

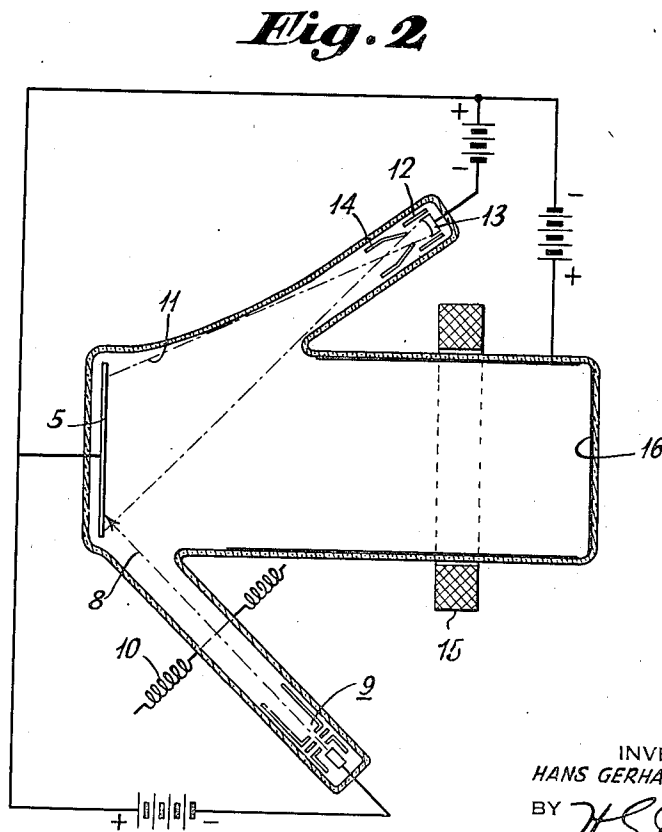
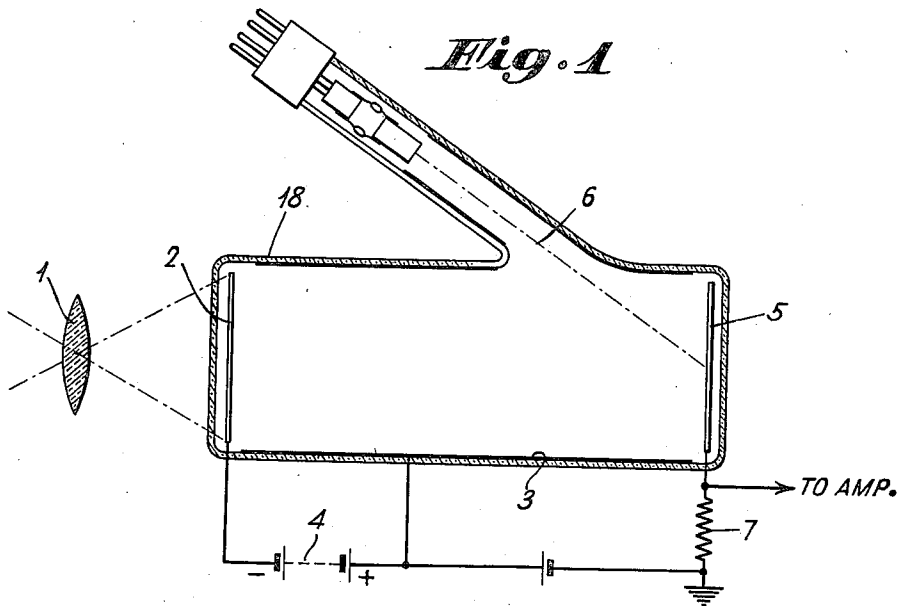
Dec. 2, 1941.

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2,264,540

CATHODE-RAY TUBE

Filed Sept. 9, 1937



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2,264,540

CATHODE-RAY TUBE

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Application September 9, 1937, Serial No. 162,999
 In Great Britain September 10, 1936

12 Claims. (Cl. 250—27)

This invention relates to the production and use of secondary electron emissive substances. Such substances are becoming used to an increasing extent in the fields of wireless signalling, television and sound recording and reproduction.

Most substances, when bombarded by a beam of primary electrons emitted, for example, from a heated cathode, will emit secondary electrons the quantity depending upon the nature of the bombarded substance and upon the velocity of the primary electron beam.

The number of the secondary electrons may be smaller than, equal to, or greater than the number of primary electrons and substances yielding the last effect are used in thermionic valves, cathode ray tubes and electron multipliers.

The expression

$$\frac{I_s}{I_p}$$

is used for the ratio between the secondary electrons emitted and bombarding primary electrons of a given velocity.

Applicant has found that certain classes of surfaces have an

$$\frac{I_s}{I_p}$$

ratio which depends upon the nature and extent of the bombarding beam of electrons. Thus, in the case of particular substances, it has been found that bombardment by a primary beam of electrons of a given velocity following bombardment by electrons of a lower velocity results in the production of more secondary electrons than when these substances are subjected to only a single bombardment by electrons of the given velocity.

A nickel surface was treated with a solution of uranyl nitrate. After drying by heat and removal of crystals from the surface of the treated nickel it was found to present a grey-black appearance and the applicant believes such a surface to consist of nickel nitrate or of a thin layer of uranium oxide. This surface, when bombarded by a beam of primary electrons having a velocity of between 3000 and 4000 volts produced secondary electrons in the ratio

$$\frac{I_s}{I_p} 0.35$$

After bombardment of the surface for a short time by a beam of electrons having a velocity of 1000 volts, at a subsequent bombardment by an

electron beam having a velocity of 4000 volts, the ratio

$$\frac{I_s}{I_p}$$

was found to be 0.8. Further bombardment by the 4000 volts electron beam again produced the original ratio of 0.35 and it was found possible to repeat this sequence of steps.

Whilst the measurements were in fact made with a ballistic galvanometer it was found possible to measure the whole of the secondary emission curve by means of D. C. measurements, thus indicating that the resistance of the bombarded surface layer was comparatively low.

According to the present invention, in a method of utilizing a surface capable of emitting a quantity of secondary electrons greater than that of an electron beam caused to impinge upon said surface, said surface is subjected to bombardment, firstly by electrons of a given velocity and subsequently by electrons of a higher velocity, said secondary electrons resulting from the subsequent bombardment, being utilized to provide signal currents. The surface so utilized may consist, for example, of nickel treated with uranyl nitrate.

A secondary electron emitting surface used in accordance with the invention may be employed in electron discharge devices such as cathode ray tubes, thermionic valves or electron multiplier devices. An electron discharge device containing such a surface may be employed in modulated carrier wave signalling systems either at the transmitting or receiving ends in certain systems of electrical sound record or reproduction or in any system where a storage of signals is wanted over a certain period, as, for example, multiplex telegraphy or telephony.

In order that the invention may be more clearly understood and readily carried into effect, certain applications thereof will now be described in greater detail with reference to the drawing wherein Figures 1 and 2 show representative forms of the present invention. Brief reference will also be made to further possible applications of the invention.

In a television system, for example, a transmitting tube may utilize a surface exhibiting the effect described. The elements of such a tube are illustrated diagrammatically in Fig. 1 which also shows part of the circuit connections of the tube, the envelope of which is shown at 18.

Referring to Figure 1, the picture to be transmitted is focussed by a lens *f* upon a transparent

photosensitive surface 2 from which photoelectrons are emitted in quantity depending upon the light and shade of the picture in the well known manner.

These photoelectrons, which constitute a primary beam are accelerated by means of an anode 3, connected to a battery 4, to a velocity of, for instance, 1000 volts, and are focussed by either or both electrostatic and electromagnetic means, not shown in the drawing, upon a target 5 which has been treated in the manner previously set forth.

The target 5 has applied to it a potential about 50-100 volts less than that applied to the anode 3 and is scanned by a cathode ray beam 6 having a velocity of about 4000 volts, this beam causing uniform secondary emission over the whole surface of the target. Owing to the bombardment of the target by the primary 1000 volts beam of electrons representing the picture to be transmitted, however, the number of secondary electrons released by the scanning beam from point to point of the target will be greater than before bombardment by the 1000 volt beam. A signal voltage will thus be set up in a resistance 7, connected in series with the target 5 and this signal voltage is passed to an amplifier in the usual way.

It will be seen that signal potentials may thus be derived from a scanning tube without the use of a mosaic electrode, the surface of the target 5 being quite plain.

An incidental advantage is that all secondary electrons may be collected and so dealt with so that the effect known as "tilt" or "Keystone" may be eliminated.

Further applications of the invention include the use of a surface exhibiting the effects of electron multiplication. In such a case a modulated beam of electrons is caused to fall upon one of the multiplying electrodes which is constituted by a surface treated to exhibit the effect previously described and subjected to bombardment by electrons of a higher velocity than that of the modulated beam.

Again it may be desirable to store the whole of a picture upon a surface by scanning it with a relatively weak modulated cathode ray beam and then simultaneously to transfer all the electrons representing the picture to another screen.

An arrangement illustrating this application of the invention is shown in Fig. 2 of the drawing. The essential elements of a cathode-ray tube required in such a case are shown diagrammatically.

The surface 5 is scanned by a modulated electron beam 8, provided by an electron gun 9 and deflected in the usual way by electromagnetic coils, one set 10 of which is shown. The beam 8 will alter the secondary electron emissive properties of the target 5 from point to point in accordance with the modulation. During the instant that the beam 8 is returned from the top of a picture frame to the bottom, a cathode ray beam 11 having a cross-section sufficiently wide to cover the whole picture area at once is caused to impinge upon the target 5 releasing secondary electrons from all points of the picture area simultaneously.

The wide section beam 11 is developed by an electron gun 12 including a concave cathode 13 providing a parallel beam of electrons which is focussed by and diverges from an electrode 14.

The secondary emission from the surface of the target 5 constitutes an electron image of the picture corresponding with the modulation of the

beam 8 and this electron image is focussed by coil 15 upon a fluorescent screen 16. The image thus becomes visible on the screen 16. It will be seen that whereas the current in the relatively low velocity modulated beam 8 is relatively small, the current in the wide section beam may be made much greater and a brightly illuminated picture on the screen 16 may thus be obtained.

It will be understood that the scope of the invention is not limited to the use of a surface prepared in the manner described or to the special applications of such a surface as set forth in this specification.

What I claim is:

1. In an electronic tube, an impact electrode surface comprising a nickel element treated with a solution of uranyl nitrate, a light sensitive electrode, means for subjecting the light sensitive electrode to radiant energy to release electrons in accordance with the intensity of the radiant energy, means for directing the released photoelectrons upon the first electrode element to alter the secondary electron emissive quality of the first electrode, means for bombarding the first electrode member with an electron stream having a velocity high with respect to the velocity of the photoelectrons to release secondary electrons in variable quantities, and means for utilizing the released secondary electrons for the production of signal currents.

2. The electron tube claimed in claim 1 comprising, in addition, an electrode adjacent the first electrode member adapted to be maintained at a potential positive relative to said first electrode member whereby secondary electrons released from said first electrode member may be collected thereby.

3. The electron tube arrangement claimed in claim 1 comprising, in addition, a resistance element connected to the said first electrode member across which a signal voltage is developed in accordance with secondary electrons released from the first electrode member.

4. An electron tube comprising an electrode surface, means for tracing a signal modulated electron beam of relatively low velocity across said electrode surface, a target element positioned in a plane substantially parallel to said electrode member and spaced apart therefrom, means for developing a flooding electron beam to cover substantially the entire surface of said electrode member to release secondary electrons therefrom in proportion to the intensity of the low velocity electrons directed upon the electrode element, and means for focussing the released secondary electrons upon the target element.

5. An electron tube comprising a metallic impact electrode, a target electrode positioned to receive electrons released from the impact electrode, means for developing a concentrated electron beam and directing the said beam toward the impact electrode, means for traversing said impact electrode by said developed concentrated electron beam, and electrode means for producing a high velocity electron stream for periodically flooding the entire area of the impact electrode.

6. An electronic system for translating signal energy into optical images which comprises an electron tube having positioned therein an impact electrode, a luminescent target electrode adapted to receive electron emission from the impact electrode and convert the said electrons into electro-optical representations, means contained within the tube for developing a relatively low velocity

concentrated electron beam, means for modulating the said electron beam under the control of received signal energy, means for traversing the impact electrode according to a predetermined traversal pattern with said low velocity signal modulated electron beam, means for developing a diffused high velocity electron beam, means for directing said high velocity beam upon said impact surface to release therefrom secondary electrons in proportion per elemental section of the impact element to the intensity of the low velocity electron beam directed thereupon, means for focusing the released secondary electrons upon the luminescent target to produce luminous representations of the electron density, and means for alternating the operative periods of the low velocity and high velocity electron streams.

7. In an electronic tube, an impact surface comprising a nickel element treated with uranyl nitrates, a light sensitive surface, means for focusing a light image upon the light sensitive surface to release photo-electrons in accordance with the light values of the image, means for directing and focusing the released photo-electrons upon the impact surface at low velocity to alter the secondary electron emissive properties of elemental areas on the surface in accordance with the quantity of photo-electrons directed thereagainst, means for bombarding the impact surface with an electron beam having a velocity high with respect to the velocity of the photo-electrons to release secondary electrons from the impact surface, and means for utilizing the released secondary electrons for the production of signal currents.

8. The electron tube claimed in claim 7 comprising, in addition, an electrode adjacent the impact surface and adapted to be maintained at a potential positive relative to said impact surface to collect the secondary electrons released from said impact surface as a result of the impact of the scanning beam.

9. An electron tube comprising an electrode surface capable of emitting secondary electrons, the secondary electron emissive properties of which is controllable, means for scanning said surface with a modulated electron beam of relatively low velocity to vary the secondary electron emissive properties of elementary areas on the surface in accordance with the intensity of the modulated beam, a target element of luminescent material positioned in a plane substantially parallel to said electrode member and spaced apart therefrom, means for developing a flood-

ing electron stream to cover substantially all of said electrode surface to release secondary electrons therefrom in proportion to the intensity of the low velocity electrons directed upon the electrode element, and means for focusing the released secondary electrons upon said target element.

10. An electron tube comprising a metallic impact electrode capable of producing secondary electrons, the secondary electron emissive properties of which is controllable, a fluorescent screen positioned to receive secondary electrons released from the impact electrode, means for developing a concentrated electron beam of low velocity, means for modulating said beam, means for scanning said impact electrode by the modulated electron beam whereby the secondary electron emissive properties of elemental areas on the surface may be controlled in accordance with the intensity of the modulated beam, and means for flooding the entire area of the impact electrode by high velocity electrons to release secondary electrons in proportion to the intensity of the modulated low velocity beam.

11. In an electronic device, an impact surface comprising a nickel electrode treated with a solution of uranyl nitrate and having the property of possessing a variable secondary electron emissive factor, means for directing relatively low velocity electrons upon the impact surface, means for subsequently bombarding the impact surface by high velocity electrons to release thereby secondary electrons from the surface proportional in magnitude to the low velocity electrons, means for repeating the sequence of low velocity and high velocity electron bombardment and means for utilizing the secondary electrons released by high velocity bombardment.

12. An electronic tube comprising a homogeneous metallic electrode member the surface of which is treated with an uranic compound whereby the secondary electron emissive factor will be variable, means for subjecting the electrode member to variable intensity low velocity electrons to alter the emission factor of said member, means for subsequently subjecting the electrode member to uniform intensity high velocity electrons to release therefrom secondary electrons the intensity of which is controlled in accordance with the initially impinging low velocity electrons and means for utilizing the released secondary electrons.

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