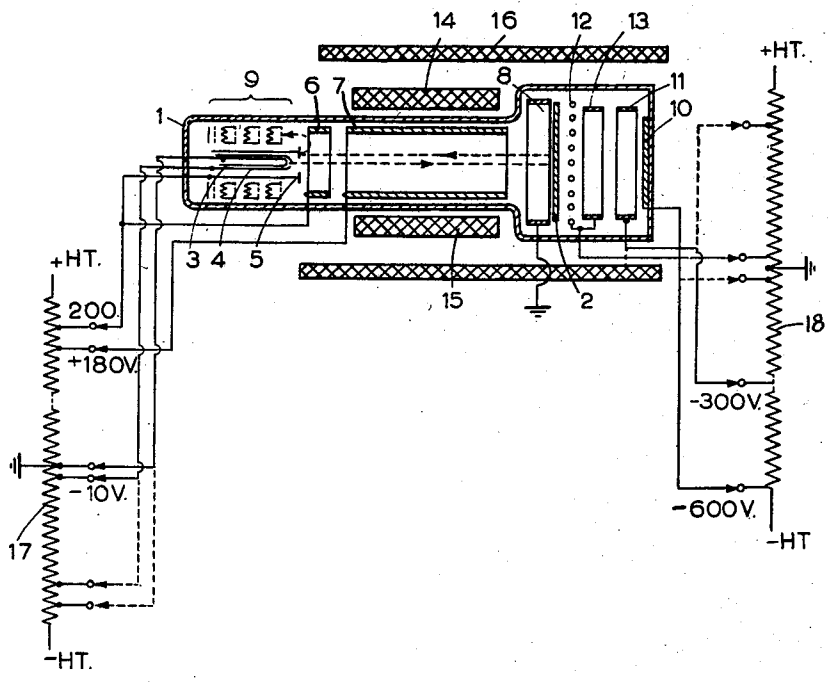
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ELECTRON DISCHARGE DEVICES

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Inventor
J. D. McGee
By Glascock Downing & Seebold
Attys.

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ELECTRON DISCHARGE DEVICES

James Dwyer McGee, Ealing, London, England, assignor to Electric & Musical Industries Limited, Hayes, Middlesex, England, a company of Great Britain

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This invention relates to electron discharge devices of the type comprising a target composed of slightly conducting glass, and an electron gun adapted to produce a beam of low velocity electrons which can be caused to scan said target, so that during normal operation of the device the target is stabilised at a potential corresponding substantially to that of the cathode of the gun from which the beam electrons originate. Devices of this type are frequently employed for generating picture signals for television.

In one form of device of the above type which is employed as a television pick-up tube an electron image is projected on to one side of the target which it charges positively by liberation of secondary electrons and the opposite side of the target is scanned by a low velocity electron beam, and the beam electrons which are not required for discharging elementary areas of the target are returned from the target to an electron multiplier, where they are multiplied and serve to generate the picture signals.

In employing devices of this form it is found that after some hours of use, which may be after 500 to 1,000 hours, the quality of a picture reproduced from signals generated by such a device deteriorates due to a tendency for undue lag or persistence to occur on the target. This phenomenon is colloquially referred to as "sticking."

An object of the present invention is to provide a circuit arrangement embodying an electron discharge device of the type referred to whereby such devices can be rejuvenated so as to improve the quality of pictures reproduced from signals generated in such devices.

Another object of the present invention is to provide a method of operating an electron discharge device of the type referred to whereby the useful life of the device can be prolonged.

According to the present invention there is provided a circuit arrangement embodying an electron discharge device comprising a target composed of conducting glass, an electron gun including a cathode for producing a beam of electrons for scanning one side of said target, and a photo-electric cathode for producing an electron image which can be projected on the other side of said target, and circuit connections having one condition in which the target is scanned with a beam of electrons from said gun of such low velocity as to stabilise the first-mentioned side of the target at the potential of said gun cathode whilst electrons are projected from said photo-electric cathode on to the other side of said target with sufficient velocity to produce a positive charge, and having another condition in which the target is scanned with a beam of electrons from said gun of sufficient velocity as to stabilise the first-mentioned side of the target at a potential which is positive with respect to said gun cathode whilst electrons are projected from said photo-electric cathode on to said target with such low velocity as to produce a negative charge.

It will be understood that under the first condition described above, the electrons of the scanning beam must

be caused to impinge on the target with such a low velocity that they liberate less than one secondary electron for each incident electron whereas the positive charge on the other side of the target is produced by the incidence of photo-electrons of the electron image at sufficient energy to liberate more than one secondary electron for each incident electron. Thus a positive current passes through the target towards the scanned side thereof. Under the second condition described above, the electrons of the scanning beam must be caused to impinge on the target with sufficient velocity as to liberate more than one secondary electron for each incident electron and as a consequence this side of the target is stabilised at the potential of the anode which collects the secondary electrons, whereas the other side of the target is charged negatively by the incidence of photo-electrons of the electron image of such low velocity that they liberate less than one secondary electron for each incident electron. The current through the glass of the target now passes in the opposite direction.

According to the present invention there is also provided a method of operating an electron discharge device comprising a target composed of slightly conducting glass, an electron gun including a cathode for producing a beam of electrons for scanning one side of said target and a photo-electric cathode for producing an electron image which can be projected on the other side of said target, wherein the tube is operated alternately and for times which are long compared with the picture period under the two conditions described above.

In accordance with the present invention it is possible to arrange, for example, that after each 10 hours of operation of the device under the conditions which are the normal conditions, that the target is scanned with a beam of electrons of low velocity, the device is then operated under the condition that the target is scanned by a beam of electrons of high velocity say for 1 hour, so as to rejuvenate the device. The operation under either set of conditions need not, of course, be continuous.

It is thought that the "sticking" phenomenon is due to a slow progress of electrolysis in the thin glass target through which a small electron current flows, whilst the device is operating in its normal condition. This current at any point is roughly proportional to the photo-electric current which is proportional to the light which is projected on to the device and it is possible that the "sticking" phenomenon is due to electrolysis of positive sodium ions in the lime soda glass from which the target of conducting glass is usually formed, which results in the migration of these ions from one side of the target to the other. By arranging that the device is operated at intervals under the second condition described above a positive current is caused to flow in the reverse direction so as to counteract the cumulative electrolytic effect occurring during normal operation and so prolong the useful life of the device.

In order that the invention may be clearly understood and readily carried into effect, the invention will now be described with reference to the accompanying drawing the single figure of which illustrates one example of a circuit arrangement in accordance with the present invention.

The circuit arrangement illustrated embodies an electron discharge device 1 in the form of a television pick-up tube in which during normal operation the target is scanned with a low velocity beam of electrons, and an electron image is projected on to the side of the target opposite the scanned side. The target is denoted by the reference 2 and comprises a thin sheet of conducting glass, formed of lime soda glass. The device also comprises an electron gun which includes a thermionic cathode 3, a control electrode 4 and an anode 5. Between

the gun and the target there are disposed in succession three cylindrical electrodes **6**, **7** and **8** which constitute a persuader electrode, a shielding electrode and a decelerating electrode. An electron multiplier represented in general by the reference **9** is disposed about the electron gun in known manner, the multiplier being of a known type and therefore merely shown diagrammatically in the drawing. The device also embodies a photo-electric cathode **10** which faces the side of the target **2** turned away from the electron gun. The photo-electric cathode is deposited on the end wall of the device **1** and between it and the target **2** are disposed a cylindrical accelerating electrode **11**, and a mesh **12** which is connected internally to another cylindrical electrode **13**.

The operating circuit for the device **1** includes scanning coils for deflecting the beam of electrons produced by the gun in horizontal and vertical directions so as to cause the beam to scan the target **2**. Two of the scanning coils denoted by references **14** and **15** are visible in the drawing. The tube is enclosed in the focusing solenoid **16** in known manner which ensures that the electron beam impinges substantially normally on the target during scanning. The operating circuit further includes connections for applying appropriate potentials to the various electrodes of the device **1**, these being shown, conventionally, as connections to suitable tapping points on potentiometers **17** and **18** connected between the positive and negative H. T. terminals of the arrangement. The connections have two conditions in one of which the target **2** is scanned by a beam of electrons from the electron gun of such low velocity as to cause stabilisation of the target at the potential of the cathode **3** of the gun, and in the other of which the target is scanned with a beam of electrons from the gun of such high velocity as to cause the scanned side of the target to become positively charged due to the release of more than one secondary electron for each impinging beam electron. The first condition is the normal operating condition for the device and in this condition, the electrodes **3**, **4** and **5** of the gun are connected respectively to points on the potentiometer **17** yielding potentials of approximately zero volts (ground), −10 volts, and +200 volts, as shown in the drawing. The persuader electrode **6** is maintained at the same potential as the gun anode **5**, the shielding electrode **7** is connected to a point having a potential of about +180 volts and the decelerating electrode **8** is grounded. For normal operation it is required that the light image to be televised should produce a positive charge image on the side of the target **2** turned away from the gun and to achieve this, the electrodes **10**, **11** and **12** in the image section of the tube are connected to points on the potentiometer **18** yielding potentials of approximately −600 volts, −300 volts, and a few volts positive of ground. The output of signals representing the image to be televised are derived from the final electrode of the electron multiplier **9** in known manner, and potentials which are successively more positive than that of the anode **5** are applied to the electrodes of the multiplier **9**. These connections are not however shown in the drawing.

When, after a period of operation of the tube under the normal conditions above described, it is desired to rejuvenate the tube, the circuit connections are changed so that the cathode and control electrodes **3** and **4** of the electron gun are switched to points on the potential divider yielding potentials of the order of several hundred volts negative of ground. If desired it may be arranged that the potential applied to the control electrode is now slightly positive with respect to the cathode potential so as to increase the intensity of the beam. Moreover the photo-cathode **10** and the accelerator **11** are switched to points on the potentiometer **18** yielding potentials which are respectively a few volts negative (say 5 to 10) of the potential of the mesh **12** and about 100 volts positive with respect to ground. The adjustments effected are indicated in the drawing by the dotted lines, and these adjustments can be made manually, through the intermediary of relays if desired, and are not in the nature of adjustments made automatically during operation of the tube at frequencies of the order of field frequency. During rejuvenation of the tube, uniform illumination is applied to the photo-electric cathode **10** and the potentials of the electrodes in the image section of the tube are now such that the electrons released by the illumination produce a negative charge on the side of the target **2** turned away from the gun. Moreover the beam electrons now impinge on the target with a velocity of several hundred volts and in consequence each beam electron releases more than one secondary electron from the target and a positive charge is built-up on the scanned surface of the target, the positive charges being limited by the potential of the shielding electrode **7**. The conditions produced on the target during operation under the second set of conditions are therefore the reverse of those which occur during normal operation of the device. It is thought that the rejuvenation of the tube **1** resulting from this reversal of operating conditions arises from the fact that movement of ions due to electrolysis in the glass of the target is reversed compared with the movement occurring under normal operating conditions. Hence the undesirable effects resulting from such electrolysis are reduced or eliminated.

The rejuvenation process can be accelerated if desired by using a larger effective beam current than is employed during normal operation, the beam current being increased by increasing the potential of the control electrode **4** relatively to that of the cathode **3** as above indicated. The process may also be accelerated by projecting more light to a photo-cathode **10** than normal. These expedients, together with the larger potential difference which occurs across the target **2** results in a larger current flow through the target, and since the electrolysis is roughly proportional to the current the corrective treatment can be effected relatively quickly. For example it may prove practical to correct the result of 10 hours of normal operation in one hour of corrective treatment.

What I claim is:

1. A method of operating an electron discharge device comprising a target composed of conducting glass, an electron gun including a cathode for producing a beam of electrons for scanning one side of said target and a photo-electric cathode for producing an electron image which can be projected on the other side of said target, wherein the tube is operated alternately and for times which are long compared with a picture period under a normal picture-signal generating condition in which the target is scanned with a beam of electrons from said gun of such low velocity as to stabilise the first-mentioned side of the target at the potential of said gun cathode whilst electrons are projected from said photo-electric cathode on to the other side of said target with sufficient velocity as to produce a positive charge, and under an abnormal target-rejuvenating condition in which the target is scanned wtih a beam of electrons from said gun of sufficient velocity as to stabilise the first-mentioned side of the target at a potential which is positive with respect to said gun cathode whilst electrons are projected from said photo-electric cathode on to the other side of said target with such low velocity as to produce a negative charge.

2. A method according to claim 1 wherein the electron beam current is greater during said abnormal operation than during said normal operation.

3. A circuit arrangement embodying an electron discharge device comprising a target composed of conducting glass, an electron gun including a cathode for producing a beam of electrons for scanning one side of said target to stabilise said target, and a photo-electric cathode for producing an electron image which can be projected on the other side of said target, potential sources,

circuit connections from electrodes of said device to said potential sources having a normal picture-signal generating condition predetermined to cause stabilisation of the first-mentioned side of the target at the potential of said gun cathode and to produce positive charge image formation in response to electron image projection on the other side of said target, and means for switching said connections to an abnormal target-rejuvenating condition predetermined to cause stabilisation of the first-mentioned side of the target at a potential which is positive relative to said gun cathode and to produce negative charging in response to electron projection on the other side of said target.

4. A circuit arrangement according to claim 3 said switching means including means for increasing the electron beam current during said abnormal condition, compared with the beam current during said normal condition.

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