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ELECTRONIC STORAGE TUBES

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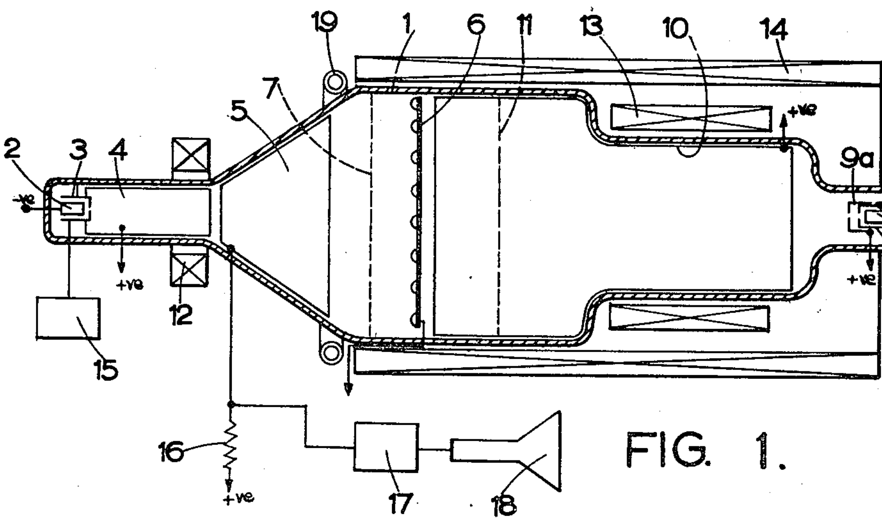

FIG. 1.

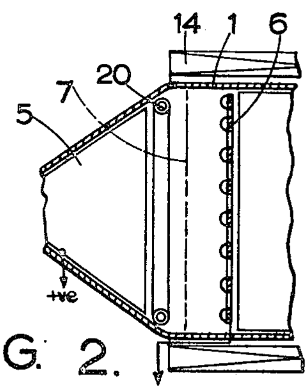

FIG. 2.

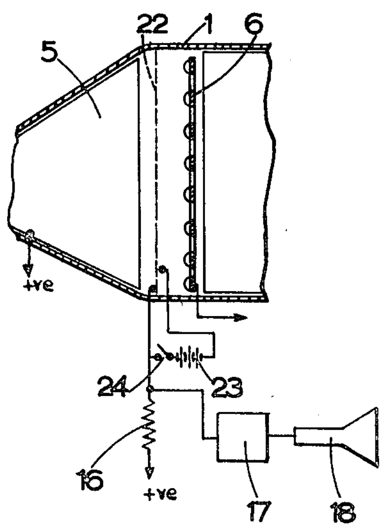

FIG. 3.

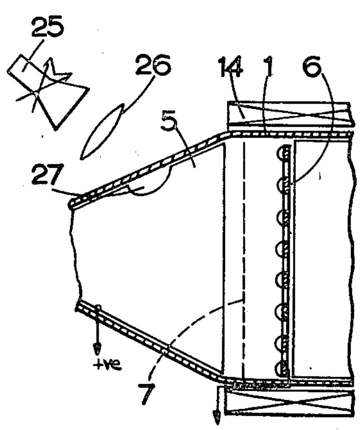

FIG. 4

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ELECTRONIC STORAGE TUBES

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4 Claims. (Cl. 315—12)

This invention relates to electronic storage tubes and to circuit arrangements including such tubes.

Electronic storage tubes are often required for storing information so that it may be reproduced at a later time or to provide means whereby transient signals may be observed for longer periods.

Such tubes are sometimes employed for radar purposes and in general they are provided with means whereby received signals can be stored on a storage electrode in the form of electrical charges, and means are also provided whereby signals can be derived from said charges to provide during a number of successive scannings a high intensity display which can be rendered visible for a much longer duration than the duration of the received signals. In these tubes it is usual to refer to the function of storing the signals as the writing operation and the process of reproducing the signals from the stored charges as the reading operation.

The storage electrode should be capable of retaining the charges without appreciable loss during the reading operation and yet be capable of being erased at will in order that fresh information may be written thereon.

It is therefore an object of the invention to provide an electronic storage tube with an improved storage electrode whereby erasure of signals from the charged surface can be effected in a simple manner.

According to one feature of the invention there is provided an electronic storage tube arrangement comprising an electronic storage tube having a target electrode including photo-conductive material on an electrically conducting support, means for bombarding said material with a beam of electrons whereby charges representing electrical signals can be applied to said photo-conductive material and means for irradiating said material with light so as to increase the conductivity thereof and thereby cause said charges to leak away to said conducting support.

A second feature of the invention comprises an electronic charge storage tube having a mesh electrode of electrically conducting material having a coating of photo-conductive material, a first electron gun disposed so as to face one side of said mesh and capable of generating a beam of electrons for applying charges to said coating, and a second electron gun capable of generating a beam of electrons for reading charges applied to said coating disposed so as to face the opposite side of said mesh, an electron collecting electrode arranged between said first electron gun and said mesh all arranged within an evacuated envelope and means for irradiating said coating with light.

A further feature of the invention comprises an electric circuit arrangement including an electronic charge storage tube having an electrically conducting mesh electrode having a coating of photo-conductive material, an electron gun disposed on each side of said mesh electrode and means for scanning said mesh with electrons from each of said guns, means for modulating said electrons from said electron gun which is disposed facing

said coating so as to bombard and charge said surface in accordance with signal means for operating said other electron gun so as to produce a beam of low velocity electrons which are scanned over the opposite side of said mesh so as to become modulated in accordance with the charges thereon and means disposed between said mesh and said first-mentioned electron gun for collecting said modulated electrons and means for irradiating said coating with light so as to increase the conductivity thereof and cause said charges to be removed by leaking away to said conducting mesh.

In order that the said invention may be clearly understood and readily carried into effect, it will now be more fully described with reference to the accompanying drawings, in which:

Figure 1 illustrates a tube arrangement according to one embodiment of the invention,

Figure 2 illustrates a section of the tube of Figure 1 modified to include a light source within the envelope,

Figure 3 an alternative way of providing a light source within the envelope and circuit connections therefor, and

Figure 4 is a section of a tube having a scanning light source provided externally of the envelope.

As shown in Figure 1, an electronic storage tube is provided which is particularly suitable for radar purposes, comprising an evacuated envelope **1** having at one end a cathode **2** for generating a beam of electrons, a modulating electrode **3**, an anode **4**, and an electron collecting or signal electrode **5**. In the enlarged centre portion of the envelope **1** there is provided an electron permeable charge storage electrode **6** which comprises a metal mesh or grid having, for example, a thousand meshes per linear inch and is provided at least on its side facing the cathode **2** with a layer of photo-conductive material such as antimony tri-sulphide or cadmium sulphide. If desired both sides of the conducting mesh **6** may be covered with photo-conductive material but a more efficient operation of the device is obtained when only the side of the mesh facing the cathode **2** is coated, the opposite side being left uncoated. In the following description examples of devices having a mesh coated on only one side are described.

Between the signal collecting electrode **5** and the storage electrode **6** there is provided a further mesh or grid **7** which functions as an electrostatic shield. At the other end of the tube there is provided a further cathode **8** adapted to generate a beam of electrons, a cathode shield **9**, a beam limiting electrode **9**_a_, an anode **10** which extends close to the storage electrode **6**, and between the cathode **8** and the electrode **6** there is provided a mesh or grid **11** which functions as an ion trap. The electron beam from the cathode **2** is scanned over the coated surface of the storage electrode **6** in any suitable manner, as by means of scanning coils indicated at **12** and the electron beam from the cathode **8** is also scanned over the opposite uncoated surface of the storage electrode **6** as by means of scanning coils **13**, the beam from the cathode **8** being caused to scan the storage electrode at a low velocity and in an orthogonal manner for which purpose the beam from the cathode **8** is caused to scan in the presence of a longitudinal magnetic field generated by a solenoid coil **14**.

In operating the tube shown in Figure 1, the cathode **2** may be maintained at a negative potential of 1500 volts and the modulating electrode **3** is connected to a source **15** of signals which may, for example, be signals derived from radar apparatus. The anode **4** may be maintained at a negative potential of 50–100 volts and the signals or collecting electrode **5** may be connected to a positive potential of about 35 volts through a signal resistance **16** which is connected to an amplifier **17** and to a reproducing cathode ray tube **18**. The grid or mesh **7** may be maintained at the potential of the signal collecting electrode **5** or preferably at a few volts positive with respect thereto so as to collect unwanted secondary electrons released from the electrode **6** by the beam from the cathode **2**. The cathode **8** may be maintained at zero volts, the cathode shield **9** at a negative potential of about 30 volts, the limiter **9a** at a positive potential of about 250 volst and the anode **10** and the ion trap mesh **11** at a positive potential of 180 volts. The conducting member of the storage electrode is maintained at the potential of the cathode **8** or at a few volts positive with respect thereto. It should be noted that in devices having both sides of the mesh coated with photo-conductive material any suitable potential which is below the breakdown voltage of the insulating properties of the material may be applied to the conductive portion of the storage electrode. The electron beam from the cathode **2** serves to perform the writing operation and the electron beam from the cathode **8** the reading operation. A light source such as a circular lamp illustrated at **19** in Figure 1 is provided in such a position that light therefrom can illuminate the photo-conductive surface of the electrode **6** in a uniform manner said light source being connected in a circuit whereby it can be switched on or off as required and also the light output therefrom varied in intensity.

It is well known that photo-conductive materials such as antimony tri-sulphide and cadmium sulphide are almost perfect electrical insulators under conditions of total darkness, but when subjected to light they become electrically conductive. Hence with a tube in accordance with the invention during the process of writing and reading it is necessary to maintain the tube in darkness if maximum storage and reading times are required. To write signals on the storage electrode corresponding to signals from the signal source **15**, the potential applied to the electrodes associated with the cathode **2** are arranged to be such that the beam from the cathode is caused to impinge on the insulating photo-conductive layer of the storage electrode **6** with a velocity greater than that corresponding to the first cross-over point on the secondary electron emission curve of the photo-conductive material in its insulating state so that a greater number of secondary electrons are released from the insulating surface compared with the incident electrons so that the insulating surface facing the gun **2** becomes charged positively. The order of positive charging of said surface may be up to 5 volts. When it is desired to read the charges a low velocity beam from the cathode **8** is employed. The potential applied to the conducting member of the storage electrode **6** is the same as the cathode **8** or in an alternative mode of operation a few volts positive with respect to the cathode **8** so that during the reading operation the low velocity electrons of the reading beam will reach to the conducting side of the mesh, but the number of electrons which actually pass through the mesh will depend on the potential of the stored charge in the vicinity of the beam the remainder being returned to the cathode **8** and hence the electrons will be modulated by the stored charges. In an alternative mode of operation the metal portion of the electrode **6** is maintained at a few volts positive with respect to the cathode **8** whereby the low velocity reading beam of electrons is slightly accelerated by the conducting member of the storage electrode and in this mode of operation the electrons of the beam have a greater tendency to pass through the storage electrode without impinging on the insulating photo-conductive surface. The electrons passing through the storage electrode are collected by the electrode **5** and set up signals across the signal resistance **16** which are then reproduced by the tube **18**. Thus the storage electrode can be repeatedly scanned by the reading beam without any substantial discharge of the charges occurring and in fact, the storage electrode can be scanned by the reading beam 10^3 to 10^4 times without there being any appreciable loss of charge.

When it is desired to erase the charges from the storage electrode before applying fresh charges, the storage surface thereof is irradiated with light from the source **19** whereby the photo-conductive material becomes conducting and the charges thereon are able to leak away to the conducting mesh.

Light may be directed onto said surface in many ways as by the light source **19** mounted externally of the envelope so that light therefrom reaches the photo-conductive surface via the glass wall **1** of the enevelope or, as illustrated in Figure 2 by means of a ring light source **20** which is mounted within the enevelope **1** so that it faces the photo-conductive elements.

An alternative means for providing a suitable light source within the envelope of the device is illustrated in Figure 3 in which an electrode **22** is provided as a number of filamentary wires mounted on a frame so as to be parallel with each other, said filaments being connected so as to form a parallel or series chain whereby current from a voltage source **23** may be passed therethrough by operating the switch **24** to cause said filaments to emit light of sufficient intensity to cause the insulating layer to become conducting. In this instance the electrode **22** serves also as the signal collector by connecting it to a source of positive potential via a signal resistance **16**, the electrode **5** of the tube being connected to a source of positive potential which may be the same as that applied to the anode **4**.

Although in the above described examples of flooding the whole of the photo-conductive surface with light some degree of control of the rate of discharge can be obtained by varying the amount of light emitted from the source and it is sometimes required that the stored charge should be erased in a line by line manner after the reading operation and an arrangement whereby this can be achieved is illustrated in Figure 4.

Referring to Figure 4 a cathode ray tube **25** is operated so that the electron beam is scanned over a fluorescent screen so as to produce a flying light spot and the light from this tube is projected by means of a suitable optical system illustrated diagrammatically at **26** so that it passes through the tube envelope on to the photo-conductive layer of the electrode **6**. In order to allow light to pass through the envelope wall in an unobstructed manner the electrode **5** is formed with a circular window **27**.

Although in the above description only reference to the storage of signals from radar apparatus has been described it is to be understood that the invention is not limited to such application since it could be employed in any arrangement where an electrical signal has to be stored and subsequently reproduced.

What is claimed is:

1. An electronic charge storage tube arrangement comprising an electronic storage tube having a target electrode including a charge storage surface composed of photoconductive material on an electrically conducting support, means for bombarding said surface with a modulated beam of electrons to cause charges representative of the modulation of said beam to be stored in said surface and means for irradiating said surface with light so as to increase the transverse conductivity thereof and thereby cause said charges to leak away to said conducting support.

2. An electric circuit arrangement including an electronic charge storage tube having an electrically conducting mesh electrode a coating of photo-conductive material thereon to form a charge storage surface, electrodes constituting an electron gun disposed on each side of said mesh electrode and means for scanning said mesh with electrons from each of said guns, means for modulating said electrons from said electron gun which is disposed facing said surface so as to bombard and cause charges in accordance with signals to be set up therein, means for operating said other electron gun so as to produce an unmodulated beam of low velocity electrons

which are scanned over the opposite side of said mesh so as to become modulated in accordance with the charges thereon, means disposed between said mesh and said first-mentioned electron gun for collecting said modulated electrons which pass through said mesh and means for irradiating said surface with light so as to increase the transverse conductivity thereof and cause said charges to be removed by leaking away to said conducting mesh electrode.

3. An electronic charge storage tube having a mesh electrode of electrically conducting material having a charge storage surface composed of photo-conductive material, a first electron gun disposed so as to face one side of said mesh and capable of generating a modulated beam of electrons for causing electrical charges to be stored in said surface, a second electron gun capable of generating an unmodulated beam of electrons for reading charges on said surface and disposed so as to face the opposite side of said mesh, an electron collecting electrode arranged between said first electron gun and said mesh all arranged within an evacuated envelope and a light translucent passage through said envelope to allow irradiation of said surface with light.

4. An electronic charge storage tube having a mesh electrode of electrically conducting material having a charge storage surface composed of photo-conductive material, a first electron gun disposed so as to face one side of said mesh and capable of generating a modulated beam of electrons for causing electrical charges to be stored in said surface, a second electron gun capable of generating an unmodulated beam of electrons for reading charges on said surface and disposed so as to face the opposite side of said mesh, an electron collecting electrode arranged between said first electron gun and said mesh and a light source disposed so as to irradiate said surface with light and all arranged in an evacuated envelope.

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