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LIGHT AND ELECTRICAL IMPULSE CONVERSION APPARATUS

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Fig. 1.

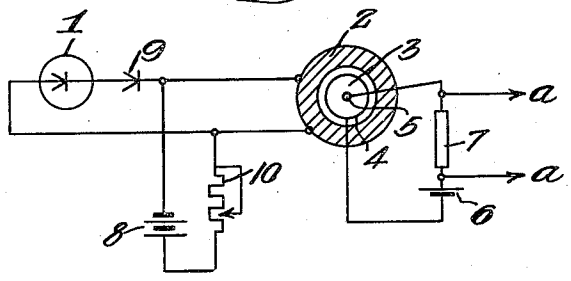
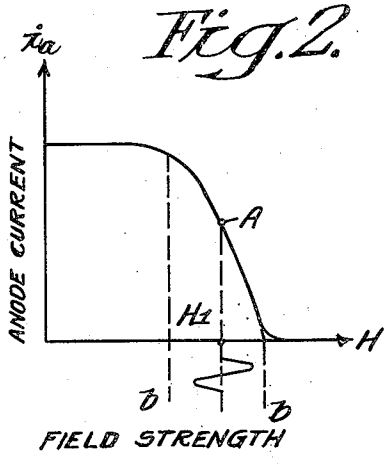


Fig. 2.



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LIGHT AND ELECTRICAL IMPULSE CONVERSION APPARATUS

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5 Claims. (Cl. 250—41.5)

This invention relates to apparatus for converting light impulses into corresponding impulses of electricity, and has for its principal object the provision of an improved apparatus and method of operation whereby relatively low resistance photoelectric devices, such as those of the copper oxide, selenium and similar types, are readily utilized in the conversion of light variations of electric current.

It is often desirable to convert light fluctuations into electric current fluctuations. This happens, for instance, with those sound film processes in which the light modulated by the film is absorbed by a photoelectric cell, and the photoelectric cell changes these light fluctuations into current fluctuations that are applied to a loudspeaker through an amplifier.

In general, relatively high resistance vacuum or gas-filled photoelectric cells are employed for such purposes. Such photoelectric cells are frequently coupled with the grid circuit of an amplifier tube through a condenser. As the input resistance of the electron tube is also large, the adaptation of the photoelectric cells used with a high inner resistance (e. g. alkali or caesium photoelectric cells) is favorable although it practically represents a short circuit which, however, avoids the frequency dependence occurring with input resistances that are even larger.

However, this is different if a photoelectric cell with a relatively low resistance is used. Such photoelectric cells may be designated as blocking layer photoelectric cells (copper oxide or selenium shielding layer photoelectric cells), or selenium resistance cells and the like. This type of cell includes an oxide layer or the like which blocks or is an asymmetric conductor. These well known photoelectric cells, particularly the blocking layer photoelectric cells, have a small inner resistance and give off comparatively large currents with an exposure with or without an initial voltage. However, it is unfortunately not so easy to operate with such photoelectric cells on an amplifier because the matching is bad in view of the small inner resistance of the photoelectric cells.

According to the invention, this difficulty is minimized or avoided by arranging a control coil of an electro-magnetically controlled electron tube in the circuit of a relatively low photoelectric cell of relatively low resistance. This photoelectric cell is preferably of the blocking layer type. As the magnetic control circuit of such a tube has a low resistance, it is easily possible to effect the matching of the photoelectric cell. As an electro-magnetically controlled electron tube, a magnetron tube or the well known secondary electron amplifier tube with magnetic field control can be employed. Should the input impedance of the electro-magnetically controlled electron tube not be large enough for the purpose of giving a sufficiently large output control to the loudspeaker or other utilization instrument, it is possible to connect a standard amplifier under normal conditions with this electro-magnetically controlled electron tube because the high empedance of its output circuit. In this way, amplification to any desired extent is made possible. In using a secondary electron amplifier tube or electron multiplier, one can generally omit a subsequent tube amplifier because the output of such a tube is usually sufficiently large.

In the past it has not been possible to correctly match photoelectric cells with a very small inner resistance to an amplifier and, as a result, the blocking layer photoelectric cells that possess many inherent advantages have never been used for reproducing sound films and the like in practice. By the invention, there is realized the possibility of employing such photoelectric cells that have a comparatively good efficiency and are considerably cheaper than the photoelectric cells hitherto used.

As the characteristic curve of anode current i_a, as a function of the magnetic field strength H, decreases with a rising field strength H, it is necessary to give the system an initial or bias voltage, so that the operating point appears on the declining section of the characterizing line, preferably at the center of this declining section. This initial voltage can be obtained by subjecting the photoelectric cell to such constant illumination that it generates sufficient field strength to cause operation of the amplifier on the declining section of the characteristic curve. As it is, however, according to the system used, not always possible to produce the initial magnetizing required with a constant bias exposure of the photoelectric cell, it may be advantageous, in some cases, to use a permanent magnet for the initial magnetizing of the electron tube. It is also possible to provide a second coil which is fed by such a current that the initial magnetizing of the system can be adjusted through the control coil of the system. In using a single coil and bias magnetization, it is necessary to include a rectifier or rectifying means in the blocking cell circuit in such a fashion that the direct voltage, serving for the initial magnetizing of the tube, is kept away from the blocking layer cell.

The invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope is indicated by the appended claims.

Referring to the drawing—

Figure 1 shows the connections of a low resistance photoelectric cell with a magnetron tube.

Figure 2 illustrates the characteristic of a magnetically controlled electron tube.

Fig. 1 shows a low resistance photoelectric cell, which is preferably a blocking photoelectric cell. The cell 1 is connected with the control circuit of control coil 2 of magnetron tube 3. Anode 4 of the magnetron tube and cathode 5 are connected with each other through battery 6 and output resistance 7. At the output resistance 7, the output voltage of the tube can be derived at tapping points *a*—*a*. If this voltage or current is not sufficiently large, an amplifier may be connected with points *a*—*a* because the anode-cathode circuit of the tube is of high impedance, and matching with the amplifier is, therefore, easily effected. As already mentioned, magnetron tube 3 can be replaced by an electro-magnetically controlled electron tube in this system. For this purpose, one can, for example, use also a secondary electron amplifier tube or electron multiplier with a magnetic field control with which there is the advantage that this tube produces a comparatively large output without the necessity of subsequent amplifier stages. As already stated, photoelectric cell 1 has a relatively small inner resistance. As coil 2 of the magnetron tube has also a small resistance, it is easily possible to obtain matching of cell 1 and coil 2. Therefore, the connection of a photoelectric cell of low resistance and of the control coil of a magnetron tube is a satisfactory solution of the problem.

Fig. 2 shows the characteristic curve of tube 3. Anode current i^a is plotted on the ordinate, and the magnetic field strength H on the abscissa. One sees that the output control of such a tube is possible within range *b*—*b*. Therefore, one is compelled to provide magnetically such an initial bias voltage to the tube that the operating point can be placed about at the center of range *b*—*b*. This operating point is indicated with A.

In order to produce this magnetic bias voltage field strength, it is required to so illuminate photoelectric cell 1 with constant light so that the necessary magnetic field strength H is produced for point A. With fluctuations of the light applied to the cell, there will also occur corresponding fluctuation of anode current i^a. If it is not convenient to subject the photoelectric cell 1 to such a great initial illumination, it is necessary to send additionally a direct current through coil 2 for the purpose of reaching the operating point A. This is made possible by battery 8 in Fig. 1. It is, however, evident that the voltage of battery 8 can act also on photoelectric cell 1 and eventually cause damage to this cell. For this reason, according to the invention, rectifier 9 is so connected in the photoelectric cell circuit that the current from battery 8 is prevented from flowing over photoelectric cell 1. Rectifier 9 must, of course, be built in such a fashion that the current from battery 8 can flow over coil 2 of the magnetron tube, so that the initial voltage required is produced. It is also possible to apply the initial voltage through a second coil for tube 3. In this case, battery 8 is disconnected from the photoelectric cell circuit and connected with the second coil which now serves only for the initial magnetizing of the system. For the purpose of having the possibility of adjusting the correct initial magnetizing an adjustable resistance 10 is preferably arranged in the circuit of battery 8. It is also possible to generate the magnetic initial voltage by a permanent magnet which takes the place of the second coil just mentioned.

We claim as our invention:

1. The combination of a photoelectric cell of the blocking layer type, an electron discharge device provided with an input coil for magnetically controlling its output, and means for subjecting said coil to the output of said cell.

2. The combination of a photoelectric cell of the copper oxide type, an electron discharge device provided with a low impedance input circuit, and means for applying to said input circuit the output voltage of said cell.

3. The combination of a low resistance photoelectric cell, an electron discharge device provided with an input coil for magnetically controlling its output, and means for subjecting said coil to the output of said cell.

4. The combination of a low resistance photoelectric cell, an electron discharge device provided with an input coil for magnetically controlling its output, means for subjecting said coil to the output of said cell, and means for applying a bias potential to said coil.

5. The combination of a photoelectric cell of the blocking layer type, an electron discharge device provided with an input circuit of the same order of impedance as the impedance of said cell, and means for applying a bias potential to said input circuit.

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