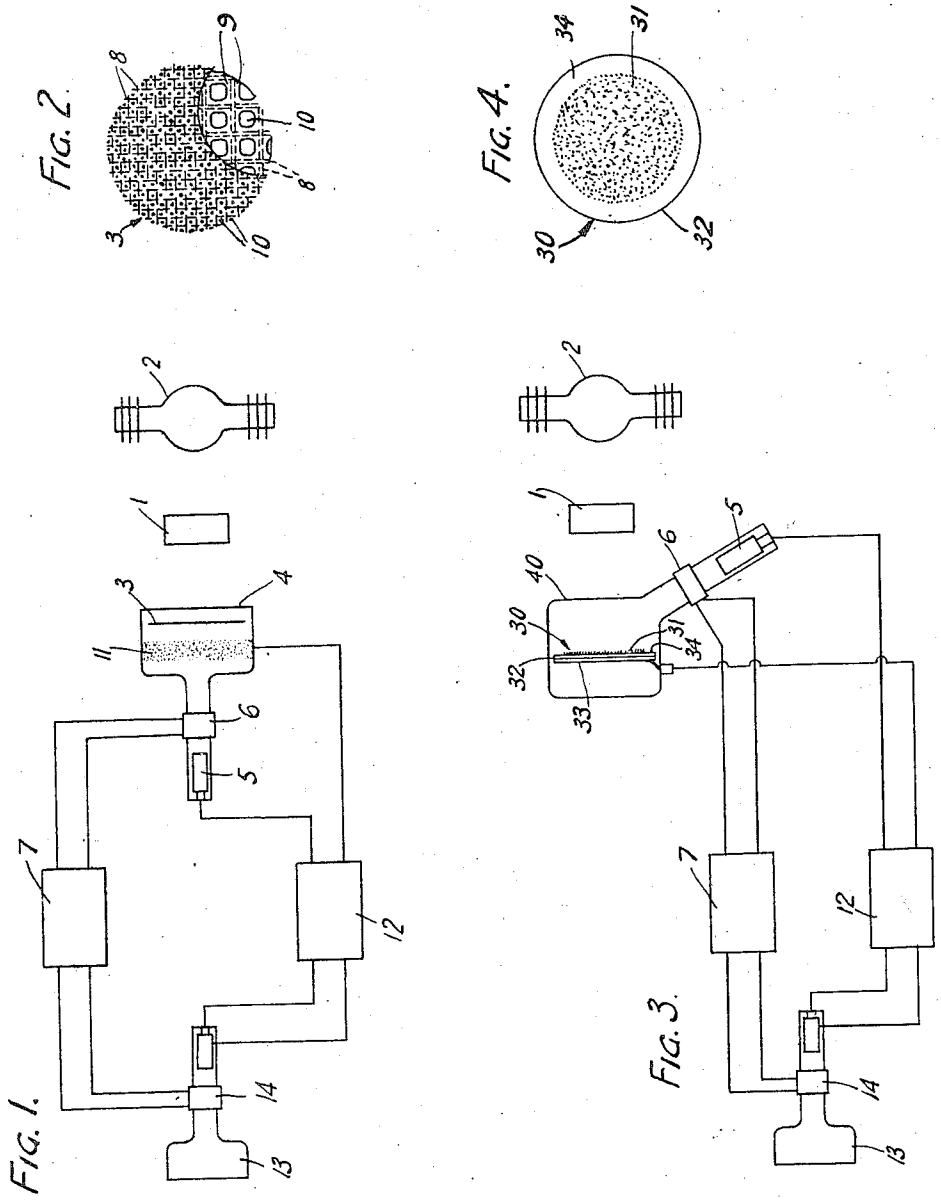
May 25, 1948. B. J. EDWARDS 2,442,287

MEANS FOR REPRODUCING X-RAY IMAGES

Filed Nov. 15, 1944



Inventor
B. J. EDWARDS
By
Emery Holcombe & Blair
Attorneys

Patented May 25, 1948 2,442,287

UNITED STATES PATENT OFFICE

2,442,287

MEANS FOR REPRODUCING X-RAY IMAGES

Baden John Edwards, Cambridge, England, assignor to Pye Limited, Cambridge, England, a British company

Application November 15, 1944, Serial No. 563,553
In Great Britain August 13, 1943

10 Claims. (Cl. 178—6.8)

1

The present invention relates to means for reproducing X-ray images.

According to the invention, a mosaic screen is employed upon which is projected an image produced by X-rays, the mosaic then being scanned by an electron beam which gives rise to fluctuating potentials in accordance with the X-ray image on the screen, which potentials are collected to give a waveform which may then be used with television apparatus, for constituting a reproduction of the X-ray image on a cathode ray tube or equivalent picture reproducing device.

By means of the invention X-ray images may be reproduced at a remote point over television apparatus. The invention also provides a means for viewing X-ray images, in which there is no danger to the operator from the X-rays.

For carrying the invention into effect, a cathode ray tube may be employed having beam forming means and a mosaic screen comprising numerous small conducting particles which is arranged so as to be exposed on one side to the X-rays, and scanned on the opposite side by the electron beam. The exposure of the mosaic on one side to the X-rays causes the elementary particles of the mosaic to be charged up in dependence upon the modulation applied to the X-rays by the subject being X-rayed, thus forming an electron image on the mosaic. The electron beam which scans the opposite side of the mosaic discharges the particles, the electrons emitted therefrom being collected by a collecting electrode arranged adjacent to the mosaic. The fluctuating potentials arising at the collecting electrode are then amplified and may be used to modulate a television transmitter, a cathode ray viewing tube, or other desired apparatus.

In an alternative arrangement, the same side of the mosaic screen may be both exposed to the X-rays and also scanned by the electron beam.

In order that the invention may be more clearly understood, some embodiments thereof will now be described with reference to the accompanying diagrammatic drawings in which:

Fig. 1 depicts a schematic arrangement for viewing X-ray images.

Fig. 2 depicts on an exaggerated scale one form of construction of the mosaic screen, a portion of the screen being represented as highly magnified.

Fig. 3 depicts a modified arrangement employing an alternative form of cathode ray tube.

Fig. 4 depicts another form of mosaic screen employed in the tube of Fig. 3.

In the arrangement illustrated in Fig. 1, the

2

X-ray image of the subject 1 being X-rayed by means of the X-ray tube 2 is projected on to one side of the mosaic screen 3 of the cathode ray tube 4, the opposite side of the screen 3 being scanned by an electron beam produced and deflected in known manner. 5 represents the electron gun of the tube 4, 6 the beam deflecting means, and 7 the time base apparatus controlling the deflecting means 6. The mosaic screen 3 may, in one embodiment, be constructed as a fine wire mesh coated with an insulating layer and then having small metallic or conducting particles inserted in the mesh. Fig. 2 illustrates such a form of mosaic screen constituted by a fine copper wire mesh 8 which, as depicted in the highly magnified portion of the figure, is coated with glass insulation 9 so as to leave small apertures in the glass corresponding to the meshes in the wire. These apertures are then filled with a material, such as zinc sulphide, which can be easily reduced to a metal, the material then being reduced to the metal so as to produce a screen 3 comprising discrete metallic particles 10 carried in the glass insulation between the meshes of the wire. The tube 4 is provided with a collector electrode 11 adjacent to the mosaic screen 3 on the side thereof which is scanned by the electron beam. For example, and as shown, the collector electrode 11 may be in the form of a conducting coating of graphite deposited on the wall of the tube surrounding the mosaic.

The X-rays projected through the subject 1 produce an image thereof on the mosaic screen 3, as charges on the individual particles 10 thereof according to the intensity of the X-rays impinging thereon. The electron beam scanning the opposite side of the mosaic discharges the particles, and the emitted electrons are collected by the collector electrode as a picture waveform which, after amplification in an amplifier 12 is used to modulate the beam of a cathode ray viewing tube 13 so as to reproduce the X-ray image visually on the screen of the tube 13. The time base apparatus 7 also controls the beam-deflecting means 14 of the tube 13 so as to maintain the scans of the tubes 4 and 13 in synchronism.

In a modification, the converter tube 4 may be constructed so that the mosaic screen may be scanned from the same side as it is exposed to the X-rays. This is exemplified by Fig. 3 which shows an arrangement similar to that of Fig. 1, but in which a converter tube 40 is employed having the electron gun 5 thereof offset, to scan the same side of the mosaic screen 30 as is ex-

posed to the X-rays from the X-ray tube 2. The screen 30 may be formed by discrete metallic particles 31 deposited, for example by evaporation, upon one side of a mica plate 32 having on the other side a metal backing 33 which constitutes the collector electrode corresponding to the electrode 11 of Fig. 1. As depicted in Fig. 4, it is advantageous to provide the mica plate 32 with a margin 34, or equivalently, a surrounding mica ring, which is free from the metallic mosaic 31, and to coat this surround with fluorescent material, for the purpose of facilitating the focussing of the electron beam upon the mosaic 31. By preliminarily focussing the beam on to the fluorescent surround 34 it can be seen visually, from the glowing spot produced, when the beam is properly focussed.

The form of mosaic screen 3 employed in conjunction with a separate collector electrode 11, as described with reference to Fig. 1, may be incorporated in the form of tube exemplified by Fig. 3, in place of the mosaic screen 30, so that the same side of the screen 3 would, in that case, be both scanned and exposed to the X-rays. Also, it will be evident that the form of mosaic screen 3 described may be provided with a fluorescent surround or ring, analogous to the surround 34, for focussing purposes.

The described embodiments of the invention are but illustrative, as various arrangements employing the invention are possible. For instance, the signal waveform collected at the collector electrode (11, Fig. 1; 33, Fig. 3) may, after amplification, be used to modulate a television transmitter and transmitted over a wire or wireless link to a remote point where the X-ray image is reproduced visually by means of conventional television receiving apparatus.

I claim:

1. Apparatus for producing an electric waveform of an X-ray image, comprising a mosaic screen, consisting of small discrete particles of a metal which is photo-electrically inert to visible light arranged in a cathode ray tube, an X-ray tube for projecting an X-ray image upon said screen, means to scan said screen with an electron beam, and means to collect electrons emitted from said screen by said beam.

2. Apparatus for producing an electric waveform of an X-ray image, comprising a cathode ray tube containing a mosaic screen consisting of small discrete metallic particles, an X-ray tube for projecting an X-ray image on to the mosaic, means for scanning said screen with an electron beam, means for collecting the electrons emitted from said screen to said beam, and a fluorescent surround in the plane of said screen for enabling the electron beam to be visually focussed.

3. Apparatus for producing an electric waveform of an X-ray image, comprising a cathode ray tube containing a mosaic screen consisting of a fine wire mesh coated with insulation and having small particles of a metal which is photoelectrically inert to visible light inserted in the mesh and insulated from the wire thereof by said insulation, an X-ray tube for projecting an X-ray image upon said screen, means to scan said screen with an electron beam, and a collecting electrode separate from the mosaic screen but arranged adjacent thereto for collecting the electrons emitted from said screen by said beam.

4. Apparatus for producing an electric waveform of an X-ray image, comprising a cathode ray tube containing a mosaic screen consisting of a fine wire mesh coated with insulation and having small zinc particles inserted in the mesh and insulated from the wire thereof by said insulation, an X-ray tube for projecting an X-ray image upon said screen, means to scan said screen with an electron beam, and a collecting electrode separate from the mosaic screen but arranged adjacent thereto for collecting the electrons emitted from said screen by said beam.

5. Apparatus for producing an electric waveform of an X-ray image, comprising a cathode ray tube containing a mosaic screen consisting of a fine wire mesh coated with insulation and having small particles of a metal which is photoelectrically inert to visible light inserted in the mesh and insulated from the wire thereof by said insulation, an X-ray tube for projecting an X-ray image upon one side of said screen, means to scan said screen with an electron beam from the other side thereof, and a collecting electrode separate from the mosaic screen but arranged adjacent thereto for collecting the electrons emitted from said screen by said beam.

6. Apparatus for producing an electric waveform of an X-ray image, comprising a cathode ray tube containing a mosaic screen consisting of a fine wire mesh coated with insulation and having small metallic particles inserted in the mesh and insulated from the wire thereof by said insulation, an X-ray tube for projecting an X-ray image upon said screen, means to scan said screen with an electron beam, a collecting electrode separate from the mosaic screen but arranged adjacent thereto for collecting the electrons emitted from said screen by said beam, and a fluorescent surround in the plane of said screen for enabling the electron beam to be visually focussed.

7. Apparatus for producing an electric waveform of an X-ray image, comprising a cathode ray tube containing a mosaic screen consisting of a plate of insulating material having conducting particles of a metal which is photo-electrically inert to visible light deposited as a mosaic, on one side thereof and a conducting backing on the other side thereof to constitute a collecting electrode, an X-ray tube for projecting an X-ray image on to the conducting particles, and means for scanning said conducting particles with an electron beam.

8. Apparatus for producing an electric waveform of an X-ray image, comprising a cathode ray tube containing a mosaic screen consisting of a plate of insulating material having zinc particles deposited as a mosaic on one side thereof and a conducting backing on the other side thereof to constitute a collecting electrode, an X-ray tube for projecting an X-ray image on to the zinc particles and means for scanning said zinc particles with an electron beam.

9. Apparatus for producing an electric waveform of an X-ray image, comprising a cathode ray tube containing a mosaic screen consisting of a plate of insulating material having metallic particles deposited as a mosaic on one side thereof and a conducting backing on the other side thereof to constitute a collecting electrode, an X-ray tube for projecting an X-ray image on to the metallic particles, means for scanning said metallic particles with an electron beam, and a fluorescent surround in the plane of said screen for enabling the electron beam to be visually focussed.

10. Apparatus for producing an electric waveform of an X-ray image, comprising a cathode

ray tube containing a mosaic screen consisting of small discrete particles of a metal which is photo-electrically inert to visible light, an X-ray tube for projecting an X-ray image on to the mosaic, means for scanning said screen with an electron beam, means for collecting the electrons emitted from said screen to said beam, and a fluorescent surround in the plane of said screen for enabling the electron beam to be visually focussed.

BADEN JOHN EDWARDS.

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