changes may be made in the form, construction and arrangement of the several parts without departing from the spirit or scope of the invention, or sacrificing any of its attendant advantages, the form herein disclosed being a preferred embodiment for the purpose of illustrating the invention.

The invention is hereby claimed as follows:

1. A device of the class described, comprising an envelope having an opening, an electrode sup-

port comprising metal plate means having marginal edge portions sealed in said opening, an electrode having a head and a tubular portion mounted on said electrode support in position defining a chamber within said tubular portion between said plate means and said head, said chamber having communication with the interior of the envelope outwardly of the electrode through a restricted passage opening remotely from the said head, support means for gettering material disposed within said chamber, and means forming an electric circuit, including a conductor extending through, sealed in and insulated from said plate means for vaporizing the gettering material in said chamber in response to the application of electrical power to said circuit outwardly of said envelope.

2. A device of the class described, comprising an envelope having an opening, an electrode support comprising metal plate means having marginal edge portions sealed in said opening, an electrode having a head and a tubular portion mounted on said electrode support in position defining a chamber within said tubular portion between said plate means and said head, said chamber having communication with the interior of the envelope outwardly of the electrode through a restricted passage opening remotely from the said head, support means for gettering material disposed within said chamber, and means forming an electric circuit, including said plate means and a conductor extending through, sealed in and insulated from said plate means for vaporizing gettering material in said chamber in response to the application, outwardly of said envelope, of electrical potential between said conductor and said plate means.

3. A device of the class described, comprising an envelope having an opening, an electrode support comprising metal plate means having marginal edge portions sealed in said opening, an electrode having a head and a tubular portion mounted on said electrode support in position defining a chamber within said tubular portion between said plate means and said head, said chamber having communication with the interior of the envelope outwardly of the electrode through a restricted passage opening remotely from the said head, support means for gettering material disposed within said chamber and comprising electrical conductor means electrically connected with said plate means inwardly of said envelope, and a conductor extending through, sealed in and insulated from the said plate means and electrically connected with said conductor means within said envelope whereby to heat said conductor means and thereby vaporize said gettering material in response to electrical potential applied outwardly of said envelope between said conductor and said plate means.

4. A device of the class described, comprising an envelope having re-entrant portions defining an opening, an electrode support comprising metallic plate means having marginal edge portions sealed in said opening, an electrode comprising a head and a tubular portion mounted on said electrode support in position with the head spaced from said plate means and the tubular portion encircling said support and re-entrant envelope portions, whereby to define a chamber within said tubular portion between said plate means and said head, said tubular portion being spaced from said plate means and re-entrant envelope portions to provide a restricted passage interconnecting the chamber with the interior

of the envelope outwardly of said electrode and remote from said head, means for supporting gettering material within said chamber, and an electric circuit, including a conductor extending through, sealed in and insulated from said plate means for vaporizing the gettering material within the chamber in response to the application of electrical power to said circuit outwardly of said envelope.

5. A device of the class described, comprising an envelope having re-entrant portions defining an opening, an electrode support comprising metallic plate means having marginal edge portions sealed in said opening, an electrode comprising a head and a tubular portion mounted on said electrode support in position with the head spaced from said plate means and the tubular portion encircling said support and re-

entrant envelope portions, whereby to define a chamber within said tubular portion being spaced from said plate means and re-entrant envelope portions to provide a restricted passage interconnecting the chamber with the interior of the envelope outwardly of said electrode and remote from said head, a metal wire for supporting gettering material within said chamber, said wire being electrically connected with said plate means, and a conductor extending through, sealed in and insulated from said plate means and electrically connected with said wire within the envelope whereby to heat the wire and thus vaporize the gettering material within the chamber in response to the application of electrical potential between said plate means and said conductor outwardly of said envelope.

ZED J. ATLEE.