Dec. 2, 1958 M. BARBIER 2,863,088

ELECTRON SIGNAL STORAGE TUBES

Filed April 6, 1953 3 Sheets-Sheet 1

Fig. 2

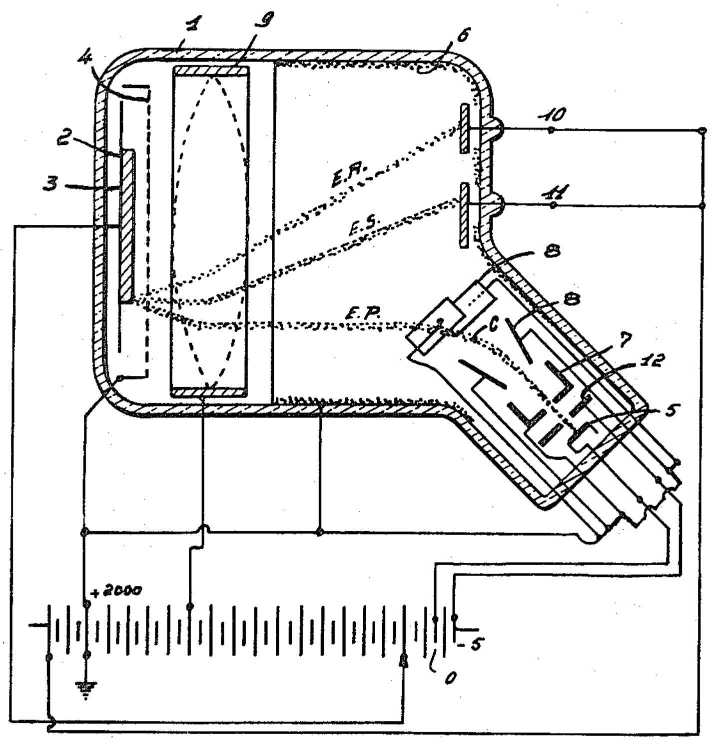
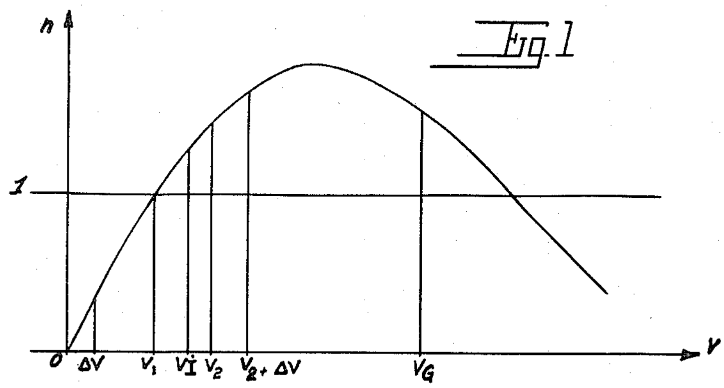


Fig. 1



Dec. 2, 1958

M. BARBIER

2,863,088

ELECTRON SIGNAL STORAGE TUBES

Filed April 6, 1953

3 Sheets-Sheet 2

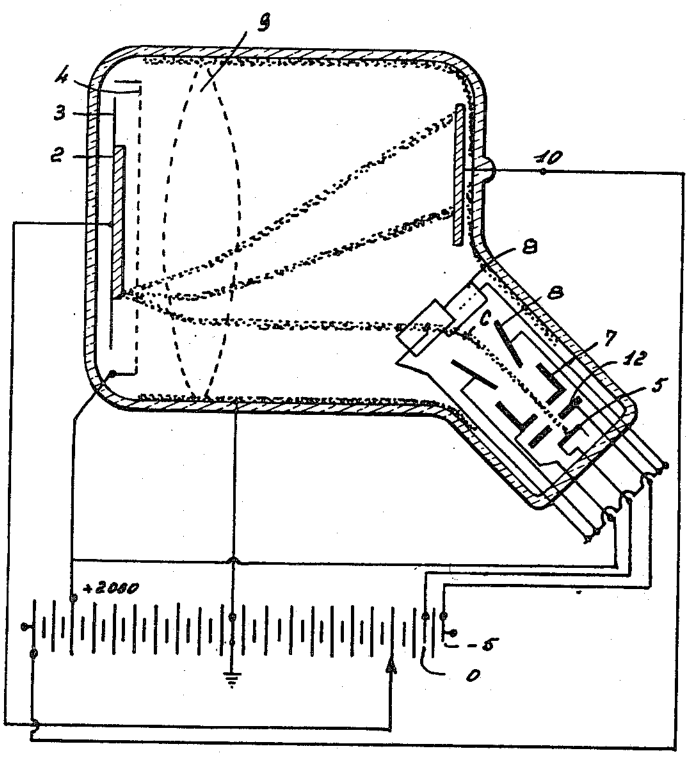


Fig. 3

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ELECTRON SIGNAL STORAGE TUBES

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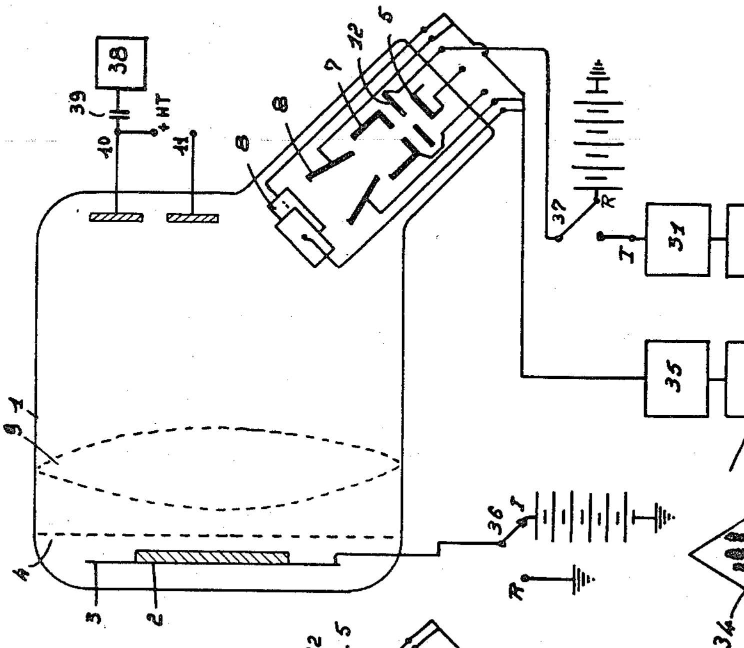

Fig. 5

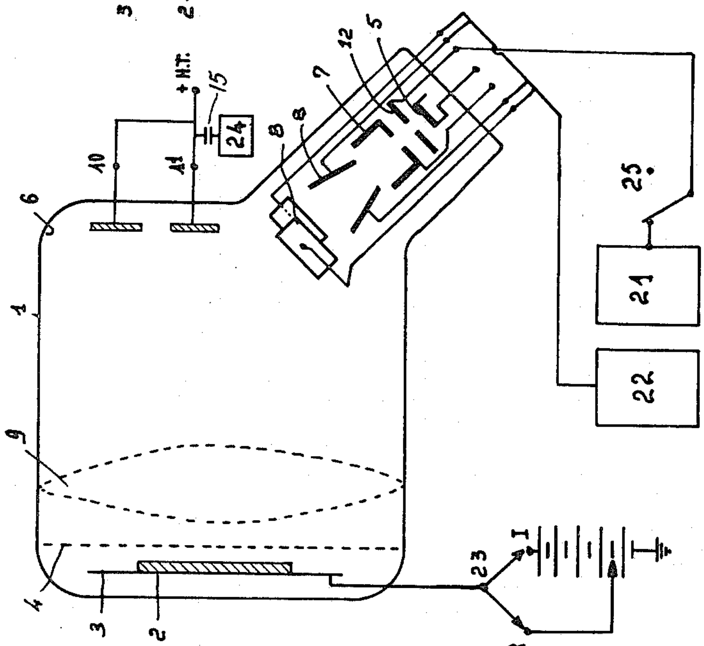

Fig. 4

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ELECTRON SIGNAL STORAGE TUBES

Marcel Barbier, Paris, France, assignor to Compagnie Generale de Telegraphie Sans Fil, a corporation of France

Application April 6, 1953, Serial No. 347,019

Claims priority, application France April 25, 1952

8 Claims. (Cl. 315—12)

The invention relates to electron signal storage tubes and more specifically to such tubes of the known kind which utilise the secondary electronic emission properties of an insulating substance under the impact of a beam of electrons to retain on the surface of said substance an electrical image of a signal or signal train. A known electronic discharge tube operating on this principle usually comprises an electron gun and associated electron-optical system providing an electronic beam, signal controlled means for varying the beam, and a target constituted by a thin sheet of dielectric material of high resistivity. One side of the target sheet is subjected to the impact of the electronic beam and the other is in contact over its area or part thereof with a conducting plate, for example of metal, which is maintained at a pre-determined potential in relation to the cathode of the electron gun.

Every time a point on the bombarded surface of the target is subjected to the impact of electrons, it emits secondary electrons in a number which is a function of the number of electrons received, of their speed, and of the nature of the surface of the dielectric.

If, at a given point on the target, the number of secondary electrons emitted is in a ratio higher than 1 to the number of primary electrons received, a positive charge will appear at that point. It is this phenomenon which is utilised to provide an electric charge at such a point and thus to retain at that point a "memory" or electric image of a signal.

If the number of secondary electrons emitted at a bombarded point of the target is proportional in a ratio higher than 1 to the number of primary electrons received, this ratio being termed hereinafter the "rate of secondary omission," the positive electric charge appearing at the said point will be proportional to the intensity of the electron beam at the time it struck the said point. There will thus be retained at the point in question an electric charge the intensity of which will represent the intensity of the electron beam when it struck said point.

The electron beam may be deflected to scan the target, as in television technique, in which case the target will retain an electric charge image in the form of positive electric charges the intensities of which will be a function of an electric signal used to modulate the intensity of the beam while scanning.

Electric charge image tubes as above described are in current use in practice, but as at present known they have a serious disadvantage which will now be explained.

A positive charge produced as above described by the impact of an electron is not in fact a punctiform charge, but, in practice, an electron gives rise to a group of charges distributed around its point of impact. The secondary electrons do not in fact always have sufficient speed to move away from the target. They are accordingly subjected to the electric fields of neighboring parts of the target and fall back onto the said target, where they give rise to the appearance of new charges. It

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will therefore be understood that, however sharp or fine the electron beam is made, the fineness or resolution of the charge image on the target is limited by this phenomenon.

The present invention seeks to provide improved electron tubes in which this limitation is avoided or reduced.

According to this invention an electron signal storage tube adapted to store a series of electric signals by accumulation of electric charges on a dielectric target plate comprises, in combination, within a vacuum-tight envelope, a dielectric target plate in contact over at least part of one side with a conducting back plate parallel thereto, an electron gun system adapted to project a fine primary electron beam onto the side of said target plate remote from said back plate, means for producing on the surface of the target plate towards said gun a high electric field to prevent secondary electrons created by the impact of said electron beam on said target plate from returning thereto and being deposited thereon, means for varying the speed of impact of the primary electrons on said target plate, and means for separately collecting primary electrons reflected by said target plate and secondary electrons emitted thereby as the result of electronic bombardment thereof.

With a tube in accordance with this invention, a signal can be recorded at a point in the target in the form of a positive electric charge when the speed of impact of the electrons on said target is regulated to a value such that the rate of secondary emission is higher than unity and the stored charge can be read off by bombardment of the same point with a new speed of impact of the electrons such that the rate of secondary emission is lower than unity.

In a preferred embodiment of the present invention a tube comprises a planar dielectric plate, for example in the form of a disc in contact over at least a part of one of its faces with a plane conducting back plate parallel thereto; at least one electron gun system with its axis inclined in relation to the axis of the target plate, and situated pointing towards the face of the target plate remote from the back plate; means for deflecting the electron beam over the target plate; a planar metallic grid electrode adjacent and parallel to the target plate on the gun side thereof; means for maintaining the grid electrode at a high positive potential in relation to the emitting cathode of the gun; means for maintaining the metallic back plate at a substantially lower variable positive potential; an electron lens placed between the grid electrode and the electron gun, said lens having its optical axis in the axis of the target plate, and its focal plane passing through the centre of deflection of the beam; a first collector electrode in or intersecting the axis of the target plate, and in said focal plane of the lens for collecting secondary electrons emitted by said target plate; and a second collector electrode out of or spaced from the axis of the lens for collecting reflected primary electrons. These two collector electrodes may be replaced by a single collector electrode sufficiently large to intersect the axis of the lens.

In use the two collector electrodes (or one if only one is used) are brought to a higher potential than the neighbouring walls of the tube envelope. The grid electrode is preferably maintained at a potential of the order of 2000 to 3000 volts relative the cathode, and the metallic back plate at a potential of the order of 0 to 100 volts relative the cathode, means being provided for varying the potential of said metallic back plate between the potential of the cathode and the gun and a higher potential.

The electron lens is preferably formed by a simple metal ring in the envelope of the tube, and maintained at a suitable fixed potential lower than the grid electrode potential so as to stop secondary electrons created by impact on the target plate. Alternatively, the lens may be constituted by the envelope itself, which in this case must be, at least in part, metallic, the grid electrode being maintained at a suitable potential higher than that of the envelope.

The present invention also provides circuit arrangements wherein tubes as above described may be used for the following operations:

(1) Recording a series of signals as deposited electric charges of variable magnitude on the dielectric target plate and reading off the recorded signals at least once. For these purposes a tube in accordance with the invention is associated with electric circuits, certain of which are used for recording and the others for reading off. The circuits for recording include:

Means such as a grid in the electron gun for modulating the intensity of the beam with the electric signals, means for making the speed of impact of the electrons on the target plate such that the secondary emission rate resulting therefrom at any point is higher than unity, said means being preferably constituted by a source of direct current voltage for giving to the metallic back plate a suitable potential; and means such as plates or coils for deflecting the beam over the target electrode in a desired raster or pattern.

The circuits for reading off include:

A collector electrode in the axis of the target plate for receiving secondary electrons emitted by said plate, this collector electrode being connected to an output circuit; means such as a source of potential for rendering the speed of impact of the electrons on the metallic back plate sufficiently low for the rate of secondary emission to be smaller than unity; and means for deflecting the beam over the target in the same raster or pattern as in recording. Recording may be effected a number of times in succession and the total of the recorded signals read off in a single read-off scan.

(2) Recording signals representative of a two tone image by deposition of electric charges of fixed magnitude at discrete points of the target plate and the cyclic reading off and restoration of the recorded charge image.

For these purposes a storage tube in accordance with the invention is associated with a series of electric circuits of which some serve for recording and others for reading off and restoration.

The recording circuits comprise means, for example connected to a control grid in the electron gun, for interrupting the gun electron emission under the control of a series of electric signals of appropriate form, for example square impulses or signals, of the same amplitude; a beam deflection system for scanning the beam over the target in a pre-determined raster or pattern e. g. in successive straight lines, as in television practice or in a spiral as in a panoramic Radar, the result of this scanning being to divide the discrete points in the target plate into two categories, namely points which have undergone the impact of electrons and points which have not, the former points having like positive electric charges which raise them to a potential close to the grid electrode potential and the latter having no charges, so that they remain at the potential of the back plate; and means such as a source of potential connected to the back plate which, during recording, ensures that the electrons have a sufficiently high impact speed for the secondary emission rate to be higher than unity; the circuits for reading off and restoring include an output circuit associated with a collector electrode out of the axis of the target plate, and adapted to receive primary electrons reflected by the parts of said plate at the potential of the cathode; deflector means as used in the recording and operated similarly, said means being such as to scan, if desired, a series of times cyclically or under manual control; and means such as a potential source connected to the back plate for giving to the speed of impact of the electrons on the target plate a value such that the secondary emission rate resulting therefrom will be lower than unity on non-charged points of said plate and higher than unity on charged points of said plate.

The invention is illustrated in and further explained in connection with the accompanying drawings in which:

Figure 1 is a graph connecting the secondary emission rate *n* (ordinates) of an insulating body with the speed of impact of the incident electrons thereon expressed in volts (abscissae);

Figure 2 is a sectional elevation through the plane of symmetry of one form of tube in accordance with the invention;

Figure 3 is a view, similar to Figure 2 of another embodiment of the invention;

Figure 4 shows diagrammatically an arrangement of circuits including a tube as shown in Figure 2 for recording a series of signals and reading them off once only; and

Figure 5 shows similarly diagrammatically an arrangement of circuits for recording an image in two tones, reading it off and restoring it cyclically.

From Figure 1 it will be seen that the secondary emission rate of a given insulating body, that is to say the number of electrons emitted by the body on impact by an electron of speed expressed in volts starts from 0, for zero volts 0, passes through 1 for a voltage value V_1, then attains a maximum, and finally decreases again when the voltage is very large. The voltage is of course the difference of potential between the bombarded body and the cathode emitting the bombarding electrons. The actual speed of impact of the electrons is, as is well known, proportional to the square of the difference of potential.

Consider now what happens when a dielectric plate, which for example is planar, is bombarded while the unbombarded face in contact with a metal plate is brought to a potential V which is variable in relation to the emitting cathode.

The speed of impact of the electrons on the dielectric plate is proportional to the square of the potential V in the absence of charges on the insulating plate. Two cases have to be distinguished:

(*a*) The case when V is higher than V_1, the potential at which the secondary emission rate of the dielectric plate is equal to 1. [It will be assumed hereinafter that the dielectric plate is of sufficiently high resistivity to retain for a long time a punctiform charge deposited on it.] In this case the surface of the dielectric loses more electrons by secondary emission than it gains by bombardment. The points of the surface subjected to bombardment become the seat of positive charges, and this surface will be charged positively until it attains a potential V_g of the nearest metal parts, which are assumed to be at a potential higher than that of the surface at the beginning of the bombardment, and towards which the secondary electrons flow. When this potential is reached, the secondary electrons remain on the surface. There is no longer any secondary emission and this potential is therefore a potential of equilibrium for the surface. If the bombardment is interrupted before the surface has reached this state of equilibrium, the charge which will have been deposited at a point is proportional to the intensity of the electron current.

(*b*) The case where the potential V is lower than V_1. In this case the surface gains more electrons than it loses. It will be charged negatively until it attains the potential of the cathode, i.e. $V=0$. This potential is again a potential of equilibrium, because the surface cannot be brought to a lower potential—the electrons in this case could no longer reach it. When $V=0$, the electrons arrive at zero speed and there is no further secondary emission.

Thus if V is higher than V_1 and if means are provided for a fine electronic beam to scan the surface of the plate point by point, each point of the surface will store a charge which will be proportional to the intensity of the beam at the moment when it strikes that point and inversely proportional to the speed of scanning. If therefore the different points of the surface are scanned with a thin electronic beam which is modulated in intensity while scanning, there will be obtained different positive charges at each point, it being assumed that the beam is sufficiently fine not to strike more than one point of the surface at a time.

It may be remarked here that Figure 1 is general, i.e. all bodies capable of giving rise to secondary electronic emission under the influence of electronic bombardment have a secondary emission rate the variation of which as a function of the speed of impact of the primary electrons are as indicated in the curve in Figure 1.

If the secondary electrons are not subjected to other forces, they will fall back onto the dielectric surface and create fresh charges. This action, known as "secondary electron redistribution" is, as already pointed out, very harmful for it produces the result that, whatever the fineness of the beam, even if it is fine enough for only a single pint of the plate to be hit at a time, the passage of the beam over each point will give rise to a positive or negative charge not only at the point concerned, but also at other points which are points of impact of returning secondary electrons resulting from the bombardment.

Figure 2, which illustrates in section through its plane of symmetry, one embodiment of the invention, shows how this disadvantage may be eliminated.

In Figure 2, 1 is a vacuum-tight envelope for example of glass, the interior wall of which is provided with a conducting deposit 6. In the envelope is a plane plate **2** of dielectric material of high resistivity, for example mica. This plate is in the form of a sheet with parallel circular plane faces. One of these plane faces is in intimate contact with a metal plate 3. This plate 3 is connected to a source of variable direct current voltage which can bring it to a potential which may be varied, for example from 0 to 150 volts positive in relation to the cathode of a gun provided in the tube.

Near the free face of the dielectric plate 2 is a plane grid 4, constituted by a metal meshwork for example.

The distance from the grid to the dielectric plate is not critical and may be great in relation to the diameter of the electronic beam. On the other hand, the mesh of the grid is preferably smaller than that diameter. This grid is parallel to the surface of the plate and is connected to a source of direct current voltage bringing it to a fixed potential of the order of 1000 to 3000 v. relative to the cathode.

At the other end of the enclosure is placed an electron-optical system, comprising a cathode 5 emitting an electronic beam E. D. (primary electrons) and at zero potential. This cathode is part of an electron gun of construction known per se and which is inclined in relation to the axis of the plate, and includes an accelerating anode 7 and a control electrode 12. A system of deflection plates 8 enables the beam to scan the plate, C being the effective centre of deflection of the beam.

A metal ring 9 co-axial with the plate is mounted in the casing, in the immediate proximity of said plate. This ring is brought to a lower potential than the grid 4, and is situated between the grid and the gun. Its distance from the gun and its voltage are such that said ring behaves as an electrostatic electronic lens having its focal plane passing through the centre C. In this way the trajectories of the electrons emitted by the gun are parallel to one another at and near the dielectric plate.

Two co-planar metallic collector plates 11 and 10 are similarly placed in the focal plane of the lens 9. The collector **10** is situated off the axis of the plate **2**, its centre being symmetrical with the point C, in relation to the said axis of the said dielectric plate **2**. The other plate **11** intersects at its centre the axis of plate **2**. These two electrodes are maintained at the same potential, which is substantially higher than the potential of the neighboring parts of the envelope.

This tube will record an electric signal as a charge image and will allow the subsequent restoration of that signal as will now be explained.

(*a*) To record a signal, the metal plate **3** is brought to a potential V which is higher than the potential V_1 of Figure 1 i. e. such that the rate of secondary emission is more than unity. [All potentials will be given in relation to cathode potential as datum.]

The electrons emitted by the electron gun arrive on the grid **4** at the same angle of incidence, whatever may be the voltages applied to the deflection plates 8. Their potential, which is that of the grid, i. e. V_g, is high. They are then slowed down in the homogeneous field prevailing between the grid and the surface of the dielectric plate **2**. They nevertheless keep constant the component of their speed parallel to the insulating surface, and consequently describe a parabola. They strike the surface with an impact speed such that the secondary emission rate will be higher than 1. A positive electric charge will therefore appear because of the secondary emission of the plate. The finer the beam the smaller the area of the surface at which the charge appears and as a first approximation the charge may be said to be punctiform. The primary electrons are then absorbed by the surface.

The secondary electrons leave the surface of the plate accelerated by the potential V_g; but their initial speed being zero, their speed component parallel to the surface is likewise zero. They therefore leave the surface in a direction parallel to the optical axis of the lens 9, and are concentrated on the electrode 11, which is placed at the intersection of the lens axis and its focal plane, that is to say at its focal point. Therefore not only is redistribution of the secondary electrons over the surface of the plate avoided, since these electrons are accelerated by the grid, but the secondary electrons are collected at a point remote from the grid. Other secondary electrons may nevertheless appear, namely those which are created by the impact of the primary electrons on the grid 4. But these electrons leave the grid at a low speed and are stopped by the lens, which is at a less positive potential than the grid, and return to the grid.

Assuming that no scanning beam takes place, the charge deposited on the plate is then proportional to the time of duration of the bombardment and to the intensity of the beam. This is conditional on the time of bombardment not being long enough to bring the potential of the area of the surface effected to the potential V_g. For at this potential, as has been seen above, secondary emission ceases to charge the plate.

(*b*) In order to efface the electric charge, the insulating plate and the metal plate which are associated with one another are brought to a potential which is not only lower than V_1, but also sufficiently low for the charged area itself to be at a lower potential than V_1. Under this condition the secondary emission rate is lower than 1 and the area will therefore reach the zero potential after a time which is selected to be fairly long, as has been seen in the explanatory study of Figure 1. E. P. and E. S., in Figure 2 designate trajectories of primary and secondary electrons respectively.

The broken line lens representation in Figure 2 illustrates diagrammatically the action of the lens **9** on the electron trajectories. E. R. designates the trajectory of primary electrons which are reflected by the parts of the surface charged at the potential of the cathode. These electrons, keeping constant their speed component parallel to the surface, are reflected onto the collector **10**, the centre of which is symmetrical with the centre of deflection C in relation to the axis of the plate **3**.

Figure 3 shows another embodiment of the invention.

In this figure like references designate like parts as in Figure 2.

In Figure 3 the two collectors **10** and **11** of Figure 2 are replaced by a single collector **101**, which is sufficiently large to collect simultaneously, on two distinct zones, the reflected primary electrons and the secondary electrons. Also the electron lens **9** is incorporated in the envelope **1**, which in this embodiment is metallic. In this envelope insulated lead-in conductors are provided to permit the passage of the various connections.

In Figure 3 the envelope is earthed, and consequently the same is true of the lens **9**. The emitting cathode **5** is at a high negative potential, the grid is at a suitable positive potential, the plate **2** at a variable potential which may be varied, for example, by from 0 to 100 volts with relation to the cathode.

The circuits of Figure 4 include a tube as shown in Figure 2, with its parts designated by the same reference numerals as in Figure 2. Block **21** represents a signal source modulating the intensity of the beam emitted by the electron gun by action on the control electrode **12**. The deflection plates **8** are connected to time base circuits at **22** to produce a desired scanning raster as is well known per se.

A two-position switch **23**, under automatic or manual control, in one position (R) brings the metal plate **3** to a potential V_R lower than the potential V_1 hereinabove defined, and preferably zero, while in its other position (I) it brings the said plate to a potential higher than V_1. A receiver **24** is connected through a condenser **15** to the plate **11**. The two modes of operation, recording and reading off, will now be explained.

For recording, the switch **23** is placed in position I. In this case, the secondary emission rate of the plate being higher than unity, the passage of the beam on its successive points of impact creates positive charges proportional to the instantaneous intensities of the beam and inversely proportional to the speed of scanning, which is assumed to be constant. These charges will be representative of the instantaneous values of the signal from the source **21**. As will be seen subsequently, the speed of scanning and the signal should be such that the positive charges resulting therefrom on the plate will all be lower than a value such that the local potential resulting therefrom, i. e. ΔV, will be lower than V_1.

For reading off, a switch **25** is opened and the source **21** thus disconnected so that the beam is no longer modulated. The contactor **23** is moved to position R so that the potential of the metal plate **3** is zero. Since the speed of scanning and the signal strength are chosen during recording as above stated the maximum potential of the charged points of the plate **2** is $\Delta V<V_1$, and the secondary emission rate is therefore still lower than unity.

The scanning beam of constant intensity will therefore eliminate the positive charges and bring the potential of any point of the plate back to the equilibrium potential zero. At every point, the number of secondary electrons emitted will be proportional to the charge existing there. If therefore a receiver **24** is connected to the collector **11** it will receive a series of signals corresponding to those originating from the source **21**.

It should be observed that if ΔV were higher than V_1, the electrons arriving at points where the potential is higher than V_1 would continue to charge the surface of the plate positively. There would no longer be effacement of the charge, that is to say reading off of the signal, but on the contrary an increase of the charge, up to the equilibrium potential V_g if continued long enough.

As will now be seen the tube allows the faithful recording and subsequent reading off of the signal which may for example be one obtained by scanning a television image. The tube will store the image with all its half-tones and allow it subsequently to be read off. The definition of the image on the dielectric plate is limited only by the attainable fineness of the beam, the phenomenon of redistribution of the secondary electrons being eliminated, so that the definition will be greatly improved as compared to known storage tubes.

The stored signal can be read off with different polarities on the electrodes **10** or **11**, or with electrodes **10** and **11** connected together.

Figure 5 illustrates circuits including a tube as shown in Figure 1 whereby a two-tone image can be stored and read off cyclically.

Referring to Figure 5, block **31** represents a source controlled by impulses from an impulse source **32** and adapted, when the switch **37** is in the appropriate position, to deliver a constant positive voltage to the control electrode **12** of the gun when, and only when, an impulse is emitted by the source **32**. Circuits for use in blocks **31** and **32** are well known per se and need no description here.

Pulse source **32** is connected, for example, to a known image analyser **33** scanning in a pre-determined cycle an image **34** in two tones, for example white and black. This scanning is effected by means of a time-base unit **35**, and is effected in lines, as in normal television practice. The arrangement is such that any white point will give rise to a voltage impulse from **31**, of fixed shape and amplitude, the image **34** being of two shades only—black and white, half-tones being excluded. This voltage impulse is such as to remove cut off from the electron gun which is so operated as to be able to emit electrons only when it receives such an impulse on its control grid. The time base limit **35** is also connected to the deflection plates **8** of the tube so that synchronous scanning of the plate **2** is effected by the electron beam.

There will thus appear on the plate **2** a positive electric charge which is always of the same value φ, every time the analyser **33** encounters a white point in the image and no charge whenever it encounters a black point. This is effected, of course, when the potential of the metallic plate **3** is brought to a potential $V_I>V_1$. A contactor **36** having two positions I and R and controlled manually or automatically brings the plate, in its position I, to the necessary potential V_I. There will thus be a reproduction on the plate, in the form of positive electric charges, of the image **34**.

In contradistinction to what occurs in the case of Figure 4, the speed of scanning and the intensity of the beam are so regulated that the charge φ gives rise on the plate to an increase of potential ΔV such that $\Delta V>V_1$ and even for preference such that $V_I+\Delta V$ is equal to V_g.

In order to read off the image, the potential of the plate is brought back to zero, by moving switch **36** to position R and switch **37** is also changed over to position R. The unit **31** is thus disconnected from the grid **12** to which is applied a voltage such that the gun is unblocked permanently i. e. the beam is permanently "brightened."

The plate is now scanned by a beam of constant intensity, this scanning being again effected by the unit **35**. The different points of the plate are charged at a potential $\Delta V>V_1$, ΔV being near the potential V_g of the grid **12** that is to say such that the secondary emission rate will be higher than unity, or at zero potential 0 (position R of the contactor **36**), which entails zero secondary emission.

The charged points will thus have their potentials increased by a fresh quantity ΔV_1, which depends again on the speed of scanning and the intensity of the beam, but which is near V_g, the upper equilibrium potential. The points not charged will remain at the equilibrium potential 0.

When the beam passes over the parts of the surface which are charged at a potential near that of the grid, the reflected primary electrons and the secondary electrons will leave the surface at a speed corresponding to the difference of the potential $V_g-\Delta V$. They will then be stopped by the potential barrier formed by the lens, which is at a lower potential than V_g, and will not go to the collector. When the beam passes, on the other hand, over the points charged at the potential of the cathode, there will be no secondary electrons, but the primary electrons will be reflected at a speed such that they will be able to reach the collector electrode **10** which is outside the axis. This electrode **10** which is connected to a receiver **38** by a condenser **39**, will thus read off the image with its two tones.

This operation can be continued and reproduced as long as desired. The scanning during reading off regenerates the image of charges of the plate by increasing the charge of the charged points and taking away any charge at the points not charged, if the latter have been able to acquire a positive charge from some fortuitous reason. Since the plate **2** is a condenser whose electrodes are constituted by the charges on the one hand and the plate **3** on the other hand, it may happen that, at the end of a certain time, the image will be destroyed or at least attenuated by disappearance of the charges. The image is thus regenerated by the restoring scanning in reading off. At the end of a certain time the charged points can be brought to the equilibrium potential V_g.

If on the other hand ΔV is made $<V_1$, that is to say if a new regulation is adopted for the recording beam, the image will certainly not be restored by the reading beam, but on each occasion the potential of the points charged will diminish by a quantity ΔV_2, disappearing at the end of a certain number of readings.

Such a tube may be used for example to restore the image from the viewing screen of a panoramic radar, as may be required for military purposes.

What is claimed is:

1. An electron signal apparatus adapted to store a series of electric signals by accumulation of electric charges at discrete points on a dielectric target plate comprising, in combination in a vacuum-tight envelope, a planar dielectric target plate in contact over at least a part of one of its sides with a conducting back plate parallel thereto, an electron gun system having a cathode, the axis of the gun being inclined in relation to the axis of the target plate, and said gun being pointed to project a beam of primary electrons towards the side of the target plate remote from the back plate, means for deflecting the beam of primary electrons, a planar metal grid electrode situated on the gun side of said target plate and parallel thereto, means outside said envelope for maintaining said grid at a high potential relative to the cathode and to the back plate, an electronic lens situated between said grid electrode and said electron gun, said lens having its optical axis in the axis of the target plate, at least one planar collector electrode within said envelope outside the axis of the target plate and in the focal plane of the lens for the collection of reflected primary electrons, means for maintaining said collector electrode at a higher potential than the neighboring walls of said envelope and another planar electrode in said envelope intersecting the axis of the target plate in a position wherein secondary emission electrons from the target may be focused thereon by said lens.

2. An electron signal storage apparatus adapted for recording a series of electric signals by accumulation of electric charges at discrete points on a dielectric target plate and for reading off at least one of those signals, comprising, in combination in a vacuum-tight envelope, a planar dielectric target plate in contact over at least a part of one of its sides with a conducting back plate parallel thereto, an electron gun system having a cathode, the axis of said gun being inclined in relation to the axis of the target plate, and said gun being pointed to project a beam of primary electrons towards the side of the target plate remote from the back plate, means for deflecting the beam of primary electrons about a centre of deflection, a planar metal grid electrode situated on the gun side of said target plate and parallel thereto, means outside said envelope for maintaining said grid at a high potential relative to the cathode and to the back plate, an electronic lens situated between said grid electrode and said electron gun, said lens having its optical axis in the axis of the target plate, and its focal plane passing through the centre of deflection of the beam, at least one planar collector electrode within said envelope outside the axis of the target plate and in the focal plane of the lens for the collection of reflected primary electrons, and means for maintaining said collector electrode at a higher potential than the neighbouring walls of the tube envelope.

3. Apparatus as claimed in claim 2 and comprising means for maintaining said grid electrode at a potential of the order of 2000 to 3000 volts relative the cathode, means for bringing said back plate to a positive potential of between 0 and 100 volts relative the cathode and means for varying the potential of said back plate between said positive potential and the potential of the cathode.

4. Apparatus as claimed in claim 2 wherein the lens is constituted by a metallic ring, means being provided for maintaining said ring at a fixed potential lower than the potential of said grid electrode.

5. Apparatus as claimed in claim 2, wherein the lens is constituted by the envelope itself which is made at least in part of conducting material, means being provided for bringing said conducting material to a lower potential than that of said grid electrode.

6. Apparatus as claimed in claim 2 and comprising a second planar collector electrode intersecting the axis of the lens for the collection of secondary electrons emitted by said target plate.

7. Apparatus as claimed in claim 2 and comprising means associated with the electron gun for modulating the beam in intensity by said electric signals, a source of direct current voltage and a switch system for bringing said conducting back plate to either of two potentials relative the cathode, one of which is such that under the impact of said beam on said target plate the secondary emission rate therefrom is higher than unity and the other of which is such that under said impact said rate is less than unity, means for producing scanning deflecting wave forms and applying the same to the deflection means of the tube so that the beam sweeps the target plate according to a predetermined raster and another planar collector electrode provided in said tube intersecting the axis of the lens and connected to an output circuit.

8. Apparatus according to claim 2 for recording signals representative of a two-tone image by deposition of electric charges of fixed magnitude at discrete points of a dielectric plate and the reading off and restoration cyclically of said image subsequently, comprising means for producing scanning deflection wave forms and applying the same to the deflecting means so that the beam sweeps the target plate according to a predetermined raster, a source of direct current voltage and a switch system for bringing said conducting back plate to either of two potentials relative the cathode, one of which potentials is such that under the impact of said beam the secondary emission rate from points on said target plate which have undergone electron bombardment is higher than unity and the other of which is such that said rate from said points is lower than unity, means connected to said electron gun for interrupting the electronic emission under the control of the series of signals, an output circuit connected with the collector which is outside the axis of the target plate, and a source of direct current voltage for applying to the back plate a potential such that the secondary emission rate is lower than unity at uncharged, and higher than unity at charged points.

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