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DEVICE COMPRISING AN IMAGE INTENSIFYING TUBE HAVING A

PLURALITY OF SECTIONS

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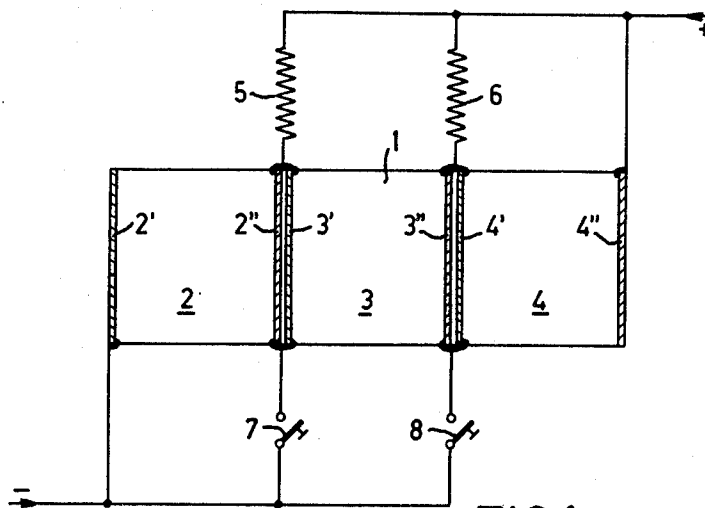


FIG.1

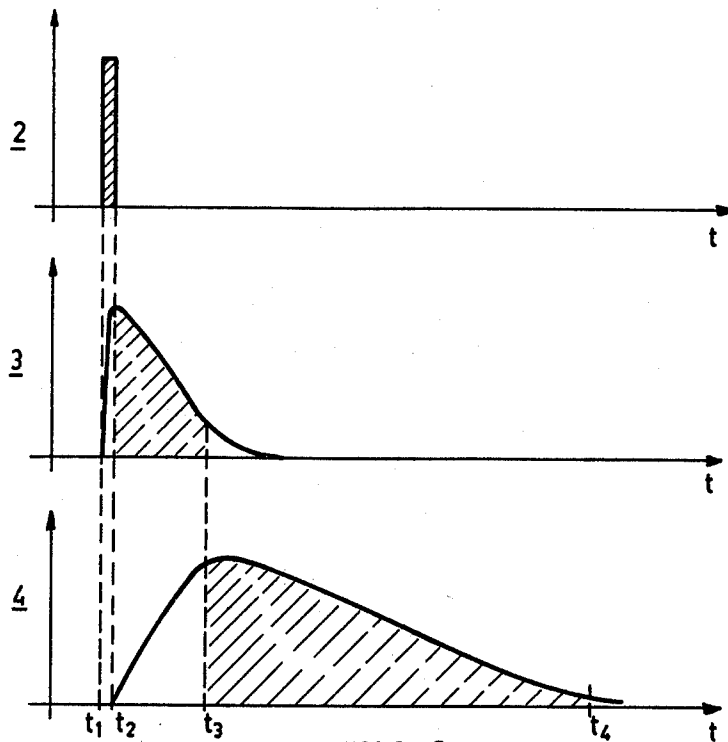


FIG.2

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DEVICE COMPRISING AN IMAGE INTENSIFYING TUBE HAVING A PLURALITY OF SECTIONS

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4 Claims

ABSTRACT OF THE DISCLOSURE

An image intensifier device employing a tube having a plurality of optically coupled sections, each having a photo-cathode and a phosphor screen, all energized from a single voltage source which is successively applied to each of the consecutive sections in sequence during consecutive time periods.

The invention relates to a device comprising an image intensifying tube having a plurality of consecutive, optically coupled sections, so that the luminescent screen of one section is arranged at a distance of only a few microns from the photo-cathode of the next-following section.

Such a device is particularly suitable for brightness intensification of flash images of very short duration (about 1 to 100 nsec.).

The continuous supply of direct voltage to the image intensifying tube in such a device encounters two difficulties: on the one hand a certain degree of optical feedback occurs across the various sections due to return light, since the phosphor screens and the photo-cathodes are slightly transparent; this is a cumulative phenomenon as a result of which the screens will soon luminesce uniformly.

On the other hand, if it is not possible to provide adequate electric insulation between the phosphor screen of a section and the photo-cathode of the next-following section, it is necessary to feed the consecutive sections of the tube by consecutive portions of a higher over-all voltage.

The invention has for its object to provide a device which mitigates the aforesaid disadvantages.

According to the invention a device comprising an image intensifying tube having a plurality of optically coupled sections is characterized in that only one voltage source supplying a voltage suitable for feeding any one of the sections of the tube is provided and in that there are provided means by which the voltage of said source is applied consecutively to the next-following section of the sequence in consecutive periods of time.

The invention will be described more fully with reference to the accompanying drawing.

FIG. 1 shows diagrammatically one embodiment of a device according to the invention.

FIG. 2 shows a time diagram of the intensification cycle.

FIG. 1 shows an image intensifying tube having three sections 2, 3, 4, which are optically coupled with each other by the presence of the phosphor screen of one section and the photo-emissive cathode of the next-following section on opposite faces of a thin, transparent plate. The photo-emissive cathode 2' of the first section is arranged on one of the end faces of the tube. The phosphor screen 2'' of the central section is optically coupled with the photo-emissive cathode 3' of the second section 3 and the phosphor screen 3'' of the central section is coupled with the photo-emissive cathode 4' of the last section 4,

the phosphor screen 4'' of which is applied to the other end face of the tube.

The phosphor screen 2'' and the photo-emissive cathode 3' are electrically connected to each other and through a common resistor 5, which serves for limiting the current to about $1 \mu\text{a.}$, to the positive terminal of a voltage source (not shown), which can supply a voltage up to 20 kv. The screen 3'' and the photo-emissive cathode 4' are also electrically connected to each other and, in common, through a similar current-limiting resistor 6 to the positive terminal of said source. The screen 4'' of the last stage is directly connected to the positive terminal of said source.

The photo-emissive cathode 2' of the first intensifying section is permanently connected to the negative terminal of the source. The groups of electrodes 2''-3' and 3''-4' may be connected to the negative terminal through the contacts 7 and 8 respectively, represented for the sake of simplicity by switches. These switches may be formed each by a quick-acting electronic switching circuit, for example, a thyatron circuit.

The operation of the device described will be explained with reference to FIG. 2 in which the cross-hatched regions represent the quantity of light obtained in each section.

In the state shown in FIG. 1, that is to say, when the switches 7 and 8 are open, the voltage of the source (not shown) applied between + and - is operative across the first section 2—that is between the photo-cathode 2' and the phosphor screen 2''—and hence across this section alone. It will be supposed that at the instant t_1 a flash image is produced up to the instant t_2 . The light intensity of this flash image is indicated by the cross-hatched area in the upper part of FIG. 2. Simultaneously with the end of the flash, i.e. at the instant t_2 the switch 7 is closed so that the voltage across the section 2 disappears and becomes operative across the central section 3. The resistor 5 restricts the current between the + and - terminals of the battery across the switch 7.

The light output of the phosphor screen 2'' due to the bombardment of the electrons emanating from the photo-cathode 2' of the section 2 during the preceding energization of this section is indicated in the central diagram of FIG. 2. The cross-hatched portion lies within the time interval $t_2 \rightarrow t_3$, when the central section 3 is energized. The time interval $t_2 - t_3$ is about 100 times that of $t_1 - t_2$. At the instant t_3 the switch 8 is connected. The voltage between - and + disappears from the central section 3 and becomes operative across the last section 4. The light output of the phosphor screen 3'' is indicated in the lowermost diagram of FIG. 2. The cross-hatched part thereof, starting at t_3 occurs during the period that the last section 4 is energized.

At the instant t_4 the second screen 3'' extinguishes; the intensifying cycle terminates.

In this process the persistence of the phosphors of the screens 2'' and 3'' is utilized to intensify the image, although the consecutive sections of the tube are rendered operative with a given time lag. For the various screens different phosphors are used, the persistences of which increase in the order of operation.

This operation with time lag is attended with a prolongation of the time of operation at the transition from one section to the other. The assembly does not provide an intensification of the brightness in the sense proper, but it provides rather an increase in light quantity by the prolongation of the duration of the intensified image with respect to that of the flash image on photo-cathode 2'.

This method has various advantages: each intensifying section can operate with the full available high voltage; this high voltage is applied in order of succession to each

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section for a given period of time which is proportional to the remanence of the phosphor screen of the preceding screen; and the light feedback between the consecutive screens is systematically avoided since each time only one section has voltage supplied thereto.

The risk of inhibition and defocusing due to spacial charge in the section is also avoided, since it is not the peak of the pulse which is intensified, but the duration of the pulse which is prolonged.

What is claimed is:

1. A device comprising an image intensifying tube having a plurality of consecutive, optically coupled sections having each a photo-cathode and a phosphor screen, wherein only one voltage source, capable of supplying a voltage for feeding any one of the sections of the tube is provided and in that there are provided means by which the voltage of said source is applied to each of the consecutive sections in sequence during consecutive time periods.

2. A device as claimed in claim 1, wherein the phosphor screens of the consecutive sections exhibit a progressive persistence.

3. A device as claimed in claim 2 wherein the means for applying the voltage to the consecutive sections hold

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a next section energized for a longer time than the preceding section.

4. A device as claimed in claim 3, wherein the positive terminal of the voltage source is permanently connected to the phosphor screen of the last section and each time through an inhibiting resistor to the phosphor screen of a section and the photo-cathode of the next section connected thereto, while the photo-cathode of the first section is directly connected and the photo-cathode of the further sections are each connected through a separate switch to the negative terminal of the voltage source.

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