

April 8, 1941.

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2,237,896

ELECTRONIC DEVICE

Filed Feb. 29, 1936

2 Sheets-Sheet 1

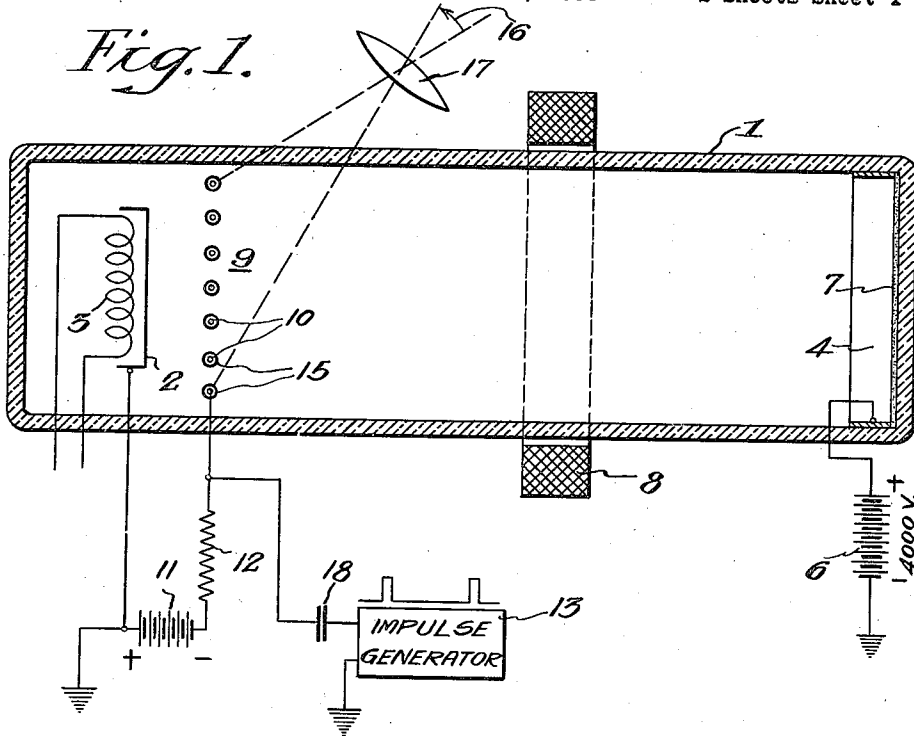
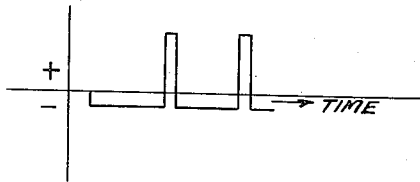


Fig. 4



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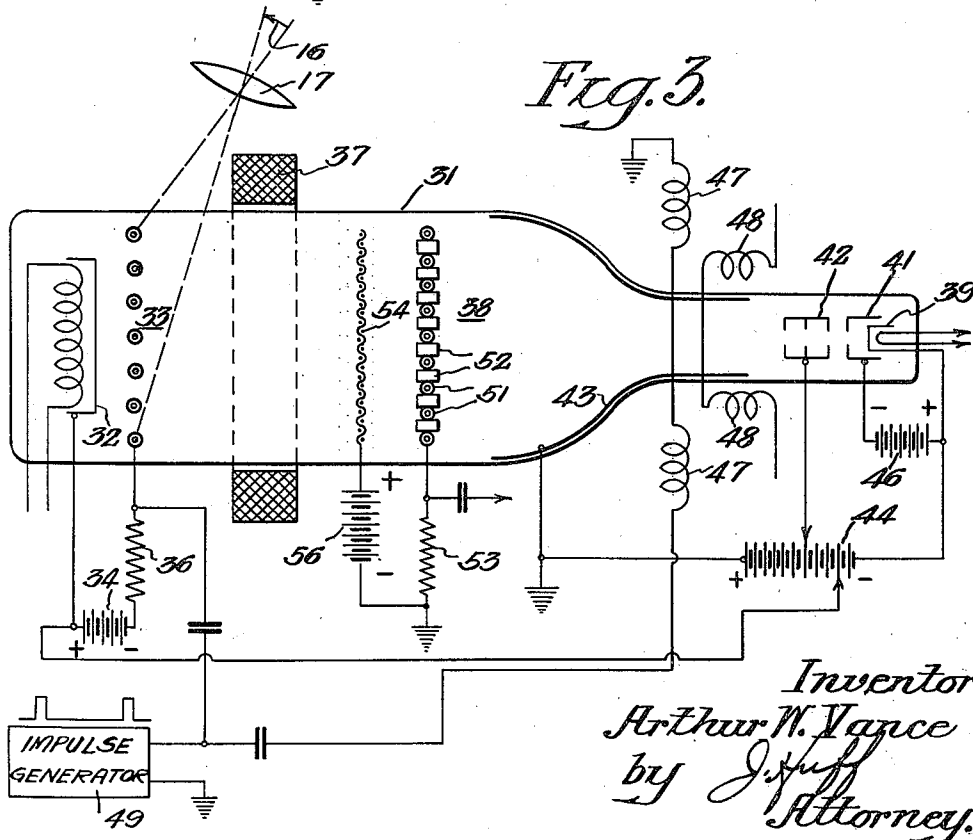
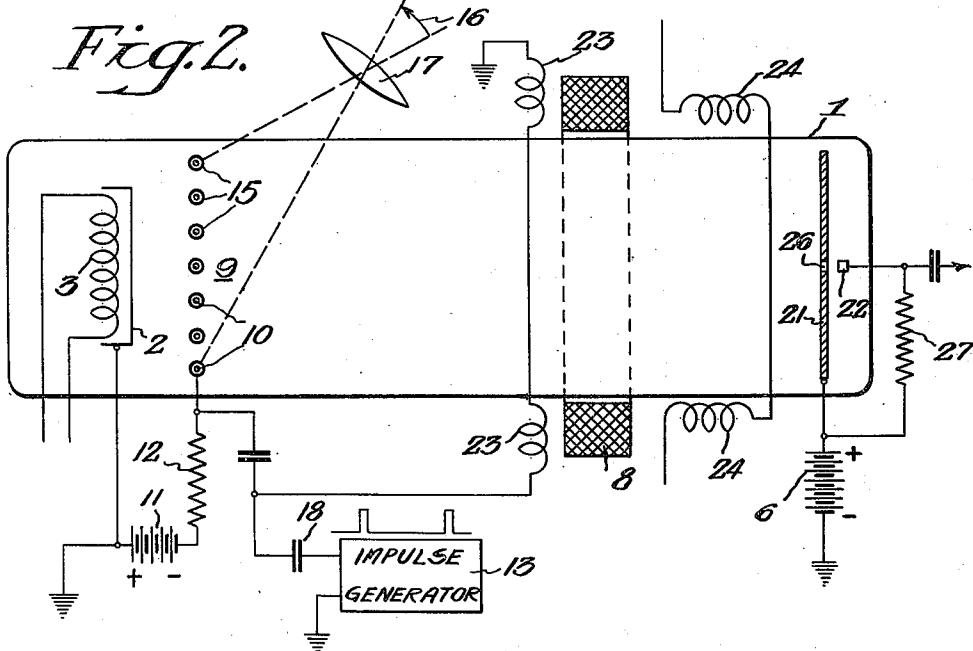
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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ELECTRONIC DEVICE

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Application February 29, 1936, Serial No. 66,342

9 Claims. (Cl. 178-7.2)

My invention relates to light-sensitive electronic devices and particularly to electron beam devices for transmitting or amplifying pictures.

At the present time there are two well known types of so-called cathode ray transmitter tubes which may be utilized for television transmission. In one type of the tube there is an anode or plate screen comprising a mosaic of light sensitive elements which are scanned by a cathode ray or electron beam of small diameter to develop picture signals. In the other type of tube there is a cathode of extended area comprising a mosaic of light sensitive elements whereby a cathode ray or beam of the diameter of the picture is produced, the intensity of the beam varying from point to point in accordance with the shading of the picture. This wide beam is caused to scan a small anode element to develop picture signals.

In both tubes of the above-mentioned types, the final limit to the sensitivity is definitely set by the energy of the light image obtained as the input. There is no possibility of amplifying the picture image before it is scanned.

It is, accordingly, an object of my invention to provide an improved method of and means for amplifying a picture image without scanning it.

A further object of my invention is to provide an improved method of and means for increasing the ratio of signal to noise in picture transmission.

A further object of my invention, is to provide a method of and means for utilizing the storage effect of a light-sensitive mosaic for controlling the intensity of a picture image.

In practicing my invention, I provide a mosaic of light-sensitive elements which is located between a cathode of extended area and some element such as a fluorescent screen, an anode of small diameter, a second light sensitive mosaic, or the like. This first mentioned mosaic functions as a control grid for the electrons supplied by the cathode, the degree of control at a particular region in the electron beam depending upon the potential of the mosaic light sensitive element in that region. By projecting a light image upon this mosaic, the light sensitive elements acquire potentials in accordance with conditions of light and shade of the light image whereby, in the electron beam and in a plane at right angles to the axis of the beam, there is an amplified electron image.

Because the light sensitive elements of the control mosaic are insulated from each other

and from the supporting screen, it is impossible to apply a potential to them by means of a direct current connection. I overcome this difficulty by applying voltage impulses to the mosaic periodically whereby a positive potential is applied to the light sensitive elements through the capacity between them and the screen. This causes the light sensitive elements to collect electrons whereby the said elements are at the proper potential at the end of the positive impulse.

As previously indicated, various devices and circuits may be designated to utilize the general ideas outlined above. If it is desired to construct a transmitter tube, instead of following the second of the above designs, one may employ a design which includes a "double-sided" mosaic so positioned as to be scanned by a cathode ray of small diameter. If it is desired to construct an image amplifier, a fluorescent screen is provided which is bombarded by the electron beam having the electrical image thereon, and there is no scanning action.

Other objects, features, and advantages of my invention will appear from the following description taken in connection with the accompanying drawings in which

Fig. 1 is a view illustrating an image amplifier constructed in accordance with one embodiment of my invention;

Figs. 2 and 3 are views illustrating cathode ray transmitter tubes constructed in accordance with two different embodiments of my invention; and

Fig. 4 is a curve which is referred to in explaining the invention.

Referring to Fig. 1, the image amplifier comprises an evacuated tubular glass or other suitable envelope 1 which has therein a uni-potential cathode 2 of extended area, the cathode being heated by a suitable heater coil indicated at 3. At the other end of the envelope 1 there is a metallic ring 4 which preferably is in the form of a silver coating on the inside of the envelope 1, which is maintained at a high positive potential with respect to ground by any suitable means, such as a battery 6. On the end of the envelope 1 there is a fluorescent screen 7.

Some suitable means, such as a focusing coil 8, is provided for focusing the electrons which leave the cathode 2 upon the fluorescent screen 7. It will be understood that with this arrangement, if the cathode 2 is in the shape of a disc, a disc of light of the same diameter as the cathode 2 will appear on the fluorescent screen 7 since the cathode and the ring 4 are maintained

at a high difference of potential, the cathode being connected to ground.

A grid-like mosaic 9 of discontinuous photo-electric or light-sensitive elements is positioned between the cathode 2 and the fluorescent screen 7. The mosaic 9 may be constructed in various ways, but a preferred way is to employ a fine mesh screen of nickel wire or the like indicated at 10, which is enameled as indicated at 15. By way of example, it may be mentioned that a screen of 200 mesh, that is 200 wires to the inch, with the spacing between wires equal to or greater than the diameter of the wire, will be found satisfactory. The enameled wire screen should be fine enough mesh so that there are several meshes per picture element. This enameled screen is coated with a thin discontinuous photo-electric surface (not shown) such that each elementary area is insulated from all others. A photo-electric surface of this character may be formed of caesium in the manner described and claimed in application Serial No. 594,779, filed February 24, 1932, in the name of Sanford E. Essig and assigned to the Radio Corporation of America. It will be understood that this photo-electric surface does not close the openings of the screen and that the finished mosaic is of grid-like structure, whereby electrons may pass therethrough to bombard the fluorescent screen 7.

The wire screen of the mosaic 9 is maintained at a negative potential with respect to ground by means of a battery 11 or the like which has its negative terminal connected to the wire screen through a resistor 12.

It will be understood that the photo-electric elements themselves are insulated from the wire screen 10 and that, as a result, it is impossible to maintain them at a particular biasing potential by means of a direct current connection. For this reason, an impulse generator 13 is provided for supplying impulses to the wire screen 10 periodically, whereby positive impulses are produced on the photo-electric elements through the capacity between them and the wire screen. The reason for this will be better understood from the description which follows.

In order to explain the operation of my image amplifier, it will be assumed that the photo-electric surface on the enamel of the screen 10 is the same voltage as the screen wire and that the wire is negative. If the cathode 2 is heated to an electron emitting condition, the electrons emitted from the cathode are drawn through the negative meshes of the mosaic 9 by the positive ring 4 and an image of the mosaic appears on the fluorescent screen 7. If the negative potential of the mosaic 9 is large enough, the current reaching the fluorescent screen 7 will be small and the image of the mosaic 9 very weak. Also, the photo-electric surface of the mosaic will not collect any electrons since it is negative.

It will now be assumed that a light image of an object indicated at 16 is projected upon the mosaic 9 by means of a suitable optical system indicated at 17. Each photo-electric element of the mosaic 9 will emit electrons at a rate depending upon the amount of light at that point of the picture. These electrons will flow either to the cathode 2 or to the highly positive silver ring 4. Each photo-electric element on the mosaic 9, therefore, will become charged less negative (more positive), with respect to the cathode 2 and at a rate proportional to the light intensity thereon. Thus, a light image will appear

on the fluorescent screen 7 similar to the light image originally focused on the mosaic 9, and it will increase in brilliancy with time, up to a certain limit.

Before the photo-electric elements of the mosaic 9 have become less negative enough to collect current, or at a time limited by other factors such as a flicker of the picture on the fluorescent screen 7, a positive impulse from generator 13 is impressed upon the wire screen 10. The photo-electric surface, which is also swung positive because of the capacity coupling to the wire, collects electrons rapidly from the cathode 2. These electrons cause the photo-electric surface to become less positive than the wire 10 and when the impulse changes to one of negative polarity, the photo-electric surface is negative and ready to be charged again by the light image.

The character of the impulses applied to the mosaic 9 will be understood by referring to Fig. 4. In this figure the time axis is also the alternating current axis for the curve. It will be understood that if rectangular impulses supplied from a multivibrator or any other suitable impulse generating device are passed through a condenser, such as the condenser 18 shown in Fig. 1, the impulses will have an alternating current axis which has a position such that the area of the curve on the positive side of the axis is equal to the area of the curve on the negative side of the axis.

It will be apparent that the sensitivity of the image amplifier described above depends upon the size of the capacity of each photo-electric element to the screen wire 10. However, if this capacity is too small, the leakage between the wire and the elements or from element to element may limit the charging time available. As to the magnitude of the positive voltage impulse applied to the screen 10, it should be great enough to cause the mosaic elements to collect electrons as described but not great enough to make the control mosaic so negative that electrons from the cathode will not reach the fluorescent screen.

It will be evident that the mosaic 9 functions as a control grid whereby the storage effect of the mosaic is utilized for controlling the intensity of the image appearing on the fluorescent screen 7.

While a cathode of extended area has been illustrated, it should be understood that any other suitable structure may be employed for obtaining a source of electrons of extended area. For example, the cathode may be of small area and the electrons sprayed at low velocity through a wide angle towards the control mosaic.

In Fig. 2 of the drawings I have shown my invention applied to a cathode ray transmitter tube of the second type mentioned above. In Figs. 1 and 2 like parts are indicated by the same reference numerals. The construction of the two devices is the same except that in the device shown in Fig. 2 a shielding plate 21 and a small anode or target 22 have been substituted for the silver ring 4 and fluorescent screen 7 shown in Fig. 1. Also vertical deflecting coils 23 and horizontal deflecting coils 24 have been provided for causing the electron beam to scan the small opening 26 in the plate 21 whereby picture signals appear across an output resistor 27 connected between the target and the shielding plate.

In the specific embodiment illustrated in Fig. 2, the positive impulses which are impressed

across the vertical deflecting coils 23 to produce a saw-tooth deflecting current are also impressed across the resistor 12 whereby the photo-electric elements of the mosaic 9 are periodically driven positive to cause them to collect electrons as previously described.

If preferred, the positive impulses which are impressed across the horizontal deflecting coils 24 at a much higher frequency than the rate of vertical deflection may be impressed across the resistor 12 instead of the lower frequency vertical deflecting impulses.

It will be seen that in this transmitter tube the electrical image is amplified by the action of the mosaic 9 before the target 22 is scanned to produce picture signals.

In Fig. 3 my invention is shown applied to the first mentioned type of transmitter tube. This transmitter tube comprises an evacuated envelope 31 which contains at one end a cathode 32 and a mosaic 33 such as described in connection with the preceding figures. The wire screen of the mosaic 33 is maintained at a negative potential with respect to the cathode 32 by means of a battery 34 which has its negative terminal connected to the screen through a resistor 36. A focusing device of some kind, such as focusing coil 37, is provided for focusing the electrical image on a double-sided mosaic 38 which will be described hereinafter.

The other end of the envelope 31 is provided with an electron gun comprising an indirectly heated cathode 39, a control electrode 41 and a first anode 42. A second anode 43 is provided which functions to accelerate the electrons and to focus them electrostatically to a beam of very small diameter at the surface of the double-sided mosaic 38. The second anode 43 is connected to ground and the cathode 39 is maintained at a high negative potential with respect to ground by means of a suitable source of potential such as a battery 44. The first anode 42 is connected to a point on the battery 44 whereby it is maintained positive with respect to the cathode. The control electrode 41 is maintained negative a certain amount with respect to the cathode by means of a suitable biasing source such as a battery 46.

Vertical deflecting coils 47 and horizontal deflecting coils 48 are provided for causing the cathode ray to scan one side of the double-sided mosaic 38.

Positive voltage impulses are supplied to the vertical deflecting coils 47 from a suitable impulse generator indicated at 49 to cause a flow of saw-tooth current through them. These same impulses preferably are impressed across the resistor 36 for the purpose of driving the photo-electric elements of the mosaic 33 positive periodically for the purpose previously described.

The double-sided mosaic 38 may be of the same type which formerly has been employed in a device where a light image is projected upon one side of the mosaic and a cathode ray is caused to scan the other side of the mosaic to develop picture signals. Such a mosaic may comprise a fine mesh screen 51 of nickel wire or the like which is enameled and which has the screen openings filled with tiny plugs 52 of metallic silver. The silver plugs may be treated for high secondary emission as by means of a coating of caesium on the side facing the control mosaic 33. Such a double-sided mosaic may be constructed in any suitable manner as by coating the enameled screen with a paste of material which can be reduced to metallic silver.

The wire screen 51 of the mosaic 38 is connected through an output resistor 53 to ground. A fine mesh wire screen 54 is placed adjacent to the treated side of the mosaic 38 and maintained at a positive potential with respect thereto by means of a battery 56 for the purpose of collecting secondary electrons.

In operation, an electron image corresponding to the light image of the subject 16 to be transmitted is formed in the manner previously described. The electron beam from the cathode 32, which beam represents the electrical image, bombards the silver plugs 52 of the mosaic 38 whereby they emit secondary electrons which are collected by the screen 54. The number of secondary electrons emitted from a silver plug 52 depends upon the intensity of the bombarding beam at that point, and the potential acquired by this silver plug depends upon the number of secondary electrons emitted by it. Thus it will be seen that the elements of the double-sided mosaic 38 acquire varying potentials in accordance with conditions of light and shade of the subject to be transmitted whereby there is an electrical image on the mosaic 38. As a result, when the mosaic is scanned by the cathode ray, picture signals appear across the output resistor 53.

Here again it will be noted that the picture image is amplified by the action of the control mosaic before there is any scanning action for the production of picture signals.

It will be apparent from the foregoing description that various other modifications may be made in my invention without departing from the spirit and scope thereof and I desire, therefore, that only such limitations shall be imposed thereon as are necessitated by the prior art and are set forth in the appended claims.

I claim as my invention:

1. An electric discharge tube comprising an evacuated envelope having therein a source of electrons of extended area, electrical image utilizing means comprising an element positioned to receive said electrons, and a mosaic of photo-electric elements electrically insulated from each other and positioned between said cathode and said element, said mosaic being of grid-like structure whereby electrons may pass therethrough from said cathode to said element, and means for applying a positive impulse to said mosaic periodically.

2. An electric discharge tube comprising an evacuated envelope having therein a source of electrons of extended area, a fluorescent screen, and a mosaic of discontinuous photo-electric elements positioned between said cathode and said screen, said mosaic being of grid-like structure whereby electrons may pass therethrough from said cathode to said screen, and means for applying a positive impulse to said mosaic periodically.

3. An electric discharge tube comprising an evacuated envelope having therein a source of electrons of extended area, a target electrode of small area compared with said cathode area, a mosaic of discontinuous photo-electric elements positioned between said cathode and said target, said mosaic being of grid-like structure whereby electrons may pass therethrough from said cathode to said target, means for focusing the electrons leaving said cathode, means for scanning said target with said beam, and means for applying a positive impulse to said mosaic periodically.

4. An electric discharge tube comprising an evacuated envelope having therein a source of electrons of extended area, a screen electrode having an opening therein, a mosaic of discontinuous photo-electric elements positioned between said cathode and said screen electrode, said mosaic being of grid-like structure whereby electrons may pass therethrough from said cathode to said screen, means for focusing the electrons leaving said cathode, means for scanning said opening with said beam, and means for applying a positive impulse to said mosaic periodically.

5. An electric discharge tube comprising an evacuated envelope having therein a source of electrons of extended area, a screen electrode having an opening therein, a mosaic of discontinuous photo-electric elements positioned between said cathode and said screen electrode, said mosaic being of grid-like structure whereby electrons may pass therethrough from said cathode to said screen, means for focusing the electrons leaving said cathode, means for scanning said opening with said beam, and means for applying a positive impulse to said mosaic at the end of each scanning period.

6. An electric discharge tube comprising an evacuated envelope having therein a source of electrons of extended area, a mosaic of conducting elements which are insulated from each other and from their supporting structure, said elements extending from one side of the mosaic to the other to form a double-sided mosaic, the side of each of said elements facing said cathode having a surface such that it emits secondary electrons when bombarded by primary electrons, a mosaic of discontinuous photo-electric elements positioned between said cathode and said double-sided mosaic, said mosaic being of grid-like structure whereby electrons may pass therethrough from said cathode to said double-sided mosaic, means for scanning the side of said double-sided mosaic which is facing away from said cathode with a cathode ray of small diameter to develop picture signals, and means for applying a positive impulse to said mosaic periodically.

7. An electric discharge tube comprising an evacuated envelope having therein a source of electrons of extended area, a mosaic of conducting elements which are insulated from each other and from their supporting structure, said ele-

ments extending from one side of the mosaic to the other to form a double-sided mosaic, the side of each of said elements facing said cathode having a surface such that it emits secondary electrons when bombarded by primary electrons, a mosaic of discontinuous photo-electric elements positioned between said cathode and said double-sided mosaic, said mosaic being of grid-like structure whereby electrons may pass therethrough from said cathode to said double-sided mosaic, means for scanning the side of said double-sided mosaic which is facing away from said cathode with a cathode ray of small diameter to develop picture signals, and means for applying a positive impulse to said mosaic at the end of each scanning period.

8. In combination, an electric discharge tube comprising an evacuated envelope having therein a cathode of extended area, means for heating said cathode to cause it to emit electrons simultaneously from substantially all points in said area, electrical image utilizing means comprising an element positioned to receive said electrons, a mosaic of photo-electric elements electrically insulated from each other and positioned between said cathode and said element, said mosaic being of grid-like structure whereby electrons may pass therethrough from said cathode to said element, means for projecting an optical image upon said mosaic, means for focusing the electrons leaving said cathode, and additional means for applying a positive electrical impulse to said mosaic periodically.

9. In combination, an electric discharge tube comprising an evacuated envelope having therein a cathode of extended area, means for causing said cathode to emit electrons simultaneously from substantially all points in said area, electrical image utilizing means comprising an element positioned to receive said electrons, a mosaic of photo-electric elements electrically insulated from each other and positioned between said cathode and said element, said mosaic being of grid-like structure whereby said electrons may pass therethrough from said cathode to said element, means for moving said electrons against said element with high velocity, means for focusing said electrons, means for projecting an optical image upon said mosaic, and additional means for applying a positive electrical impulse to said mosaic periodically.

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