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LARGE STORAGE LOW NOISE IMAGE TUBE

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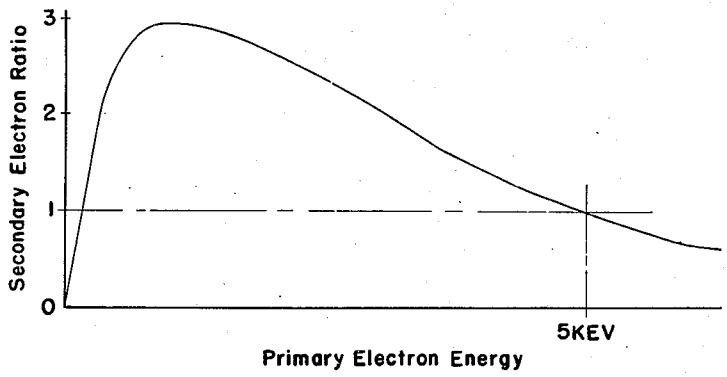


Fig. 1.

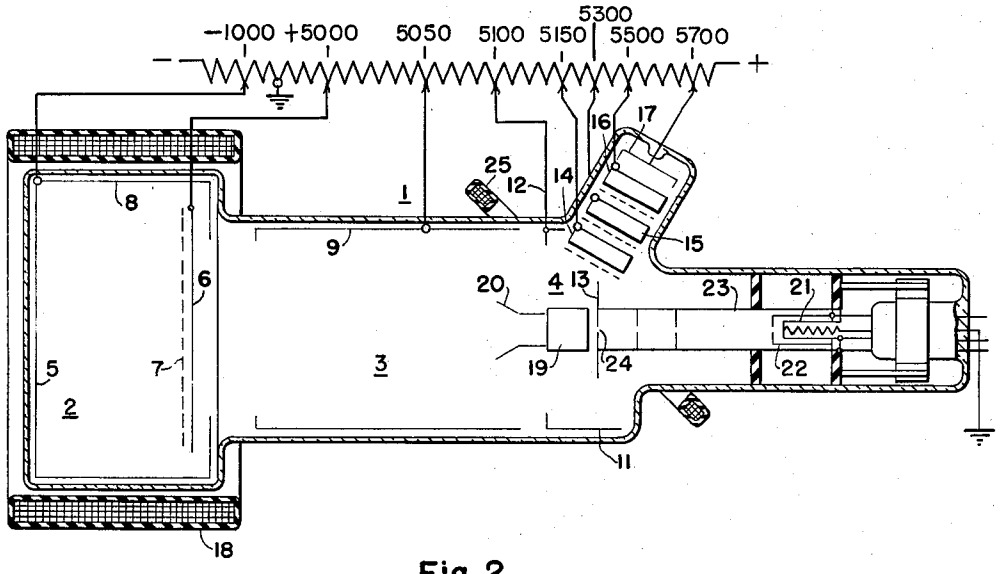


Fig. 2.

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LARGE STORAGE LOW NOISE IMAGE TUBE

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My invention relates to television image pickup tubes and in particular to image pickup tubes in which electric charges proportional to the light intensity at various points of a picture are stored at corresponding points on the surface of a screen. However, it is applicable to storage screens for other than picture purposes.

In the television image pickup tube known as the Image Orthicon, an electron image, formed at the face of a photoelectric screen by focussing the picture on it, is accelerated into impact with a screen of some electrical insulating material such as glass where it produces a charge distribution, point-by-point over the screen, by knocking out secondary electrons. This distribution is scanned by an electron beam from which electrons are abstracted instant-by-instant to neutralize the stored charge at the point of the screen on which the electron beam is incident at the moment. The electrons remaining in the beam are returned to the beam cathode as a current in an external path which controls the picture transmitter.

However, the ability of such image pickup tubes as now operated is limited in the following respects: (1) they have limited energy storing capacity, and (2) they have a high electron noise level.

When the number of secondary electrons knocked out of the glass screen per incident primary electron is measured for various potential differences between the photoelectric screen and the glass screen, a curve of the form shown in Fig. 1 results. Thus, as energy of the primary electrons is increased, the ratio of secondary electron to primary electrons is first less than unity, but soon rises above that value. This ratio rises to a maximum and then falls away until it finally crosses the value unity. The point where the ratio first rises above the value is called "the first crossover point" and where it again falls below unity is "the second crossover point." For accelerating energies between the two points, the screen is left with a positive stored charge when electron bombardment ceases; for other energy values the stored charge is negative.

Conventional Image Orthicons have glass screen potentials relative to the photoelectric input screens such that they operate in the energy range not far above the first crossover point in Fig. 1, and the electrical charge distribution on these screens are positive. In contrast with this, I proposed to operate glass screens in my tube beyond the second crossover point so that primary electrons emitted from the photoemissive screen enter the glass and distribute a negative charge over the surface of the glass screen. Because the charge image on the screen 7 is due, not to secondary electrons, but to primary electrons several hundred volts of potential difference may be produced between points corresponding to dark and bright areas in the picture with my tube, whereas the low-energy secondary electrons limit conventional Image Orthicons to potential differences of the order of one to two volts between such areas.

One object of my invention is accordingly to provide

a picture pickup tube of the storage type which operates with relatively high potential gradients between different points on its screen.

Another object is to provide an improved type of image pickup tube.

Another object is to provide a tube with large capacity of storage.

Still another object is to provide an electric image storage device of high energy gradients.

Yet another object is to provide a device for storing negative charge images of high electric gradient.

Another object is to provide a picture pickup in which the picture current is largely made up of low-energy secondary electrons.

Still another object is to provide an image storage control tube in which the noise will be greatest at points corresponding to greatest image intensities.

Another object is to provide means by which low energy secondary electrons emitted from the scanned surface of a target, are separated from reflected primary and high energy secondary electrons.

Other objects of my invention will become apparent upon reading the following description taken in connection with the drawings in which:

Figure 1 is a graph showing certain features of secondary electron emission which is useful in explaining my invention; and

Fig. 2 is a schematic showing partly in section of a picture pickup tube embodying the principles of my invention.

Referring in detail to Fig. 2 of the drawings, a picture pickup tube embodying the principles of my invention comprises the Image Orthicon which comprises an evacuated enclosure 1, which may be of glass, having an image chamber 2, a scanning chamber 3 and an electron multiplier section 4. The image chamber 2 is of a structure well known in the art and needs no description here beyond the statement that a conventional photoelectric coating forms a screen 5 on which the picture to be transmitted is focussed by a suitable optical system (not shown) outside the tube. A thin glass membrane 6 faced with a metallic screen 7 is supported parallel to screen 5. The screens 5 and 7 are provided with leads so that desired voltages may be impressed upon them by potentials derived from taps on a direct current source 5A, and the inner wall of the chamber is preferably given a conducting coating 8 which is electrically connected to screen 5. The voltage between screen 5 and 7 is such that the electrons have energy above the second crossover of the material in the membrane 6. In the case of glass, the range difference is of at least 5000 or more volts. The scanning chamber 3, which is cylindrical, is likewise provided with a conductive coating 9 and is similar to present day Image Orthicon structure. At the region remote from image chamber 2, the scanning chamber 3 is provided with a separate coating 11, the electrical potential of which may be fixed by an in-lead 12. In the central axis of coating 11 is positioned the end-disc 13 of the electron gun. Beyond the disc 13 are located dynodes 14, 15, 16 and an output electrode 17 of conventional structure which it is believed superfluous to describe, each provided with an in-lead by which its potential may be fixed at will. A focussing coil 18 is provided for image chamber 2, and a set of deflecting electrodes 19, 20 are arranged to cause an electron beam issuing from the orifice in disc 13 to scan screen 6 with a centered trace of small area. A separating coil 25 having its axis inclined to the axis of tube 1 produces a magnetic field inclined to that tube axis for a purpose pointed out below.

The scanning beam for screen 6 is produced by a conventional electron gun comprising an electron-emis-

sive cathode **21** and electron lens elements **22, 23** of a well known type terminating in end-disc **13**, from the contracted orifice **24** in the center of which the electron beam issues.

Since the structure so far described is conventional today, it is believed sufficient in further description of it to say that the light field focussed on screen **5** generates an electron image which is accelerated by the electric field in the space between screens **5** and **7** into impact with glass screen **6** and that such impact results in the storage of electric charges on screen **6** which duplicate in space distribution the light field incident on the photoelectric screen **5**.

As was stated above, the potential of glass screen **6** is the same as that applied to the metallic screen with no electron bombardment and relative to photo-emissive screen **5**, is made to be above the second cross-over point of Fig. 1 so that the charges on screen **6** due to photoelectron bombardment from photoemissive screen **5** are negative. The screen **6** is scanned point-by-point with the electron-beam emanating from the orifice **24** in electron-gun end-disc **13**, and the electron-gun cathode **21** is made negative relative to screen **6** by an amount less than the voltage corresponding to the second cross-over point and greater than first crossover on Fig. 1. Consequently the impact of the electron-beam on the latter sets free secondary electrons and imparts to screen **6** a positive charge which neutralizes the negative charge-image existing on screen **6** at the point of impact. At any particular instant, electrons coming from screen **6** are repelled by the electric field about the point on screen **6** upon which the electron-beam is then incident and return toward the dynode **14** where they generate secondary electrons which flow by external circuits to the electron-gun cathode. The number of these repelled electrons varies with the charge at the point on screen **6** where the electron-beam is incident at any time and this results in a current which varies in time at output electrode **17** in correspondence with the space distribution of charge on screen **6**, and hence with the light distribution in the picture focussed on photoelectric input screen **5**. The use of a current varying in time in correspondence with light distribution on a picture input screen to control a television transmitter is conventional in present day television systems, and is believed to require no further description here.

The secondary electrons generated at glass screen **6** by the electron beam from electron gun cathode **21** will be of relatively low energy and these alone will vary in time in correspondence with the charge-distribution on screen **6**. On the other hand any reflected primary electrons from that beam will be of relatively high energy. The separating coil **25** acts to separate the low energy and high energy electrons since dynode **14** may be positioned so that it is shielded from the only slightly curved paths of high energy electrons reflected from screen **6**, but will be struck by low-energy electrons whose paths are sharply curved by the field of the above-mentioned separating coil **25**. The signal-to-noise ratio of my present arrangement will thus be higher than that of conventional Image Orthicons. Furthermore the advantage results that noise is greatest when the signal is greatest, and least for low signal intensity.

I claim as my invention:

1. A television picture pickup tube comprising a photoelectric screen on which said picture may be focussed, a screen of glass which emits secondary electrons when primary electrons are incident upon it, means to accelerate electrons from said photoelectric screen into incidence with said glass screen with an energy greater than the second cross-over of the curve relating electron energy with secondary electron emission for said glass, means for producing an electron beam and means to cause it to scan said glass screen with electrons having an energy less than said second cross-over, electron multiplier means laterally displaced from the origin of said electron beam, and means to produce a magnetic field having a substantial component transverse to the undeflected path of said electron beam and in the region adjacent the input of said electron multiplier.

2. A pickup tube system comprising an input screen of a type which emits electrons when irradiated, a target member of insulating material which emits secondary electrons when primary electrons are incident upon it, a first current source and connections from it to said screen and said target to accelerate electrons from said first screen into incidence with said target with an energy greater than the second crossover value on the curve relating electron energy to secondary electron emission for said target member to produce a charge image on the bombarded surface, a second current source, an electron gun positioned on the opposite side of said target with respect to said input screen, a second current source connected to said gun and said target for scanning said target with a beam of electrons from said gun having an energy less than second crossover value and greater than said first crossover value and means to collect secondary electrons which are emitted from the surface of said target during said scanning operation.

3. A pickup tube system comprising an input screen of a type which emits electrons when irradiated, a target member of insulating material which emits secondary electrons from the bombarded surface when primary electrons are incident upon it, means for impressing a field between said input screen and target to accelerate electrons from said input screen into incidence with one surface of said target with an energy greater than the second crossover value on the curve relating electron energy to secondary electron emission for said target to produce a charge image representative of the radiation on said surface of said target, said charge image setting up a potential pattern on the opposite surface of said target, an electron gun provided on the opposite side of said target with respect to said input screen for generating an electron beam to scan the potential pattern on the surface of said target, said electron beam having electrons of an energy less than said second crossover value and greater than said first crossover value and means to collect secondary electrons emitted from the scan surface of said target in response to bombardment of the target by said electron beam.

4. A pickup tube system comprising an input screen of a type which emits electrons when irradiated, a target member of insulating material which emits secondary electrons from the bombarded surface when primary electrons are incident upon it, means for impressing a field between said input screen said target to accelerate electrons from said input screen into incidence with one surface of said target to produce a negative charge image representative of the radiation on said surface of said target, said charge image setting up a potential pattern on the opposite surface of said target with respect to said input screen for generating an electron beam to scan the potential pattern on the surface of said target with electrons of an energy less than said second crossover value and greater than said first crossover value on the curve relating electron energy to secondary electron emission for said target and means to collect secondary electrons which are emitted from the scanned surface of said target during said scanning operation and an electron multiplier means having its input responsive to said collected secondary electrons.

5. A pickup tube system comprising an input screen of a type which emits electrons when irradiated, a target member of insulating material which emits secondary electrons from the bombarded surface when primary electrons are incident upon it, means for impressing a field between said input screen and said target to accelerate electrons from said input screen into incidence with one surface of said target with an energy greater

than the second crossover value on the curve relating electron energy to secondary electron emission for said target to produce a charge image representative of the radiation on said surface of said target, said charge image setting up a potential pattern on the opposite surface of said target, an electron gun provided on the opposite side of said target with respect to said input screen for generating an electron beam to scan the potential pattern on the surface of said target having electrons of an energy less than said second crossover value and greater than said first crossover value, means to collect secondary electrons emitted from the scanned surface of said target during said scanning operation, said means comprising an electron multiplier, and means to produce a magnetic field having a substantial component transverse to the undeflected path of said secondary electrons to deflect said secondary electrons of low energy onto said collecting means.

6. A pickup tube system comprising a tube having a photocathode screen of a type which emits electrons when irradiated, a dielectric target positioned to intercept electrons emitted from said photocathode, means for accelerating the electrons emitted from said photocathode into incidence with one surface of said dielectric layer at an energy greater than the first and second crossover

value on the curve relating electron energy to secondary electron emission for said dielectric material to produce a negative charge image on the surface of said dielectric layer facing said photocathode, said charge image setting up a potential pattern on the opposite surface of said dielectric layer, means provided on the opposite side of said dielectric layer with respect to said photocathode for generating an electron beam having electrons of an energy less than second crossover and less than first crossover on the curve relating electron energy to secondary electron emission for said dielectric material, means for deflecting said electron beam to scan the potential pattern on the surface of said dielectric layer facing said electron gun, and means for collecting low energy secondary electrons emitted from the surface of said dielectric layer facing said electron gun in response to bombardment by said electron beam.

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