July 15, 1958 C. S. SZEGHO 2,843,777

CATHODE-RAY TUBES

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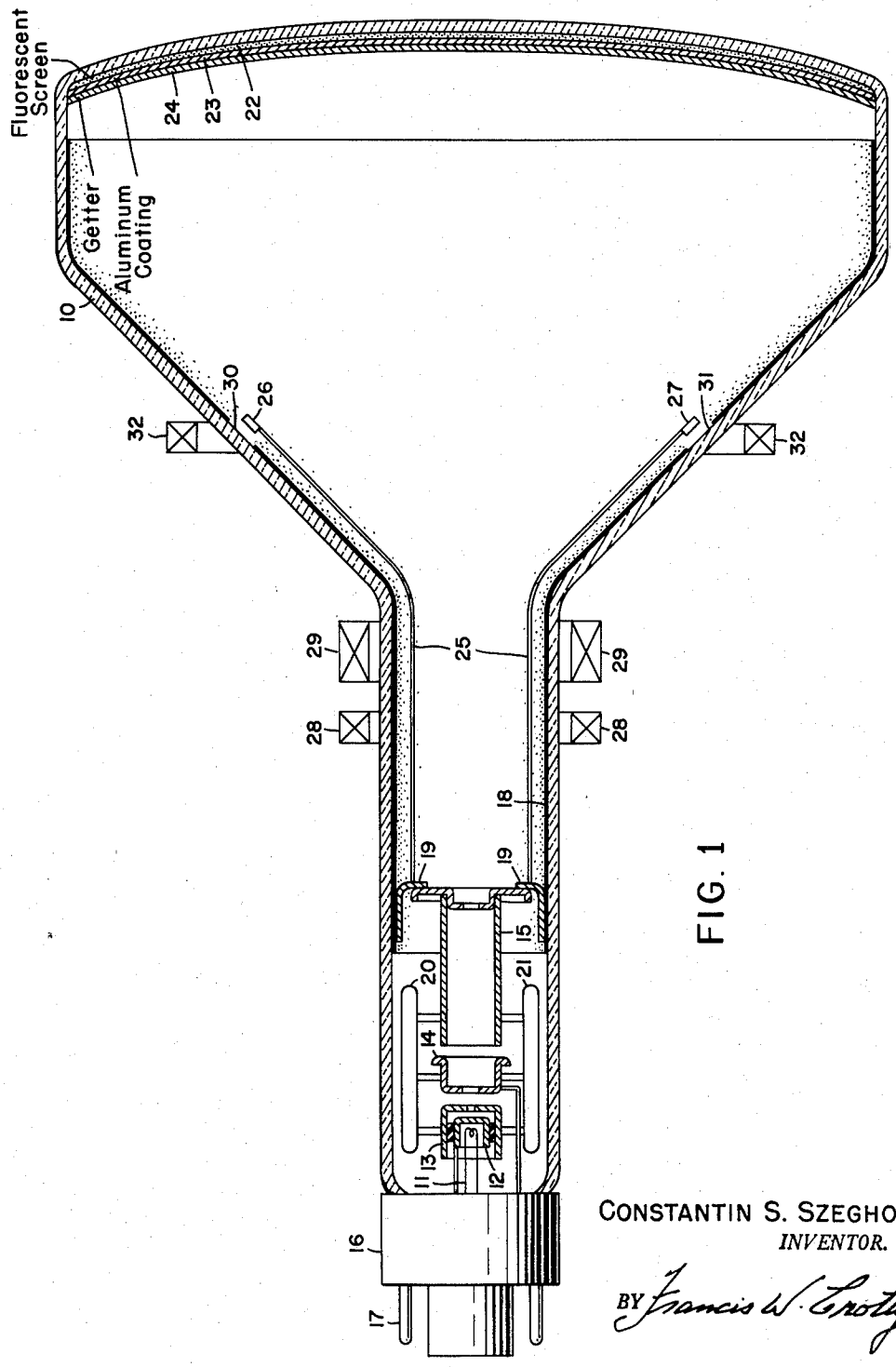


FIG. 1

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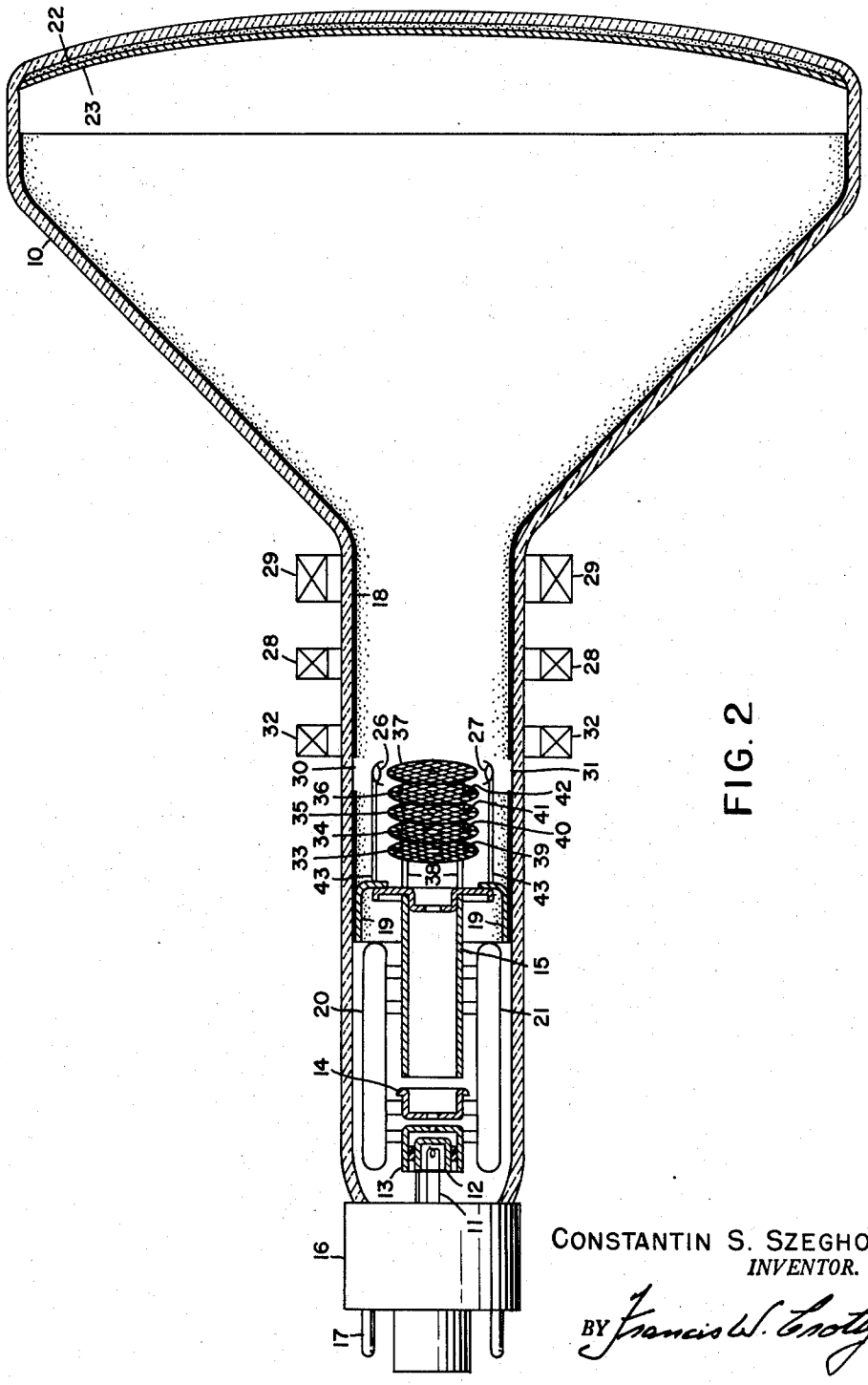


FIG. 2

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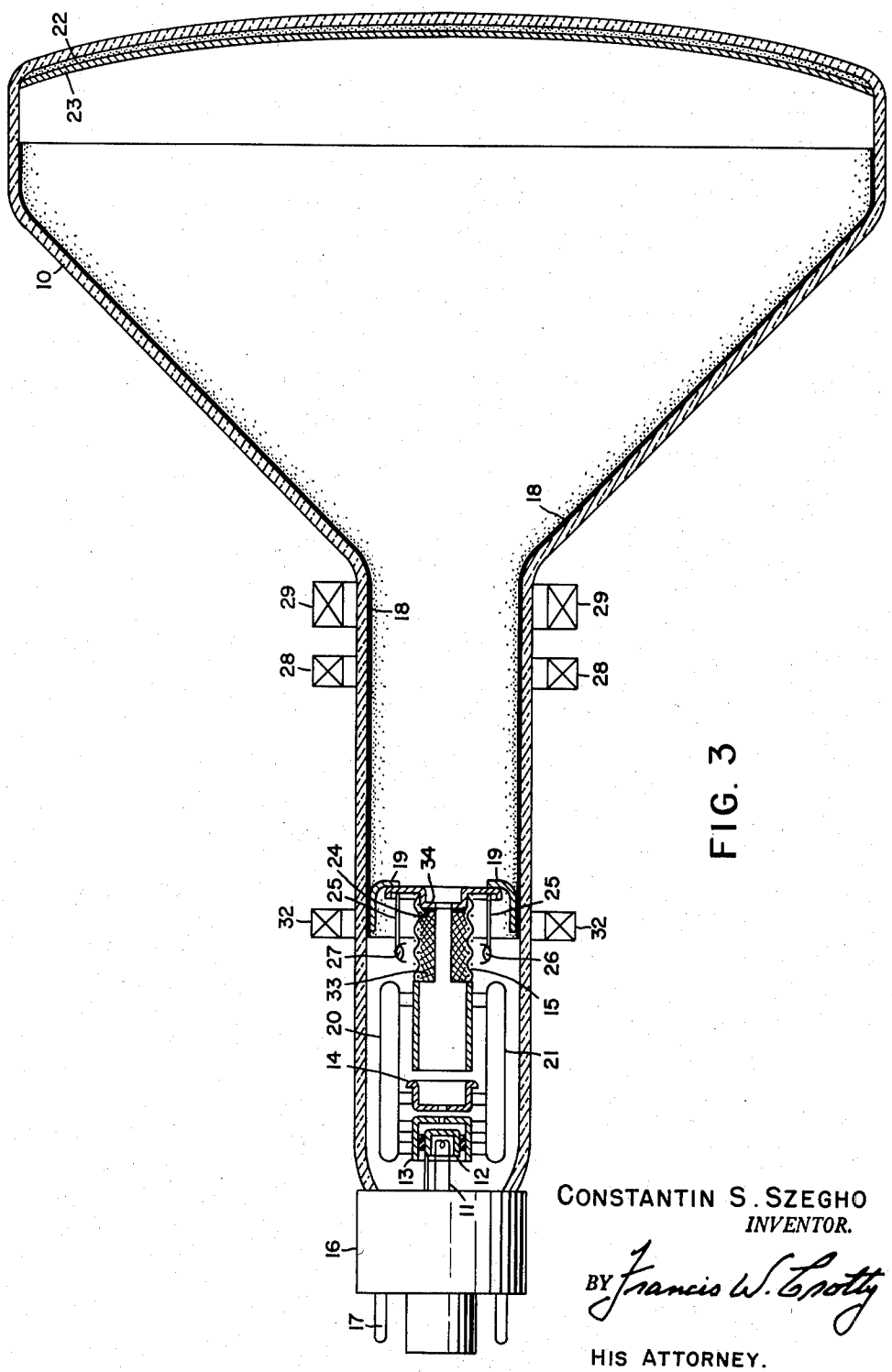


FIG. 3

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CATHODE-RAY TUBES

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2 Claims. (Cl. 313—92)

This invention relates to cathode-ray tubes and more particularly to cathode-ray tubes suitable for use as image-reproducing devices in television receivers and the like.

Conventional cathode-ray tubes may comprise an evacuated envelope enclosing an electron gun including an electron-emissive cathode for projecting electrons in the form of a beam toward a luminescent screen, a focussing system to concentrate the beam and a deflecting system for causing the beam to scan a predetermined area of the luminescent screen. Other cathode-ray tubes are arranged to function with external beam focussing and deflecting arrangements. The efficiency of operation and emission life of these tubes depend to a great extent upon the degree of evacuation of the envelope. The life of the cathode or electron emitting source varies inversely with the number of gas molecules remaining in the envelope since it is the bombardment of the cathode by such of the residual gas molecules as become positively ionized by collisions with other particles which causes deterioration of the emissive surface. In the commercial fabrication of cathode-ray tubes, a mechanical evacuation means, commonly a diffusion pump, is ordinarily utilized to remove gas from the envelope. In addition a getter substance, usually one of the alkaline earth metals such as barium or strontium, is employed to absorb gas molecules remaining after the mechanical evacuation process. Alkaline earth metals have been found to have the attribute of absorbing large quantities of gas molecules and preventing their accumulation within the envelope. In the usual case a getter material is supported in a position where it may be flashed upon an inner surface of the tube in any one of a number of ways well known in the art, as for example, by induction heating with a radio-frequency electromagnetic field or current flashing by causing a flow of current through the getter material. However, even the use of conventional gettering techniques has not led to a full solution of the problem of cathode deterioration; a sufficient number of gas molecules still remain to detract materially from the tube life by shortening the emission life of the cathode.

It is a primary object of the present invention to provide a new and improved cathode-ray tube which avoids one or more of the disadvantages of prior art structures.

It is a further object of the present invention to provide a cathode-ray tube in which the emission life of the electron source is extended by more effective absorption of gas molecules through the action of a gettering material than has been achieved by conventional practices.

It is yet another object of the present invention to produce a cathode-ray tube in which the tube life is extended by replenishing the electron emissive cathode surface with emissive material generated by volatilization of the getter material during normal operation of the tube.

It is an additional object of the present invention to provide a method for reducing the number of residual gas molecules in a cathode-ray tube to a greater extent

than is presently chieved by known evacuating and gettering techniques.

The present invention constitutes an improvement of a cathode-ray tube of the type which comprises a luminescent screen and means including a cathode and at least one accelerating electrode for projecting an electron beam adapted to cyclically scan the surface of the luminescent screen, with the luminescent screen and beam projecting means both supported within a substantially evacuated envelope. In accordance with the invention, a layer of getter material is supported between the cathode and the luminescent screen in a position at least partially intercepting the path of the electron beam during at least a portion of each scanning cycle, so that the getter material is automatically activated by electron bombardment to absorb residual gases in the envelope during normal operation of the cathode-ray tube.

The features of the present invention which are believed to be novel are set forth with particularly in the appended claims. The invention, together with further objects and advantages thereof, may best be understood, however, by reference to the following description taken in connection with the accompanying drawings, in the several figures of which like reference numerals indicate like elements, and in which:

Figure 1 is a side elevation, partially in cross section and partly schematic, of a cathode-ray tube constructed in accordance with the present invention;

Figure 2 is a side elevation, similar to that of Figure 1, of an additional embodiment of the present invention; and

Figure 3 is a side elevation, partially in cross section and partly schematic, of a further embodiment of the invention.

In the preferred embodiment of Figure 1, a cathode-ray tube comprises a substantially evacuated envelope **10** which encloses an electron gun structure comprising a heater element **11**, a cathode or electron emitting source **12**, a control grid **13** and first and second accelerating anodes **14** and **15**. Supporting structures **20** and **21**, of some non-conductive material such as glass or ceramic, provide mechanical supports for maintaining the various components of the electron gun in proper physical relationship and a base **16** is provided for mounting pins **17** which provide external connections for the application of the appropriate potentials and signals to the individual gun electrodes. A conductive coating **18**, usually of colloidal graphite of the type known in the art as Aquadag, is deposited on a portion of the inner surface of envelope **10** and is connected to accelerating electrode **15** through mechanical and electrical contact springs **19**. On the interior surface of the viewing portion or face plate of the tube is deposited a luminescent screen **22**, usually consisting of a layer of discrete phosphor particles which emit light in response to electron bombardment. A thin electron-permeable metallic coating **23** of good light-reflecting properties, such as aluminum, is deposited upon fluorescent screen **22**. Disposed around the neck of envelope **10**, in a manner well known in the art, are a focussing coil **28** and a deflection coil arrangement or scanning yoke **29**.

In accordance with the invention, the electron gun assembly is also provided with a pair of resilient getter supports **25** anchored to contact springs **19** and extending through the constricted portion of the neck to the outwardly flared cone portion of the envelope. Pellets **26** and **27** of suitable gettering material are supported at the ends of getter supports **25** in a position facing fluorescent screen **22**, in such a manner that when a suitable radio-frequency induction heating field is impressed, as by means of induction heating coils **32** positioned externally of the envelope, getter material is flashed on to

the metal backing layer 23 behind fluorescent screen 22. Upon flashing of the getter pellets 26 and 27, therefore, a continuous layer 24 of getter material is formed on the exposed surface of the metal backing layer.

Getter support members 25 are preferably constructed of resilient material to permit insertion of the gun assembly including the getter supports through the restricted-area neck, while insuring ultimate positioning of the getter pellets in a position closely adjacent the interior surface of the outwardly flared cone portion of the envelope, outside the path of the electron beam. To permit observation of the getter flashing operation, small transparent areas or windows 30 and 31 may be provided in conductive coating 18; this may be accomplished most conveniently by cleaning the desired areas with a suitable brush after deposition of the colloidal graphite on the inner wall of envelope 10.

The cathode-ray tube which has been described is of well known construction except for the getter pellet supports 25, getter material 26 and 27, and the film of getter material 24. In the conventional manner, the cathode-ray tube includes an electron gun structure which produces electrons and projects them in a form of a beam toward luminescent screen 22. Focussing coil 28, energized by a direct current, is disposed at the neck of the tube for producing a magnetic field which concentrates the electron stream during its passage from the electron gun toward the luminescent screen, so that it forms a beam of relatively small diameter. Deflection coils 29 are energized by suitable line-frequency and field-frequency sweep signal generators (not shown) so that a two-dimensional scanning pattern or raster is produced on fluorescent screen 22. Intelligence signals for example, composite video signals developed by the final video amplifier of a conventional television receiver, are applied to control grid 13 to regulate the amount of beam current. The aluminum coating 23 deposited upon the inner surface of fluorescent screen 22 serves as a reflector which increases the intensity of the light output of the screen by preventing the loss of light energy which would otherwise be dissipated within the interior of envelope 10.

The provision of a layer of getter material in a position at least partially intercepting the electron beam, in accordance with the present invention, provides a means for reducing the number of residual gas molecules within the envelope after mechanical evacuation. The beam of electrons impinging on the getter material causes a localized temperature rise which in turn activates getter material 24 to absorb residual gas molecules. The deposition of getter material on the exposed surface of the metal backing layer behind the luminescent screen is particularly advantageous since a major share of the residual gas molecules originate by liberation of occluded gases in the screen phosphors in response to electron bombardment, and the effectiveness of the getter is proportional to its proximity to the source of residual gases.

For purposes of this invention, it is not necessary to provide a continuous layer of getter material upon the metal backing layer. However, since the efficiency of the getter material is proportional to its exposed area, it is preferable to use enough getter material to cover the aluminum coating. While the thickness of the getter layer is not critical, it should not be so great as to prevent the free passage of electrons through it. In practice, a coating in the order of a micron in thickness has been found satisfactory to provide an electron-permeable layer which yet has the property of good absorption of residual gases.

The getter material may consist of any of numerous commercial products available to tube manufacturers, but in the present case it has been found that a mixture of barium and aluminum, in which barium constitutes 60% of the mixture by weight, is very effective as a getter material.

Most commercial-type cathode-ray tubes employ a coating of barium on the cathode as the electron-emissive element of the tube. In such tubes, there is an additional and unexpected result of using a getter comprising barium deposited upon the aluminum layer or otherwise intercepting the electron beam in that the tube life is extended beyond that achieved with conventional getters which are not energized by electron bombardment. One of the major difficulties which is prevalent in the manufacture of cathode-ray tubes, particularly those used in television receivers, is the high cost of replacing the image reproducing tubes after only a comparatively short period of active usage. It has been discovered that one of the prominent causes of short tube life is the deterioration of the electron-emissive cathode caused by its bombardment by positive ions formed from occluded gas molecules which are liberated because of the heat generated in the operation of the tube. In laboratory experiments involving the present invention, it has been discovered that tubes employing a barium getter upon the aluminum coating have a longer tube life than tubes employing other getter materials in a similar manner. One of the reasons for this phenomenon is that the electron beam in striking the luminescent screen creates localized areas of relatively high temperatures. The heat thus generated has a tendency to volatilize the barium molecules contained in the getter. These molecules are set free and eventually find their way to the cathode to replenish the electron emissive material which has been lost because of the positive ion bombardment.

The embodiment illustrated in Figure 2 is identical to the structure of Figure 1 except that a series of apertured discs 33—37 are interposed along the electron path between final anode 14 and metallic coating 23, and the layer of gettering material is not flashed upon metal coating 23 affixed to screen 22 but upon the surfaces of the apertured discs. The apertures in these discs are proportioned to intercept marginal portions of the electron beam and are of progressively diminishing diameter in the direction of electron travel. The discs are spaced from one another by a series of conductive supports 38—42. Resilient members 43 constitute mechanical supports for the getter pellets 26 and 27 which are flashed in the conventional manner by a radio-frequency electromagnetic field, and which are so placed that they deposit getter material upon the surfaces of discs 33—37. The discs may be electrically connected together and to anode 15. Alternatively discs 33—37 may be replaced by foraminous wire mesh electrodes onto which the getter material is flashed.

In operation, as the electron beam passes through the apertures of discs 33—37, marginal portions of the beam are intercepted by the discs. The interception of the electron beam causes heat to be generated in the surface of the intercepting disc and activates the getter material. In this fashion, gas molecules which are liberated by the screen and other elements of the cathode-ray tube are absorbed on the surfaces of the discs and are prevented from ionizing and deteriorating the cathode or electron source. As in the previous embodiment, the use of a barium getter and a barium cathode provides cathode regeneration and extended tube life.

The embodiment of Figure 3 is similar to that of Figure 1 with identical structural elements bearing identical numbers, except that the getter material is flashed upon the inner surface of the apertured diaphragm disposed across one end of the accelerating anode instead of upon the surface of the aluminum coating. In Figure 3, the getter material is disposed upon the inner surface of the apertured diaphragm 34 which closes tubular accelerating anode 15 to form a film 24. A portion of the anode barrel 15 may be constructed of a metal gauze or mesh 33 through which getter material may be flashed upon the inner surface of the apertured diaphragm. Another structure which may be successfully employed to permit flashing the getter material upon the inner surface of the

anode diaphragm consists of small apertures drilled or etched through the surface of tubular accelerating anode **15**. In this embodiment, the getter is placed so that when it is flashed it is deposited through the mesh or apertures upon the inner surface of anode **15**, including the inner surface of apertured diaphragm **34**. In addition, it has been found desirable to fabricate anode diaphragm **34** from zirconium or tantalum which have enhanced gettering properties when heated to about 1200° C.

The present invention therefore provides a structure which inhibits the deleterious effect of residual gas molecules which are not removed by the mechanical evacuation process. In all embodiments of the invention, the getter material is disposed in a position at least partially intercepting the path of the electron beam so that in addition to absorbing occluded gases at the time of flashing, the getter is continuously or repeatedly activated by electron bombardment during normal operation of the tube to absorb occluded gases released subsequently to completion of the usual evacuating and gettering processes. Moreover, the invention provides additional tube life by replenishing the electron-emissive cathode surface with emissive material generated by volatilization of the getter material in response to electron bombardment.

While particular embodiments of the invention have been shown and described, modifications may be made and it is intended in the appended claims to cover all such modifications as may fall within the true spirit and scope of the invention.

I claim:

1. In a cathode-ray tube comprising a luminescent screen, means including a cathode and at least one accelerating electrode for projecting an electron beam adapted to cyclically scan the surface of said luminescent screen, and a metallic coating affixed to the surface of said luminescent screen between said luminescent screen and said means, all supported within a substantially evacuated envelope, the improvement comprising a layer of getter material disposed upon said metallic coating between said metallic coating and said means in a position at least partially intercepting the path of said electron beam during at least a portion of each scanning cycle, whereby said getter material is automatically activated by electron bombardment to absorb residual gases in said envelope during normal operation of said cathode-ray tube.

2. Apparatus in accordance with claim 1, in which a continuous layer of getter material is disposed over substantially the entire exposed surface area of said metallic coating.

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