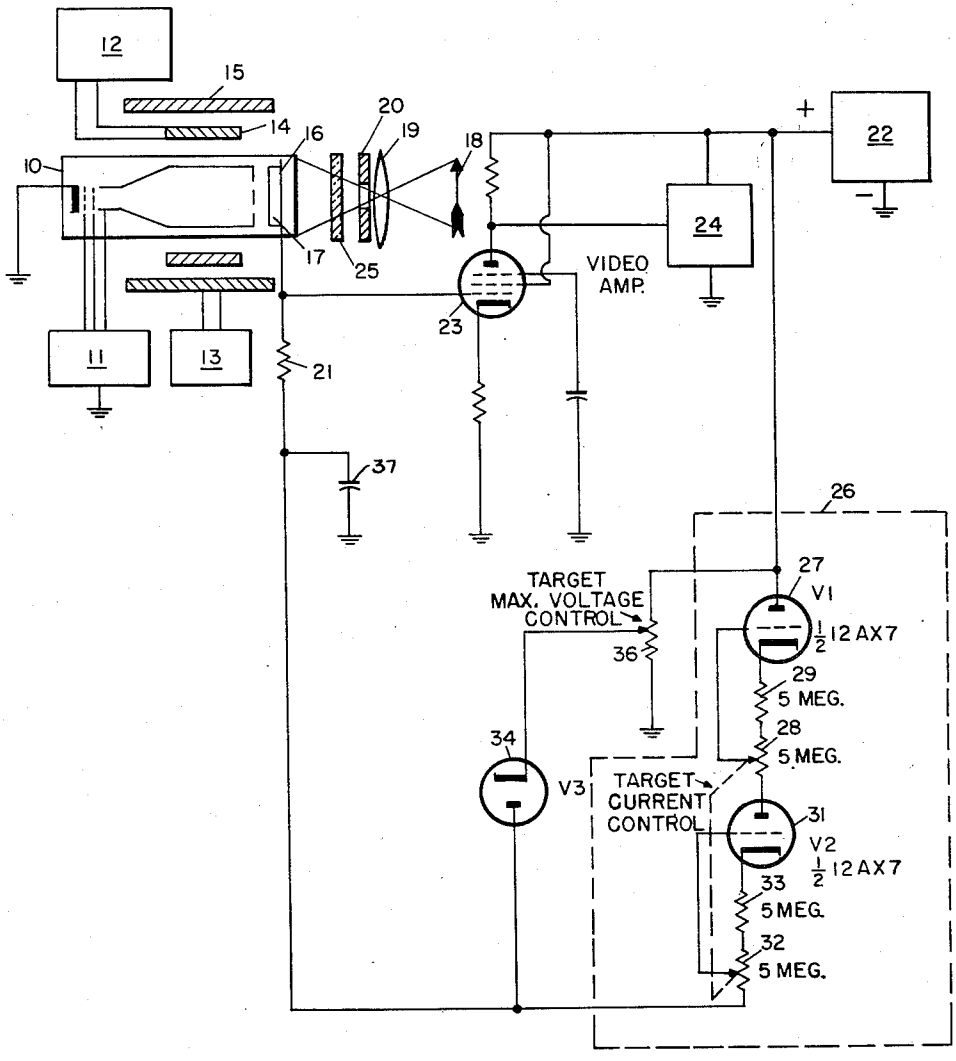
March 26, 1957 R. C. PALMER 2,786,960

PHOTOCONDUCTIVE TUBE CIRCUIT

Filed Oct. 30, 1952



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United States Patent Office 2,786,960 Patented Mar. 26, 1957

2,786,960

PHOTOCONDUCTIVE TUBE CIRCUIT

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Application October 30, 1952, Serial No. 317,679

7 Claims. (Cl. 315—10)

This invention relates to photoconductive image transducers and to preferred operating conditions and circuits for the same.

Photoconductive image transducers or tubes, of which the "Vidicon" tube is a well known example in the television art, are limited in the amount of scene illumination that can be tolerated under given operating conditions. For a particular level of illumination, operating voltages of the tube may be adjusted to enable the tube to generate an electrical signal which can be transformed in the usual monitoring apparatus into a satisfactory television image. If the high light level is changed by not more than a certain ratio, which is approximately 2:1, a satisfactory picture may be produced by varying the voltage applied to the photoconductive target element of the tube. If, however, the change is greater than the prescribed ratio, the televised image on the monitor tube will show the characteristic conditions known in the art as "sticking" and "blooming" for excessive light, or "target blemishing" for insufficient light. "Blooming" is the term commonly applied to a picture in which the white areas appear to be excessively bright and out of focus with respect to the darker areas of the picture, while "sticking" designates the retention of an image of a scene after the television camera has been shifted to a different scene. "Target blemishing" applied to the picture spots, always latent in the photoconductive target due to local inhomogeneities, which become visible when the target voltage is increased excessively in an attempt to compensate for insufficient light.

In order to regain a satisfactory image outside the original limited range of illumination, it is necessary to readjust the operating voltages of other elements in the tube to new settings or, by inserting a neutral density filter or a smaller aperture between the scene and the tube, to impose an additional limitation on the amount of light reaching the photoconductive target. Control of light reaching the tube is the more common of the so-called major adjustments. Once these major adjustments have been made, the light level may again be varied over a new 2:1 range and the target voltage readjusted to obtain a satisfactory picture. Thus, if the light varies over a wide range, say 20:1, it will be necessary to make several step adjustments of the apertures or filters or overall operating voltages, and, within each step, to adjust the target voltage. Two controls are required to accommodate both of these adjustments, one control, such as a graded neutral density filter or an aperture control, to adjust the light admitted to the photoconductive target of the tube, and a second control to adjust the target voltage of the tube.

The present invention provides means for eliminating the need for a target voltage control by incorporating the photoconductive image transducer into a circuit which automatically compensates for the intensity of illumination within the limits of any single setting of the operating potentials and aperture or filter for the pickup device. This circuit regulates the target current of the tube by changing the target voltage in a predetermined manner. In order to prevent the application of an excessively high voltage to the target, means are provided to limit the peak voltage to a safe value.

One of the objects of the invention is to provide an improved circuit for use with photoconductive image transducers.

Other objects are to reduce the number of controls in such circuits and to provide circuit means to prohibit improper operation of the photoconductive image transducers.

Still further objects may appear from the following specification together with the drawing in which the single figure is a schematic diagram of a pickup device including a photoconductive image transducer connected in a circuit according to the invention.

Referring now to the single figure shown in the drawing, the circuit includes a photoconductive image transducer **10**, of the type described, connected to a source **11** of operating potentials. A source **12** of scanning current and a source **13** of focusing current are connected to a deflection yoke **14** and a focusing coil **15** associated in the usual way with tube **10**. Within the tube **10** is a transparent conductive layer **16** in surface-to-surface contact with a photoconductive target **17** on which the light from an object scene **18** is imaged by means of a lens **19**. A load resistor **21** is electrically connected between the conductive layer **16** and an electrical energizing source comprising a source **22** of unidirectional potential. Source **22** also supplies B+ voltage wherever needed, such as to a preamplifier tube **23**, a utilization circuit **24**, and a current regulating circuit **26**.

The current regulator **26** consists of a first amplifier tube **27**, a potentiometer **28** together with its range limiting resistor **29**, a second amplifier tube **31** and a second potentiometer **32** together with its range limiting resistor **33**, all connected in series. A voltage limiting circuit is connected in parallel with the current regulating circuit **26** and consists of a diode **34** and a maximum target voltage control potentiometer **36**.

In the operation of the circuit, it will be assumed that the proper potentials and currents are generated in sources **11—13** in the usual manner to provide the necessary electron beam to scan the photoconductive target **17** in tube **10**. The detailed operation of the type tube described may be found in an article by Weimer, Forgue and Goodrich in "Electronics," May 1950, pp. 70–73. Briefly, the scanning action of the electron beam in tube **10** charges each elemental area of the rear face of target **17** approximately to the potential of the cathode, which is in the order of 20 volts negative with respect to the conducting layer **16**. The light image of the object **18** forms a pattern of conductivity on the target **17** so that the charge on the rear surface of each elemental area thereof leaks through to the conductive layer **16** thereby shifting the potential on the rear target of each element of the photoconductive surface **17** toward the potential of the layer **16** in accordance with the conductivity pattern. A second scanning of the tube restores the rear surface charge and the restoration current at any point within the rear surface area of target **17** is a function of the amount by which that point of the surface has been discharged, and, consequently, is a function of the conductivity of the target **17** and the brightness of the object **18**.

The conductive layer **16** is normally in the nature of 20 volts positive with respect to the cathode of tube **10**, and restoration current flowing through the closed circuit comprising resistor **21**, current regulator **26**, source **22**, ground connections to the cathode of tube **10**, and the path internal to tube **10** from the cathode to layer **16**, impresses a signal voltage across resistor **21**. This signal

voltage is amplified by the amplifier 23 and passed on to the utilization circuit 24 in the form of a television signal voltage.

It has been found that for a given setting of the sources 11—13, the aperture 20 in lens 19, and the density of neutral filter 25, the overall intensity of illumination of object 18 may be varied over a range of approximately 2:1, and a satisfactory television signal may be produced simply by varying the voltage applied through resistor 21 to the conductive coating 16. However, by controlling the current supplied by the source 22 to the conductive coating 16, it is possible to dispense with manual control of the voltage of the layer 16.

One form of current regulating circuit is shown within the dotted line 26. Due to the fact that the current is to be controlled in the neighborhood of ¼ microampere, it is desirable to use two controlling tubes 27 and 31 in series together with a high impedance of the order of 10 megohms in series with each tube 27 and 31 as shown. It is obvious that the values given for the resistance of the resistors 29 and 33 as well as the potentiometers 28 and 32 should not be considered as limiting the invention, since other values may be substituted therefor.

In the operation of the current regulator 26, as the current to the conductive surface 16 increases, the current through resistor 29 and the potentiometer 28 increases, thereby increasing the voltage drop across the latter two elements and increasing the bias on the control grid of tube 27, resulting in a reduction of the conductivity of the tube 27. The same effect takes place in the second regulator stage comprising tube 31. The regulating effect of the two stages is cumulative so that, as the current to the conductive surface 16 starts to increase, the impedance of the series circuit supplying this current likewise tends to increase with the result that the voltage drop across this series circuit, or regulator 26, increases, thereby reducing the voltage available at the surface 17, tending to maintain the overall current at a fixed value.

It is to be understood that this constant value of current does not mean that the value precludes signal variation, but is constant for overall picture brightness. Condensor 37 acts as a by-pass condenser to preclude the current regulator from operating so rapidly as to affect the signal currents in the load resistor 21.

An excessively high voltage applied to the target 16, such as would occur if the scene 18 were too dim for normal operation of the tube 11, would manifest itself in what is known as "target blemishing" of the image. A television monitor, which might be included in the utilization circuit 24, would show the phenomenon as a superposition of spots or stains in the background of the scene. In order to prevent this excessively high voltage on surface 16, the target voltage control is utilized. The cathode of diode 34 is connected to the arm of the control potentiometer 36 which is set at the maximum usable voltage which may be applied to the surface 16. When the actual voltage applied to surface 16 reaches the voltage setting of the arm of potentiometer 36, diode 34 conducts and prevents the voltage applied to surface 17 from going any higher.

Although this invention has been described in terms of a specific embodiment, those skilled in the art will recognize that modifications are possible within the scope of the following claims.

What is claimed is:

1. A circuit comprising: an image transducer including a photoconductive target and a cathode, a source of current and a current regulator connected between said cathode and said target, whereby the average current from said source is maintained substantially constant at a predetermined value.

2. A circuit comprising: an image transducer including a photoconductive target and a cathode, a source of electrical current and a current regulator connected in series between said cathode and said target, whereby the average current from said source is maintained substantially constant at a predetermined value.

3. The apparatus of claim 2 in which said regulator is a variable high impedance to regulate the current passing therethrough.

4. The apparatus of claim 3 in which said variable high impedance is a thermionic tube.

5. A circuit comprising: an image transducer having a cathode and a photoconductive target, said target being exposed to light of varying intensity; a uni-directional current source having a positive terminal and a negative terminal; an automatic current controlling circuit having an input terminal connected to said positive terminal and an output terminal conductively connected to said target; and a voltage limiting circuit comprising a second thermionic tube having an anode conductively connected to said output terminal and a cathode connected to a source of voltage, said second thermionic tube becoming conductive when the voltage of said output terminal becomes positive with respect to the voltage of said last-named source, whereby said output terminal is prevented from becoming still more positive.

6. The apparatus of claim 5 in which said second thermionic tube is a diode and said source of voltage comprises a potentiometer having its ends connected to the positive and negative terminals of said source of current and its arm connected to the cathode of said diode.

7. A circuit comprising: an image transducer having a cathode and a photoconductive target, said target being exposed to light of varying intensity; a uni-directional current source having a positive terminal and a negative terminal; a first conductive connection between said negative terminal and said cathode; a second conductive connection between said positive terminal and said target, said second conductive connection comprising a load impedance and a current regulator circuit including at least one thermionic tube having an anode, a cathode, and a control grid, a current control potentiometer connected in series as an element of said second conductive circuit, one end of said potentiometer being connected to said cathode, the other end of said potentiometer being connected to one end of said load resistor, and the arm of said potentiometer being connected to said control grid whereby the impedance of said thermionic tube increases when the current through it increases; a maximum voltage control diode having an anode connected to the junction of said load resistor and said potentiometer; and a voltage control potentiometer having one end connected to said positive terminal and the other end connected to said negative terminal of said source of current; and a conductive connection between the cathode of said diode and the arm of said last-named potentiometer.

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