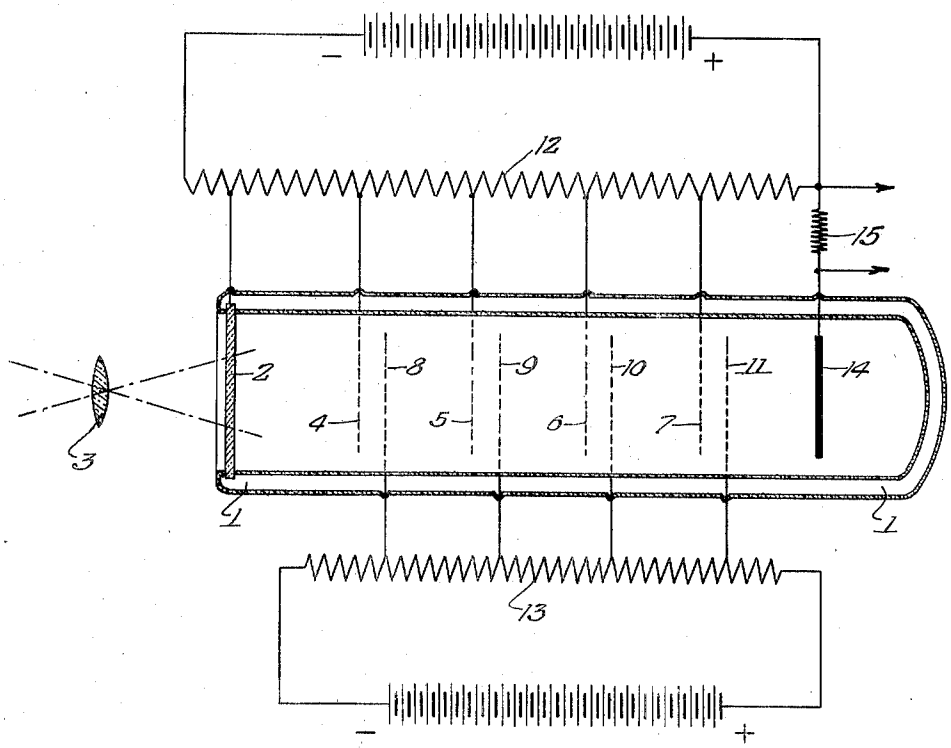
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PHOTOELECTRIC TUBE

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PHOTOELECTRIC TUBE

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1 Claim. (Cl. 250—166)

This invention relates to improvements in photoelectric tubes, and particularly in tubes amplifying the emission of secondary electrons.

In single-stage photoelectric tubes of the standard type, it has been found that there is a linear relation or interdependency between the photoelectric current and the intensity of the incident light. It has been found that this linear law ceases to prevail in photoelectric tubes provided with auxiliary electrodes adapted to amplify the emission of secondary electrons. In these multiple-stage photoelectric tubes, it has been found that the amplifying factor decreases upon increase of the intensity of light striking the primary cathode of the tube.

It is an object of the present invention to eliminate in multiple-stage photo tubes the condition which destroys the linear relation between the intensity of the light and photoelectric current.

For this purpose it is an object of the invention to provide means for eliminating or reducing the electric charge in the space between each two of the emitting electrodes of the photoelectric tube.

Another object of the invention is to provide a photoelectric tube having a plurality of auxiliary electrodes between two primary electrodes and to neutralize the space charge between selectively determined electrodes by introducing into the space containing a charge of a certain polarity a charge of a polarity opposite to that which is created by the photoelectric energization of the tube.

It is also an object of the invention to carry off the charge from the space between adjacent electrodes by locating current conducting elements within said spaces and connecting said current conducting elements to a suitable source of current located on the outside of the tube.

With these and numerous other objects in view, a single embodiment of the invention is described in the following specification and shown in the accompanying drawing with the clear understanding, however, that the invention is not to be limited to the embodiment diagrammatically illustrated in the drawing or described hereinafter.

The photoelectric tube 1, as diagrammatically illustrated in the accompanying drawing, is of the multiple-stage type. The primary cathode 2 is a transparent photo-cathode onto which the incident light is concentrated by optical means diagrammatically shown at 3. A plurality of secondary cathodes 4, 5, 6 and 7 are located within the photoelectric tube 1 in the space between the cathode 2 and the anode 14, said auxiliary electrodes 4, 5, 6 and 7 serving the purpose of setting up emission of secondary electrons to amplify the flow of electrons between cathode and anode. Advisably these secondary electrodes are of grid formation.

Additional grids 8, 9, 10, 11 are located in the spaces between each two adjacent auxiliary electrodes 4, 5, 6 and 7, and in the space between the end electrode 7 of the series of secondary electrodes and the anode 14. As indicated in the drawing, these additional grid electrodes 8, 9, 10, 11 are associated with the secondary electrodes 4, 5, 6 and 7 and are spaced relatively closely with respect to the same.

The secondary grid electrodes 4, 5, 6 and 7 are connected by conductors passing through the envelope of the photoelectric tube to tabs of a potentiometer 12 while the tension of the associated grids 8, 9, 10, 11 is derived from tabs of the resistance of a second potentiometer 13, each potentiometer being connected to a battery.

The arrangement of the secondary electrodes 4, 5, 6 and 7 induces an amplification of the flow of electrons from the primary cathode 2 to the anode 14. A regulation of the voltage is effected by a resistance 15 diagrammatically indicated as being connected with the anode 14 of the tube and with the potentiometer 12 the resistance windings of which are conductively connected to the grid electrodes 4 to 7 respectively.

The present invention is based on the assumption that the interference with the law of linear relation between photo-energization of the cathode 2 and the amplification of the electronic current emanating from the photo-cathode and the amplifying electrodes 4 to 7 is due to the formation of space charges between the several auxiliary electrodes 4 to 7. It is well known that the flow of electrons emanating from an energized photo-cathode includes electrons which travel at greatly varying speed. An entire spectrum of electrons is released from the photo-cathode and auxiliary electrodes upon energization of these elements. Those electrons which have a relatively low speed may not reach the next adjacent electrode owing to their low speed. These low speed electrons are, therefore, retained or gathered in the interspace between the two electrodes, and owing to this collection of electrons in this space the latter is subjected to or filled with an electronic charge.

This charge again has a braking or retarding effect upon the electrons traveling at a higher speed from the emitting electrodes, and the braking effect is proportional to the flow of electrons

of low speed. Now, since this flow of electrons of low speed increases with the light intensity energizing the photo-cathode, it is obvious that the intensity of the space charge due to the slow traveling electrons also is proportional to the light intensity striking the photo-cathode.

Very similar conditions prevail, whenever ions are emitted instead of the emission of electrons.

The present invention is predicated upon the insertion of the electrodes 8, 9, 10 and 11 of an opposite charge in the spaces that are charged electronically due to the gathering of electrons of low speed which will eliminate or counteract this charge. The charge in the space between two adjacent emitting electrodes may obviously be counteracted by producing within this space a charge of opposite polarity.

Again, as a means of reducing or preventing the generation of this electric charge, the tubes may be filled with gas of lower concentration.

In the present invention the means for neutralizing the space charge are formed by elements which are particularly adapted to the function of the tube. These elements by themselves may constitute the charge neutralizing means, or their efficiency may be enhanced by also reducing the concentration of the gaseous filling. If a tube of this type is to be utilized for sound reproducing purposes, for instance, the gas filling may be more concentrated in order to retain the linear relation between intensity of light and electronic current between wider limits of degrees of intensity. In a light electric tube to be used for measuring low intensities of light, this gas filling of the tube will be more reduced.

The inventive principle also might be reduced to practice by disposing a gas liberating or a gas absorbing substance in the interior of the tube, permitting thereby the tube to be selectively filled with gas of greater or lesser concentration.

Another embodiment utilizes conductive elements within the spaces in which this charge is effective. These conductive elements in the form of screens, grids or the like projecting into the charged space may carry off the charge to the outside of the tube.

The present invention, as illustrated, may be applied to amplifying tubes of any desired form as long as they utilize secondary emission of electrons. It may be used in tubes in which a plurality of grids are disposed in serial arrangement or to tubes in which a plurality of plates are serially arranged, and in which the streams of electrons are carried electromagnetically from any electrode to the next adjacent electrode.

While in the present embodiment each of the auxiliary electrodes is shown associated with a charge neutralizing electrode, it is obvious, however, that selectively some of these auxiliary electrodes may be employed solely for the production of secondary electrons, while others may be used for counteracting or neutralizing the space charge.

I claim:

An electron multiplier tube comprising within a longitudinal envelope, a photo cathode at one end and an anode at the other end of said envelope, a plurality of axially spaced secondary electron emitting grid electrodes in the space between said photo cathode and said anode, and a plurality of additional electrodes, one between each two secondary electron emitting grid electrodes and one between the last secondary electron emitting grid electrode and said anode, said additional electrodes being capable of destroying the space charges created by the electron current between said secondary electron emitting grid electrodes and the last one of the latter and the anode respectively, said additional electrodes being spaced from their next preceding secondary electron emitting grid electrode a shorter distance than from their next following secondary electron emitting grid electrode and anode respectively.

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