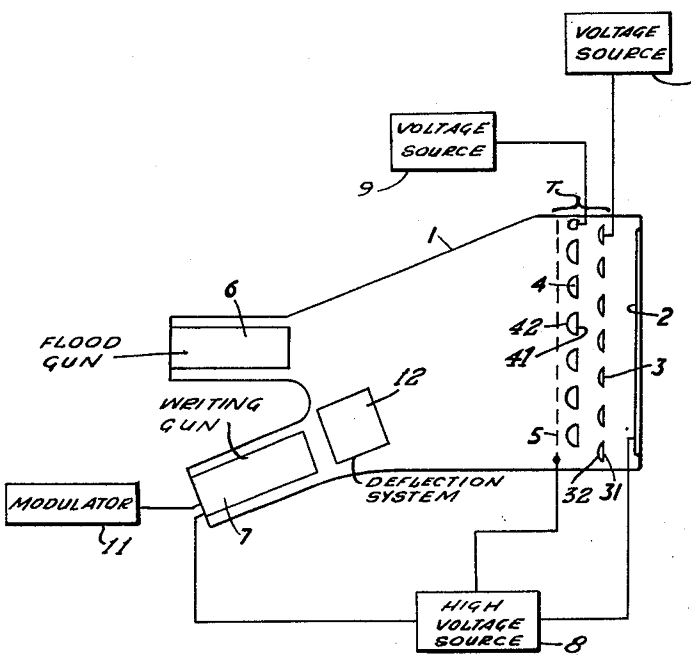

FIG.1

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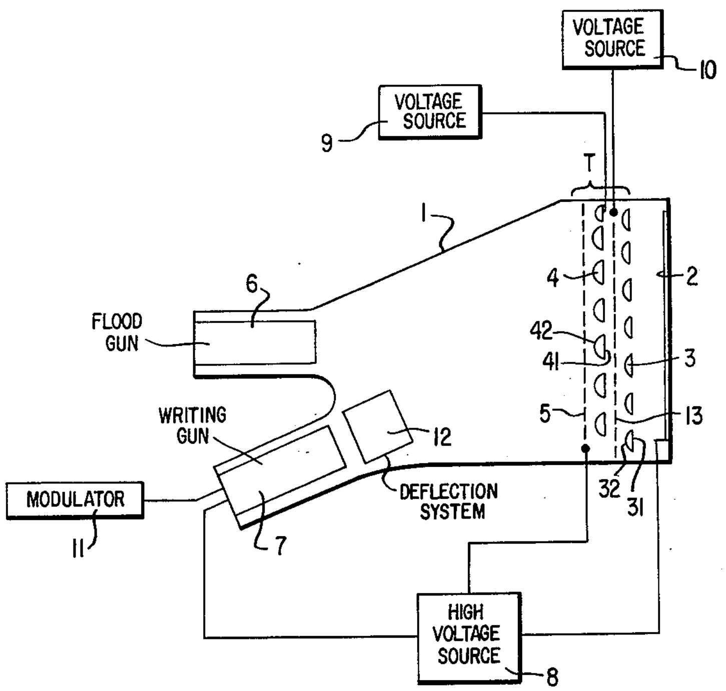
FIG. 2



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SIGNAL STORAGE TUBES UTILIZING HIGH AND LOW CAPACITANCE STORAGE ELECTRODES

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This invention relates to signal storage tubes and more particularly to so-called "direct view" storage tubes of the kind in which those areas of a foraminous storage target, comprising a dielectric layer on a conducting mesh or grid, which have been subjected to electron bombardment by means of a "writing" electron beam controlled in accordance with applied signals, increase in potential with respect to the remaining areas, and in which the number of electrons of a "flood" beam passing the storage electrode at any point and impinging on a fluorescent screen is determined by the potential of the storage electrode at that point, whereby the displayed image produced by the "flood" gun is caused to be representative of the applied signals.

In such storage tubes as at present known and which are adapted for bistable operation the areas of the storage target bombarded by the "writing" beam must be changed in potential by a substantial voltage (usually 30 volts or more) if storage is to take place, while with known so-called "half-tone" storage tubes, i.e. tubes which will store and display an image of varying shade, although the change of potential of the bombarded areas of the storage target need only be small, the capacitance between the surface of the dielectric layer of the storage target and the conducting grid or mesh must be high if long persistance of the stored image is to be obtained. Both these requirements militate against the use of high "writing" speeds, i.e. rapid deflection of the "writing" beam across the storage target, and hence these known tubes suffer from the defect that their maximum "writing" speed is low. As a result the known tubes are unsuitable for use, for example, in recording high speed transient electrical phenomena.

It is the object of the present invention to provide improved storage tubes of the kind referred to which shall be capable of much higher "writing" speeds than comparable tubes as at present known.

According to this invention a direct view storage tube of the kind referred to comprises, between the normally provided storage target of the tube and the "writing" and "flood" guns thereof, an additional storage target which is of low capacitance and is adapted rapidly to acquire a relatively non-persistent charge pattern when traversed by the "writing" beam whereby, after such a pattern has been produced thereon, a corresponding but relatively persistent charge pattern will be produced on the said normally provided target by electrons projected to it through said additional target.

The term "capacitance" as herein used with reference to the terms "storage target" or "storage electrode" designates the capacitance between the surface of the dielectric layer of the storage target or electrode and the conducting grid or mesh thereof.

Preferably a secondary electron collecting electrode is positioned between said additional storage target and the "writing" and "flood" guns.

According to a feature of this invention a "direct view" storage tube comprises a "writing" electron gun; a "flood" electron gun, said guns being provided at one end of the tube; a fluorescent screen at the other end; a relatively low capacitance storage target extending across the tube between said guns on the one hand and said screen on the other; a relatively high capacitance storage target adjacent said low capacitance electrode and co-extensive therewith and positioned on the side thereof nearer said fluorescent screen, each of said storage targets comprising a conducting grid or mesh having deposited on the side remote from said screen a layer of dielectric material so arranged as to leave the interstices of the grid or mesh open; and a secondary electron collecting electrode adapted to collect secondary electrons from said low capacitance storage target.

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Preferably said secondary electron collecting electrode comprises a conducting grid or mesh closely adjacent but spaced from said low capacitance target on the side thereof remote from said fluorescent screen. In a tube intended for operation as a "half-tone" tube there is preferably provided a further secondary electron collecting electrode positioned between said low capacitance and high capacitance storage targets.

A preferred storage tube arrangement adapted for bistable operation of the tube comprises a storage tube in accordance with the above-mentioned feature of this invention; means for switching the beam of said "writing" gun on and off; means for deflecting the beam of said "writing" gun in accordance with applied signals; means for applying a high negative potential to the cathode of said "writing" gun, a positive potential to said first mentioned secondary electron collecting electrode and a high positive potential to said screen; means for applying to the conducting grid or mesh of said relatively low capacitance storage target potentials in the range from a small negative potential to a small positive potential and means for applying to the conducting grid or mesh of said relatively high capacitance storage target potentials in the range from zero to a potential in excess of twice the so-called "first secondary emission crossover potential" of the dielectric layer of that target, all of said potentials being measured in relation to the cathode of said "flood" gun.

A storage tube arrangement adapted for half-tone operation of the tube comprises a storage tube in accordance with the above-mentioned feature of the invention and including the aforesaid further secondary electron collecting electrode; means for deflecting the beam of said "writing" gun across said low capacitance target; means for modulating said "writing" beam in accordance with applied signals; means for applying a high negative potential to the cathode of said "writing" gun, a positive potential to said first mentioned secondary electron collecting electrode, a positive potential, in excess of the "first secondary emission crossover potential" of the dielectric layer of said relatively high capacitance storage target, to said further secondary electron collecting electrode, and a high positive potential to said screen; means for applying to the conducting grid or mesh of said relatively low capacitance storage target potentials in the range from a small negative potential to a small positive potential and means for applying to the conducting grid or mesh of said relatively high capacitance storage target potentials in the range from zero to a value in excess of said "first secondary emission crossover potential," all of said potentials being measured in relation to the cathode of said "flood" gun.

The invention is further described with reference to the accompanying drawing, of which:

FIGURE 1 is a simplified diagram of a bistable storage tube according to the invention; and

FIGURE 2 is a simplified diagram of a half-tone storage tube according to the invention.

Referring to FIGURE 1, the storage tube 1 has deposited on an end wall thereof a fluorescent screen 2, shown as a thickened line, having a thin metallic backing film (not separately shown). Closely spaced from the screen 2 and parallel to it is a storage target or electrode 3 which may be as normally provided in known direct view storage tubes and which comprises a metallic mesh 31 on which is deposited, on the side remote from the fluorescent screen, a thin layer of dielectric material 32 which is so arranged as to leave the interstices of the mesh 31 open and is of such thickness as to present relatively high capacitance between its own surface and the metal mesh 31.

Parallel to the storage electrode 3 and closely spaced therefrom is a second or additional storage electrode 4, comprising a metal mesh 41 and dielectric layer 42, and which is similar to the storage electrode 3 except in respect of the thickness of the dielectric layer 42 which is arranged to be greater than that of the layer 32 so that the capacitance between the surface of the dielectric layer 42 and the metal mesh 41 is considerably smaller than the comparable capacitance of the electrode 3. A secondary electron collector mesh 5 is closely spaced from and parallel to the storage electrode 4 on the side thereof remote from the electrode 3. The electrode 3, 4 and 5 together form a composite storage target, which, for convenience of reference, is labelled T in the drawing, the grids 31, 41 and 5 being arranged in known manner so that the generation of so-called "moire" patterns is a minimum.

A "flood" electron gun 6, which is arranged to produce an electron beam which spreads evenly across the storage target T, and a "writing" electron gun 7, which is arranged to produce a substantially cylindrical "writing" electron beam which may be switched on or off at will, are arranged at the end of the tube 1 remote from the fluorescent screen 2. These electron guns may be, and as shown are, arranged with the "flood" gun mounted on the axis of the storage target T and the "writing" gun arranged at an angle thereto.

The tube 1 is, in operation, provided with means (not separately shown) for deflecting the "writing" beam across the storage target. These deflection means may, for example, comprise two pairs of mutually perpendicular deflection plates, one pair of plates being fed with deflection potential from a time base generator and the other pair with the signal to be stored. The time base generator may be arranged to be triggered by the signal to be stored.

In operation the cathode of the "writing" gun 7 and the fluorescent screen 2 are maintained at high negative and positive potentials, respectively, with regard to the "flood" gun cathode, which may be at earth potential; the mesh 5 is at low positive potential and the potentials of the meshes 31 and 41 are varied in the manner described hereafter.

Initially the metal mesh 31 is held at zero potential while the metal mesh 41 is at a small positive potential, say 5 v.–10 v. and the electrons of the "flooding" beam, which is continously on, stabilise the dielectric layer 42 at the "flood" gun cathode potential, i.e. zero volts. The mesh 31 is then slowly raised to a potential which is just below the so-called "first crossover potential" or "first secondary emission crossover potential" of the dielectric layer 32, i.e. just below the lowest potential at which the number of secondary electrons given off by the dielectric exceeds the number of bombarding primary electrons, and during this operation the "flood" electrons pass through the interstices of the storage electrode 4 and maintain the surface of the dielectric layer 32 at zero volts.

The potential of metal mesh 41 is now reduced to just below zero volts, so cutting off the "flood" electrons passing to the storage electrode 3, and the metal mesh 31 is raised rapidly to its normal residing potential which is just less than twice the so-called "first crossover potential." Because of the capacitance between the mesh 31 and the surface of the dielectric layer 32, the latter increases in potential by an amount equal to the increase in potential of the mesh 31 and so adopts a potential which is just below the "first crossover potential."

The signal to be stored and the time base voltage are applied to the "writing" deflection means and at the same time the "writing" gun is turned on by a control voltage applied to its grid. Those parts of the dielectric layer 42 struck by the "writing" beam give off more secondary electrons than they receive from the writing beam and hence store a positive charge, the secondary electrons being collected by the collector mesh 5. Because of the low capacitance between the surface of the dielectric layer 42 and the grid 41, the bombarded areas of the layer 42 may be raised in potential by a sufficient amount for satisfactory operation of the tube in a very short time. In a practical case the dielectric layer 42 need only be raised to a positive potential of, say, two or three volts. Hence the writing speed may be very high and, due to the low capacitance of storage electrode 4, may be in excess of the writing speeds of the so-called "half tone" storage tubes as at present known.

At the time the "writing" beam is switched on the potential of the metal mesh 31 is increased rapidly by an amount sufficient to bring the potential of the dielectric layer 32 above the "first crossover potential." The electrons of the "flood" beam will pass through the interstices of the storage electrode 4 at, and only at, the areas which have been bombarded by the "writing" beam and will strike, as well as pass through the interstices of, the storage electrode 3 at corresponding areas. The electrons which pass through the storage electrode 3 will impinge on the fluorescent screen with high velocity, due to the high positive potential of the screen 2, and display an image thereon corresponding to the charge pattern on the storage electrode 4, while the electrons which land on the dielectric layer 32 will generate secondary electrons in excess of the primary bombarding electrons, causing these areas to increase in potential up to approximately the potential of the metal mesh 31, by which the secondary electrons from the dielectric layer 32 are collected.

After a sufficient time for the bombarded areas of the dielectric layer 32 to stabilise in potential, which time will depend, inter alia, on the capacitance between the surface of that layer and the metal mesh 31, the potential of the metal mesh 31 is quickly lowered to its residing potential which, as stated above, is just below twice the "first crossover potential." The bombarded areas of the dielectric layer 32 are, therefore, now stabilised at approximately the potential of the metal mesh 31 under the continuing bombardment of the "flood" beam while the un-bombarded areas will remain at a potential just below the "first crossover potential." "Flood" electrons will therefore continue to pass through the interstices of the storage electrode 3 and generate an image on the fluorescent screen.

Within a comparatively short space of time, due to the low capacitance of the storage electrode 4, positive gas ions will raise the potential of the "unwritten" areas of the dielectric layer 42 until the whole surface is of uniform potential, and "flood" electrons pass through the storage electrode 4 over its whole area. These "flood" electrons which now impinge on the previously un-bombarded areas of the dielectric layer of electrode 3 cause these areas to be reduced in potential to that of the "flood" gun cathode while the image on the fluorescent screen continues to be representative only of the original applied signal.

This state of affairs will be maintained for a very long time if the various electrode potentials are unchanged, while erasure of the stored image may be achieved by reducing the potential of the metal mesh **31** to zero.

In a practical case the potentials applied to the "writing" gun cathode, secondary electron collecting mesh **5** and the fluorescent screen **2** were —2 kv., +100 v. and +10 kv. respectively while the "first crossover" of the dielectric layer **32** was 90 v.

A storage tube in accordance with this invention and adapted for half-tone operation may be similar to that illustrated in the drawing and described above but with the addition of a further secondary electron collecting mesh disposed between and parallel to the two storage electrodes **3** and **4**. Furthermore the "writing" beam is arranged to be scanned across the additional storage target in predetermined manner, for example, in a television raster, and modulated in accordance with the signals to be stored.

For convenience of reference the numerals applied to electrodes of the illustrated tube will be used to refer to corresponding electrodes of the tube now being described.

In operation, with this arrangement, the electrodes **2**, **4** and **5** and the cathodes of the "writing" and "flood" guns are operated at the same potentials as above described with reference to the illustrated tube while the further secondary collecting electrode is preferably held at a potential of about twice the "first crossover" of the dielectric layer **32**.

Initially both grids or meshes **31** and **41** are held at a slight positive potential and the dielectric layers **32** and **42** are stabilised at the "flood" gun potential.

The potential applied to layer **41** is then reduced to zero, while that applied to **31** is raised to a value such that the potential of the surface **32** is brought above the "first crossover." Thus after the "writing" beam has scanned the layer **42**, flood electrons will record a positive charge pattern on the dielectric layer **32** which corresponds to that recorded on **42** by the "writing" beam. After a suitably chosen interval of time the potential applied to grid or mesh **31** is reduced to zero, so cutting off the flood electrons from the screen, except in those areas where a positive charge has been deposited on the surface of **32**. Preferably the potential of the fluorescent screen is held at some suitable low level until the potential applied to **31** is set to zero.

In order to provide the necessary operating potentials for the elements of the tube, there is provided a high potential direct current source **8** having its negative terminal connected to the cathode of the gun **7** and its positive terminal connected to the screen **2**. From source **8** another connection is taken to grid **5** to render it sufficiently positive with respect to the cathode of gun **7**. A further source **9** is provided to apply the necessary potentials to the wire grid **41**, while a source **10** is connected to the wire grid **31** to provide it with the necessary operating potentials.

In accordance with well known practice, the writing of the required information by gun **7** is achieved through the agency of a modulator **11** which is adapted to switch the beam on and off at appropriate times and a deflection system **12** adapted to scan the beam across the target.

With reference to FIGURE 2, there is shown a tube of basically the same configuration as that shown in FIGURE 1 and similar reference numerals are used in relation to similar elements of the two figures. The principal difference between the two arrangements is that the embodiment of FIGURE 2 is adapted for half-tone storage and has a further conductive mesh **13** inserted between meshes **3** and **4**. In FIGURE 2, the source **10** is connected to the further mesh **13** instead of mesh **31** as was the case in FIGURE 1. By suitable application of potentials, the mesh **13** serves to collect secondary electrons emitted from the insulator **32**.

I claim:

1. A "direct view" storage tube of the kind referred to comprising a normally provided relatively high capacitance storage target and "writing" and "flood" guns, an additional storage target which is of relatively low capacitance and is adapted rapidly to acquire a relatively non-persistent charge pattern when traversed by the "writing" beam between said guns and said normally provided storage target, whereby after such a pattern has been produced on said additional target, a corresponding but relatively persistent charge pattern will be produced on the said normally provided target by electrons projected to it through said additional target.

2. A tube as claimed in claim 1 wherein a secondary electron collecting electrode is positioned between said additional storage target and the "writing" and "flood" guns.

3. A "direct view" storage tube comprising a "writing" electron gun; a "flood" electron gun, said guns being provided at one end of the tube; a fluorescent screen at the other end; a storage target extending across the tube between said guns and said screen; a second storage target adjacent said first mentioned target and co-extensive therewith and positioned on the side thereof nearer said fluorescent screen and having a capacitance higher than said first mentioned storage target, each of said storage targets comprising a conducting grid or mesh having deposited on the side remote from said screen a layer of dielectric material so arranged as to leave the interstices of the grid or mesh open; and a secondary electron collecting electrode adapted to collect secondary electrons from said first mentioned storage target.

4. A tube as claimed in claim 3 wherein said secondary electron collecting electrode comprises a conducting grid or mesh closely adjacent but spaced from said first mentioned target on the side thereof remote from said fluorescent screen.

5. A tube as claimed in claim 4 and intended for "half tone" operation said tube also having a further secondary electron collecting electrode positioned between said storage targets.

6. In combination a tube as claimed in claim 4; means for switching the beam of said "writing" gun on and off; means for deflecting the beam of said "writing" gun in accordance with applied signals; means for applying a high negative potential to the cathode of said "writing" gun, a positive potential to said first mentioned secondary electron collecting electrode and a high positive potential to said screen; means for applying to the conducting grid or mesh of said first mentioned storage target potentials in the range from a small negative potential to a small positive potential and means for applying to the conducting grid or mesh of said second storage target potentials in the range from zero to a potential in excess of twice the so-called "first secondary emission crossover potential" of the dielectric layer of that target, all of said potentials being measured in relation to the cathode of said "flood" gun.

7. In combination a tube as claimed in claim 5; means for deflecting the beam of said "writing" gun across said first mentioned target; means for modulating said "writing" beam in accordance with applied signals; means for applying a high negative potential to the cathode of said "writing" gun, a positive potential to said first mentioned secondary electron collecting electrode, a positive potential, in excess of the "first secondary emission crossover potential" of the dielectric layer of said second storage target, to said further secondary electron collecting electrode, and a high positive potential to said screen; means for applying to the conducting grid or mesh of said first mentioned storage target potentials in the range from a small negative potential to a small positive potential and

means for applying to the conducting grid or mesh of said second storage target potentials in the range from zero to a value in excess of said "first secondary emission cross-over potential," all of said potentials being measured in relation to the cathode of said "flood" gun.

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