Aug. 6, 1963 A. S. LUFTMAN ET AL 3,100,274

ELECTRON TUBE WITH ELECTRODE HAVING TITANIUM SURFACE SERVING AS GETTER

Filed Dec. 17, 1959

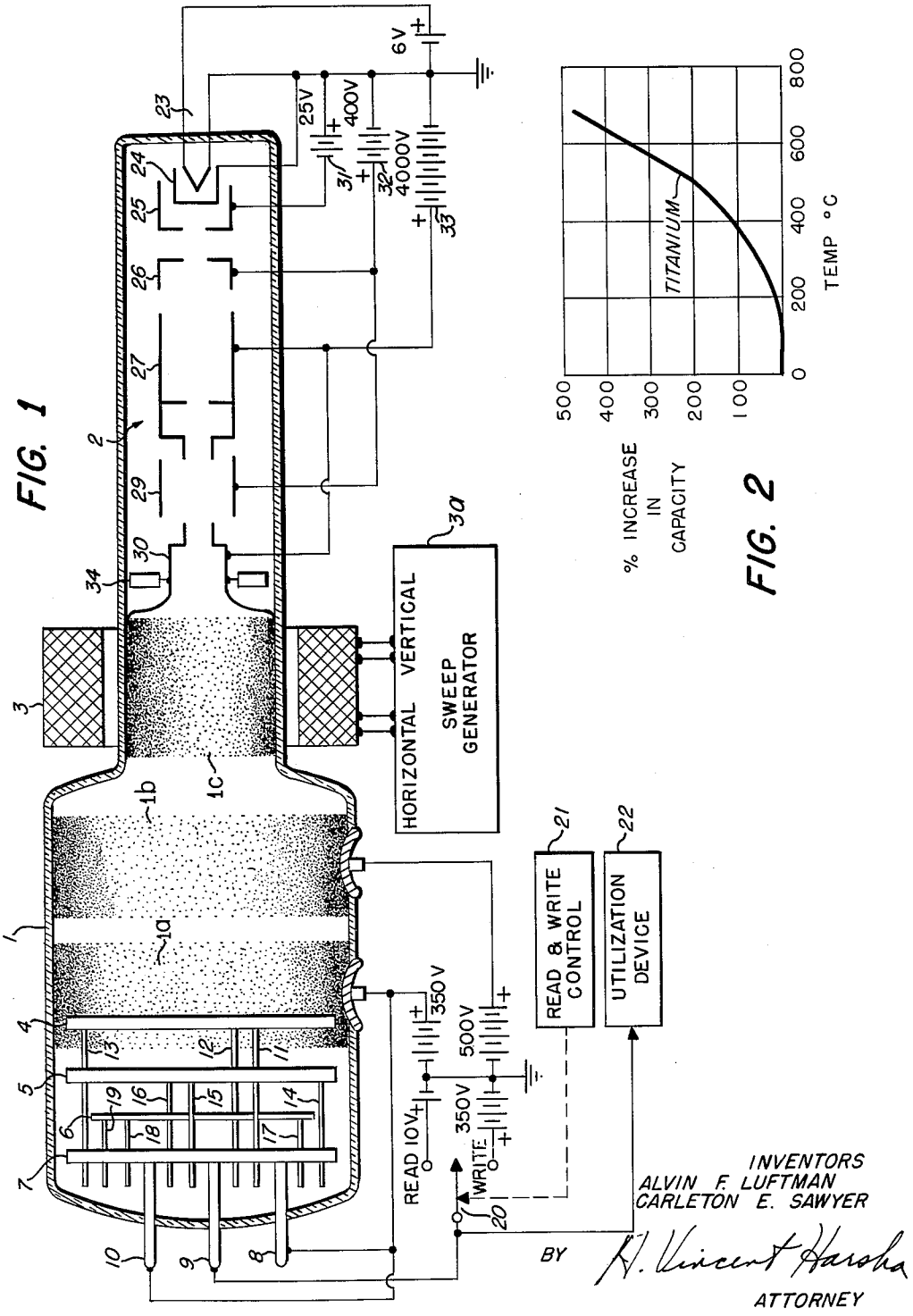


FIG. 1

FIG. 2

INVENTORS
ALVIN F. LUFTMAN
CARLETON E. SAWYER

BY H. Vincent Harsha

ATTORNEY

United States Patent Office 3,100,274 Patented Aug. 6, 1963

3,100,274

ELECTRON TUBE WITH ELECTRODE HAVING TITANIUM SURFACE SERVING AS GETTER

Alvin S. Luftman, Natick, and Carleton E. Sawyer, Acton, Mass., assignors to Raytheon Company, Lexington, Mass., a corporation of Delaware

Filed Dec. 17, 1959, Ser. No. 860,252
7 Claims. (Cl. 313—178)

This invention relates to gas ion getter means for an electron discharge device and, more particularly, to a cold bulk getter functioning also as an operational electrode in the electron discharge device.

Heretofore, in vacuum and inert gas tubes, getters have been employed to absorb undesirable gas ions in the tube. These gases are sometimes included within the envelope of the tube at the time it is sealed or they may be formed within the envelope after sealing when electrodes are raised to operating temperatures. This occurs, for example, when electrode structures contain slight impurities which break down and form gases under heat. The presence of these gases is highly undesirable since they dilute the otherwise electrically inert atmosphere in an inert gas tube or reduce the effective vacuum in a vacuum tube. When this occurs, the discharge electrodes within the tube do not function properly because of the conductive ionized gases. As a preventive measure, it is common practice to place within the tube a material having the ability to take up and remove such gases by absorbing or forming compounds with the gases, these compounds being stable at high operating temperatures. Such materials are generally known as "getter" materials.

Common getter materials are the alkaline earth metals such as barium, strontium, calcium and beryllium. Frequently, a reducing agent is mixed with a compound of one or more of these alkaline earth metals and the mixture is heated causing a chemical reaction which releases the metal from compound. Obviously, this reaction must take place in an evacuated or an inert atmosphere to prevent recombination of the alkaline earth metal. Reducing agents such as molybdenum, tungsten, columbium, titanium, tantalum and zirconium or compounds of these reducing agents are often employed in the mixture with the compound of alkaline earth metal. The reducing agents form stable compounds at high temperature, thereby releasing the alkaline earth metal in pure form.

Getters are usually divided into two classes: flash getters and bulk getters. The flash getter might be better termed evaporation getters since they are formed by evaporation of the alkaline earth metal on the surrounding envelope of the tube. Obviously, flash getters are limited to metals which may be evaporated conveniently and which, on the other hand, are not so volatile that they cannot be contained in a particular region of the tube.

With bulk getters, no evaporation is employed. The getter materials are used in their original shape either as metal powders or as wire or sheet. Such a powder may be applied as a coating on the electrodes of the tube or wires or sheets may be an integral part of one of the tube electrodes. Materials used for bulk getters usually have high melting points and low vapor pressure, the most common ones being titanium, thorium, tantalum and zirconium or alloys of these metals.

The capacity of a getter is usually measured as milligrams of gas absorbed per square centimeter surface of the getter material. This capacity will increase sharply as the temperature of the getter is increased beyond a certain point which is different for each getter material. It is assumed that this sudden increase in capacity is due to the onset of migration of gas molecules along the surface of the getter material. This migration makes it possible for molecules to move through narrow pores into more distant parts of the internal parts of the getter material which cannot be reached otherwise. As a result of this sharp increase of capacity with temperature, bulk getters are usually heated by, for example, heating coils or by passing a current through a high resistance material to which the bulk getter is attached.

As already stated above, zirconium, titanium and other metals have been employed as bulk getters and it is well known that these metals take up gases by absorption and chemical combination when they are heated to high temperatures. Furthermore, the high temperatures required to increase the capacity of such bulk getters have been attained by heating the getter material with heating coils or by passing a current through a high resistance structure to which the material is attached. Both flash-type and coil heated bulk getters have been employed in storage tubes such as described in an article entitled "Improved Storage Tube Design" which apeared in the March, 1956 edition of Tele-Tech & Electronic Industries, a magazine published by Chilton Company of Philadelphia, Pennsylvania. The bulk getter and heater in such an application requires a structure within the envelope of the tube including at least one electrical lead coupled to the getter to place a voltage thereon and other electrical leads to the heating element. The complete structure of getter and heating element serves only to remove the undesirable gas ions and does not function as an electrode in the operation of the tube. Therefore, it is one object of the present invention to provide a bulk getter in a storage tube, such as described in the referenced magazine article, which functions also as an essential electrode in the operation of the tube, for example, the collector or signal electrode.

It is another object of the present invention to provide a getter requiring no heater and capable of high getter capacity even though cold.

It is another object to provide means in combination with electrodes in a storage tube, such as described in the referenced magazine article, for intercepting and absorbing gas ions.

It is another object to employ the collector electrode in a storage tube, such as described in the referenced article, as a getter, the gettering action being accomplished in conjunction with other electrodes which serve in the operation of the tube by accelerating gas ions to a velocity such that upon striking the collector electrode said ions are readily absorbed therein.

The principle feature of the present invention follows from the discovery that a titanium electrode in a storage tube, such as described in the referenced magazine article, performs well as a getter of gas ions even though it is cold, provided the gas ions strike the titanium electrode at a velocity which is somewhat equivalent to high temperature. This discovery affords a very convenient method for making the collector or anode electrode in an electron gun storage tube function as a high capacity getter as well as a collector electrode collecting a modulated electron beam to produce an output signal.

It is a further feature to provide a collector electrode in an electron storage tube, such as described in the referenced article, for collecting a modulated beam of electrons representing output signal, said collector electrode being comprised in part or in whole of the metal titanium which, by virtue of the above mentioned discovery, will serve also as a getter of positively charged gas ions in the tube, said gas ions being accelerated by an electrostatic field so as to strike the collector electrode at a high velocity, said field normally functioning to decelerate the electron beam.

Other features and objects of this invention will be more apparent from the following specific description taken in conjunction with the drawings in which:

FIG. 1 shows a single-gun storage tube for storing and

reading electrical signals, said storage tube being constructed and operated substantially as described in the referenced magazine article, the collector or signal electrode in said tube being comprised wholly or partially of the metal titanium to accomplish the above-described gettering action; and

FIG. 2 is a curve of percentage increase in capacity of a titanium getter versus temperature.

In FIG. 1 there is shown an electrical signal storage tube comprised of a glass envelope **1** with graphite coatings **1***a*, **1***b* and **1***c* on its inside surface as shown. The tube includes an electron gun structure **2**, beam deflection coil **3**, sweep generator **3***a* and electrodes **4**, **5** and **6**. Electrode **4** may be called a decelerating electrode and is comprised of a ring with a fine screen mesh stretched across the center through which an electron beam may pass. Electrode **5** is the storage electrode and is also comprised of a ring with a fine mesh screen stretched across the center, but having, in addition, a dielectric material deposited on the side of the screen towards electron gun **2**, said dielectric material serving to store charge deposited by the electron beam. In operation, an electron beam issuing from gun **2** is caused to sweep a raster on the screen of electrode **4** by the magnetic field produced by deflection coil **3**. Electrode **4**, which is at considerably lower potential than gun **2**, decelerates the beam allowing collimation so that the beam strikes the dielectric material on the screen of electrode **5** while directed parallel to the axis of the tube. Thus, the beam is collimated with said axis regardless of the instantaneous position of the beam when sweeping the raster.

When a signal is being stored during the write cycle, a positive voltage, for example 350 volts, is placed on storage electrode **5**, while electrodes **4** and **6** are maintained at a fixed 350 volts. Consequently, a substantial portion of the electron beam will pass through electrode **4** and strike the dielectric surface of storage electrode **5**, storing electrical charge. During a read cycle, a much lower positive voltage, for example 10 volts, is applied to storage electrode **5** and, consequently, the collimated beam will be decelerated further and readily modulated upon passing through the storage screen of electrode **5**; modulation being caused by the charge stored on the dielectric surface thereof. This modulated beam will be collected by collector electrode **6** which is maintained at 350 volts positive and applied to a utilization device.

As shown in FIG. 1, ceramic support plate **7** is fixed within glass envelope **1** and supported therefrom by pins **8**, **9** and **10** which are sealed to the glass. These pins serve also as electrical leads, each pin being electrically connected to a different one of the electrodes **4**, **5** or **6**. For example, pin **8** is electrically coupled to decelerating electrode **4** by virtue of electrical coupling to support pins **11**, **12** and **13** which serve to support electrode **4** and make electrical contact from pin **8** to electrode **4** only. Electrical leads from pin **8** to pins **11**, **12** and **13** may be, for example, printed on the surface of ceramic support **7**. In the same manner, pin **9** is coupled to storage electrode **5** via support pins **14**, **15** and **16** and pin **10** is coupled to collector electrode **6** via support pins **17**, **18** and **19**. Approximately 350 volts positive is applied to pins **8** and **10** and graphite surface **1***a* while 500 volts is applied to graphite surface **1***b*. Pin **9** is connected to switch **20** which is, in turn, controlled by read and write manual control **21**. During the read cycle, output is taken from pin **9** and applied to a utilization device **22**.

Electron gun **2** might, for example, be comprised of a heater **23**, a cathode **24**, decelerating and accelerating electrodes **25** and **26**, collimating and accelerating electrode **27**, and electrodes **29** and **30** which serve to focus the beam and maintain its velocity. Electrode **30** is electrically coupled to graphite surface **1***c* by direct contact therewith. Voltages are applied to the various parts of gun **2** from batteries **31**, **32** and **33** as shown in FIG. 1. Electrodes **30** and **27** are at plus 4000 volts, electrode **26** is at plus 400 volts and electrode **25** is at minus 25 volts.

It is the principle feature of the present invention to comprise the signal or collector electrode **6** of the metal titanium so that during the read operation, when the storage electrode is close to ground potential at, for example, 10 volts, positively charged gas ions within the tube will be accelerated by said storage electrode towards said collector electrode and strike at a high velocity. It has been discovered that a titanium surface will absorb and/or combine with gas ions striking said surface at a sufficiently high velocity which is somewhat equivalent to high temperature.

In FIG. 2 there is shown a curve of percentage increase in gettering capacity of a titanium getter as a function of temperature. As can be seen, a sharp rise in capacity occurs between 400 and 600 degrees C. Imparting a high velocity to gas ions can accomplish essentially the same purpose as heating the titanium and, consequently, the increased capacity can be gained by accelerating the ions to such a high velocity. The discovery that gas ions will be taken up by the titanium by absorption and chemical combination in this manner permits the use of a cold titanium getter.

Another getter **34** shaped as a ring may be located around electrode **30** of gun **2** and electrically coupled thereto. Since electrode **30** is at a very high positive potential, for example 4000 volts, getter **34** will attract negatively charged gas ions which accumulate in the neck of glass envelope **1**. By applying this high positive voltage to getter **34**, such negative ions accumulating in the neck will be accelerated towards titanium getter **34** striking that getter at a high speed and, consequentlly, will be taken up by absorption or chemical combination in the same manner as already described with reference to collector electrode **6** located in the bulb end of the glass envelope **1**.

While there is described above one embodiment of this invention wherein suitable electrodes in an electron beam storage tube are comprised of titanium so that by operating in conjunction with other electrodes, gas ions will be accelerated to high velocity and strike the titanium electrode at sufficient velocity to be gettered thereby, it is understood that other tube structures could be employed for accelerating gas ions towards a cold titanium getter, so as to increase its getter capacity, without deviating from the spirit or scope of this invention as set forth in the accompanying claims.

What is claimed is:

1. In an electron storage device including an electron gun, a decelerating electrode and a storage electrode within a glass envelope, anode means disposed to collect electron flow modulated by said storage electrode during a read cycle producing an output signal and also serving to capture gas ions within the envelope, said anode means being composed of titanium and means coupled to said anode means and said electrodes for applying voltages during said read cycle suitable for accelerating said gas ions to a velocity such that upon striking said anode means, said gas ions are absorbed.

2. In an electrical storage device including at least one electron gun, a signal storage electrode and at least one decelerating electrode, a collector electrode disposed to collect electron flow modulated by said storage electrode during a read cycle composed substantially of the metal titanium with means for controlling voltages applied to said electrodes so as to accelerate gas ions within the envelope during said read cycle to a sufficient velocity so that said accelerated ions strike said titanium collector and are absorbed therein.

3. An electron storage device for storing and reading electrical signals comprising means emitting electrons, means storing electrons, means directing electrons from

said emitting through said storing means and an anode composed substantially of the metal titanium for producing an output signal, said anode being disposed and energized to collect electrons passing through said electron storing means and at the same time capture gas ions within said device.

4. An electron storage device for storing and reading electrical signals comprising means emitting electrons at one potential, means storing electrons, means directing electrons from said emitting to said storing means and an anode surface composed of titanium at a potential substantially higher than said one potential disposed to collect electrons passing through said electron storing means and at the same time absorb gas ions within said device.

5. An electron storage device for storing and reading electrical signals comprising means emitting electrons at one potential, a perforated surface for storing electrons, means directing electrons from said emitting means through said perforated surface, and an anode surface composed substantially of the metal titanium energized at a potential substantially higher than said one potential and disposed to collect electrons passing through said perforated surface and at the same time capture gas ions within said device.

6. An electron storage tube for storing and reading electrical signals comprising means emitting electrons at one potential, a perforated surface for storing a pattern of electrons, means directing a beam of electrons from said emitting means through said perforated surface, an anode surface comprised substantially of the metal titanium energized at a potential substantially higher than said one potential so as to collect electrons passing through said perforated surface and at the same time capture gas ions within said device and an output load coupled to said anode surface producing a signal representative of said pattern of stored electrons.

7. An electron storage device for storing and reading electrical signals comprising means emitting electrons at one potential, a substantially flat perforated surface suitably coated for storing a pattern of electrons, means directing a beam of electrons from said emitting means through said perforated surface so that said beam is modulated by said pattern, an anode surface composed of the metal titanium disposed substantially parallel to said perforated surface, means energizing said anode surface to direct the flow of electrons passing through said perforated surface and at the same time capture gas ions within said device and an output load coupled to said anode surface for producing a signal representative of said pattern of stored electrons.

References Cited in the file of this patent

UNITED STATES PATENTS

2,158,450	Willans	May 16, 1939
2,741,717	Katz	Apr. 10, 1956
2,796,555	Connor	June 18, 1957
2,919,380	Barnett	Dec. 29, 1959
2,960,618	Waer	Nov. 15, 1960