Oct. 21, 1941. A. J. YOUNG ET AL 2,259,506

CATHODE RAY TUBE OSCILLOGRAPH

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*Fig. 1*

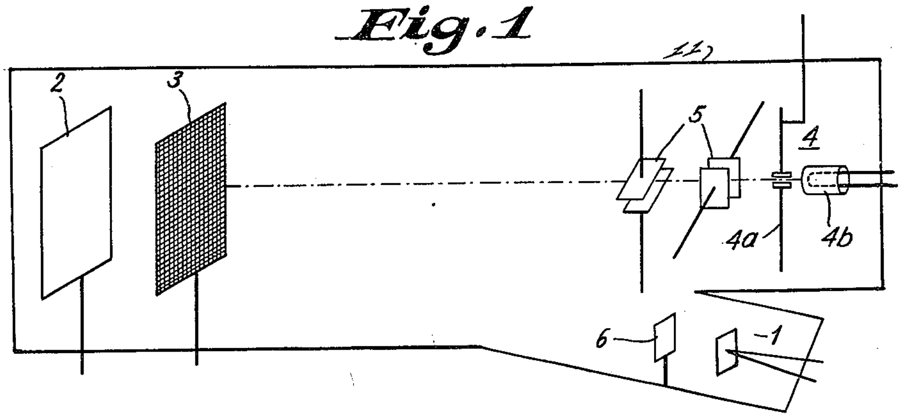



*Fig. 2*

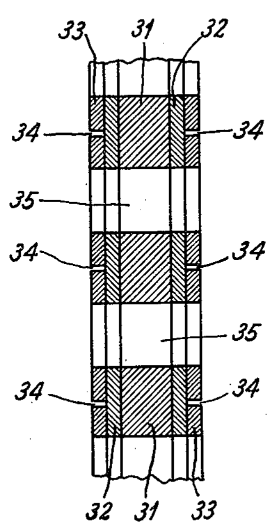
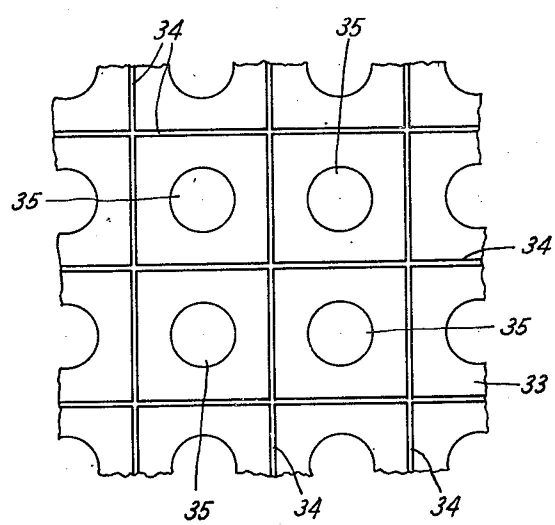



*Fig. 3*

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## CATHODE RAY TUBE OSCILLOGRAPH

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9 Claims. (Cl. 250—150)

This invention relates to cathode ray tube oscillographs and more particularly to cathode ray tube oscillographs of the kind in which a visible pattern or picture is reproduced in the form of light generated by the incidence of electrons upon a fluorescent screen. The invention is primarily intended for application to cathode ray tube television reproducers but it is not limited thereto and may be employed for cathode ray tube oscillograph purposes generally.

In the usual form of cathode ray tube reproducer as employed for television reception and similar oscillograph purposes serious difficulties are experienced in attempting to obtain a reproduced picture or pattern of any substantial light intensity and in practice it is a very difficult matter with known cathode ray tube apparatus to produce a picture of sufficient light to enable satisfactory projection upon a screen. In the usual cathode ray tube reproducer, the picture is reproduced by focussing a narrow beam of electrons upon the fluorescent screen and causing said beam to scan said screen the while it is modulated in intensity. In such tubes the principal limit of electron intensity in the beam is soon reached and in general a concentrated beam of electrons having an electron current of 1 milliampere is very difficult to achieve and as a rule the beam current is of the order of 50 microamperes. If, therefore, high powers are to be dissipated at the fluorescent screen of the tube and reasonably powerful light thereby obtained very high anode voltages are necessary; for example, in order to obtain an anode dissipation of 1 kilowatt with an oscillograph of conventional design a voltage of the order of a million is required, and so high a voltage is obviously impracticable.

The object of the present invention is to overcome these difficulties and to enable a brighter picture to be obtained without the use of impractically high voltages.

In the ordinary cathode ray tube oscillograph the intrinsic brilliance of the spot caused by the incidence of the scanning ray upon the fluorescent screen is reduced as the ratio of the area of the spot to the scanned area (i. e. the area of the "raster" as it is sometimes called) becomes smaller. In other words the greater the disparity between the area of the spot by which the raster is swept out and the total area through which said spot moves in sweeping out said raster, the less will be the intrinsic brilliance of the said spot and the less, therefore, will be the brightness of the picture.

According to this invention the whole area upon which a pattern or picture is to be reproduced is continuously bombarded by electrons and the electron density per elemental cross sectional area in the beam of electrons with which said area is bombarded is controlled by means of an interposed electrode through which said beam passes, said interposed electrode being itself controlled as to the potentials on the individual elemental areas thereof by means of a narrow electron beam which scans it. The principle of the invention thus resides in projecting a beam of electrons towards that part where the picture or other pattern is to be reproduced and controlling the electron density in different parts of the beam in much the same way as the control grid of a triode controls the electron stream to the anode, the said control being effected by means of an interposed electrode which is itself explored by a concentrated scanning electron beam or ray through or by which said electrode receives the necessary controlling potentials at the different elemental areas thereof.

The advantages of the invention will be obvious for the fluorescent screen is bombarded the whole time instead of merely being traversed by a fast moving concentrated electron beam.

The invention is illustrated in the accompanying schematic and diagrammatic drawing in which Fig. 1 shows schematically one embodiment of my invention illustrating the method and means of flooding an electrode with electrons and controlling the number of electrons by a concentrated cathode ray beam; Fig. 2 shows a side view of a portion of the electron permeable electrode; while Fig. 3 shows a portion of the same electrode in elevation.

Referring to the drawing and in particular to Figure 1 a cathode ray tube reproducer in accordance with this invention and suitable for use for television purposes comprises within an evacuated envelope 11 a cathode—for example an indirectly heated cathode—represented at 1, said cathode having a planar surface of substantial area and being arranged to project a beam of electrons on to an anode 2 which is coated with fluorescent material and constitutes the screen of the tube. If desired, any suitable auxiliary electrode system e. g. a so-called electron lens arrangement (not shown) may be provided to assist in the projection of the beam from the cathode 1 to the anode 2 and the arrangement is such that normally (that is to say apart from the action of further electrodes to be described) the beam of electrons projected upon the anode is of uniform density. Interposed between the cathode 1 and the anode 2 is a multiple grid electrode 3 made up of a plurality of individual grid elements which are insulated from one another. There may be as many grid elements as there are to be picture points in the picture or the number of grid elements may be an even multiple of the desired number of picture points in the picture. This grid electrode 3 is so constructed as to permit the cathode beam to pass to the anode. The tube 11 is also provided with an electron gun generally designated 4 and mutually perpendicular ray deflecting means associated therewith, for example mutually perpendicular pairs of deflecting plates 5. The electron gun is arranged to project a signal modulated concentrated narrow beam or ray of electrons upon the multiple grid electrode 3 and the deflecting means 5 are energized with suitable wave forms to cause the electron ray or narrow beam from the gun to scan the grid electrode 3.

The individual insulated elements of which the multiple grid 3 is composed are arranged always to be at negative potential with respect to the cathode so that the anode 2, cathode 1, and grid 3 constitute an electrode system which may be regarded as analogous to a triode or more accurately as analogous to a very large number of triodes having a common anode, a common cathode and independent grids, the grid of each triode being one of the insulated elements of the grid electrode (for the case in which there are the same number of grid elements as there are picture points). Since the grid elements are all negative with respect to the cathode 1, electrons from the cathode will pass through the grid orifices to the anode but the potentials of the grid elements will determine the electron currents projected from the cathode through the different parts of the grid electrode; in other words the potentials at different parts of the grid electrode will modify the electron effect of the anode acting through the grid electrode upon the cathode. The reproduced picture or other pattern is obtained by modulating the potentials of the elements of which the grid is composed and this modulation is effected by means of the cathode ray beam from the gun 4 and which scans the grid electrode 3. The grid elements are explored by this scanning beam and each element is charged thereby to an extent depending upon the scanning beam intensity at the moment of impact. The grid elements are so arranged that each will leak away the charge which it receives in the period occupied by one complete "frame," that is to say, in the time which the scanning beam takes to explore the grid electrode. The scanning beam from the gun 4 is, as above stated, modulated in the usual way in accordance with received television signals or other signals to be reproduced and in this way the intensity of the electron beam which bombards the anode is modulated at the different elemental areas of the beam in accordance with the picture or like signals.

Matters must, of course, be so arranged that the electrons from the cathode 1 pass through the multiple grid electrode, and therefore do not substantially affect its potential while electrons from the scanning cathode ray beam charge the grid elements. The fact that the grid electrode 3 is negative with respect to the cathode 1 ensures that electrons from the said cathode do not charge the grid elements. At the same time the apertured anode 4a of the electron gun is arranged to be negative with respect to the grid elements. In this way work can be done on an electron from the electron gun 4 by moving to the grid electrode 3 but not on an electron from the cathode 1. The "capture" of electrons from the electron gun by the grid electrode is expected to be of the order of 20%. The potentials of the grid elements vary but, as stated, they are always negative with respect to the cathode and positive with respect to the electron gun. 6 is a virtual anode associated with the cathode 1. Signals are applied to the control electrode 4b of the gun where intensity modulation is to be resorted to. The invention is, however, not limited to the use of intensity modulation since velocity modulation can be effected by controlling the ray deflection in dependence upon received signals as well known per se; e. g., by applying picture signals to the deflection plates.

There are various possible ways of making a suitable grid electrode 3 for use in carrying out this invention. One suitable construction is shown in Figures 2 and 3 which are much enlarged mutually perpendicular schematic part views. Referring to these figures, in the construction therein shown the multiple grid electrode is constituted by a perforated sheet 31 of aluminum coated on each side with a layer 32 of aluminum oxide and then "flashed" on one side (over the coating) with silver 33. If desired, as shown, both sides may be coated. Obviously a conductive coating other than silver may be used and the said coating may be deposited in any known manner. The conductive coating 33 is then cross ruled with a suitable very sharply pointed cutting tool so as to remove said coating along a series of crossing lines 34 and thereby transform the said coating into a plurality of individual conductor elements each of which is insulated from its neighbours and from the aluminum sheet by the barrier of aluminum oxide. The perforations in the sheet 31 are shown at 35 and in the illustrated embodiment there is one perforation centrally disposed in each of the little squares between the crossed ruled lines. As will be seen, this grid electrode consists of a large plurality of little condensers each having one conductor constituted by a particle of conductive coating, the other electrodes of all the condensers being common and being constituted by the aluminum core of the sheet, the di-electric of all the condensers being also common and being a leaky di-electric constituted by the aluminum oxide.

It will, of course, be appreciated that if there is to be one grid element per picture point the cross ruling will be so effected that there is an element of conductive coating between adjacent perforations in the sheet (this is the case illustrated). The aluminum core of the sheet is connected to a suitable external conductor so that the potential applied to this core may be adjusted to limit the potential of the grid elements.

Alternatively a grid electrode (not illustrated) for use in carrying out this invention may be composed of a series of conductive rings set in an insulating compound.

It will be appreciated that since the electrons from the electron gun are to be arrested by the grid elements provision must be made for these electrons to leak away in the period of one frame as otherwise the grid elements will gradually accumulate charges and eventually stop the flow of electron current from the cathode to the anode. Aluminum oxide is not a particularly good insulator and it is believed that by suitably choosing the thickness of the aluminum oxide coating upon an aluminum perforated sheet in a grid, as above described and, by adjusting the potential applied to the aluminum core of the sheet it is possible directly to obtain the required leakage conditions.

In the embodiment above described, the anode 2 was a sheet of metal coated with fluorescent material. It is, however, not necessary that the anode be itself the screen for the said anode may be constituted by a gauze behind which (that is to say on the side remote from the grid 3) is a transparent fluorescent screen. Electrons may then be projected through the gauze to the fluorescent screen and return to the anode (the gauze) by secondary emission.

Since the power which may be used in carrying out this invention is large, the screen may be constituted by a series of particles (e. g. carbon) which emit light when heated by electron bombardment to glowing temperature.

It is possible in carrying out this invention to choose the distance between the anode 2 and the control grid 3 in such manner that the normal dispersion of the electron beam from the cathode almost compensates for the finite size of the conductor members of which the grid electrode is composed and in this way it is possible to minimize any disadvantageous effect due to the projection of the grid electrode being seen upon the cathode ray tube screen. It is believed that in practice it will be possible to reduce this effect to such an extent that it will be unimportant and in any event, by suitably choosing the space factor in the grid electrode, such projection of the grid electrode as does appear may be made quite unobjectionable.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed we declare that what we claim is:

1. A cathode ray tube reproducer comprising means for projecting a main beam of electrons towards an area upon which a picture is to be reproduced so as to bombard the whole picture area, an electrode which is permeable to said main beam interposed in path of said main beam, means obliquely positioned with respect to the means for projecting the main beam of electrons for scanning said electrode by a signal controlled concentrated cathode ray beam whereby said electrode receives electron density controlling potentials at different elemental areas thereof, said picture area being longitudinally displaced from said permeable electrode at a distance at least great enough to minimize electron shadow effects of said permeable electrode upon said picture area.

2. A cathode ray tube reproducer comprising means for projecting a main beam of electrons towards a thermo-luminescent screen upon which a picture is to be reproduced so as to bombard the whole picture area of said screen, an electrode which is perméable to said main beam interposed in path of said main beam, means obliquely posiitoned with respect to the means for projecting the main beam of electrons for scanning said electrode by a signal controlled concentrated cathode ray beam whereby said electrode receives electron density controlling potentials at different elemental areas thereof.

3. A cathode ray tube reproducer comprising means for projecting a main beam of electrons towards a thermo-luminescent screen upon which a picture is to be reproduced so as to bombard the whole picture area of said screen, an electrode which is permeable to said main beam interposed in path of said main beam, means obliquely positioned with respect to the means for projecting the main beam of electrons for scanning said electrode by a signal controlled concentrated cathode ray beam whereby said electrode receives electron density controlling potentials at different elemental areas thereof, said picture area being longitudinally displaced from said permeable electrode at a distance at least great enough to minimize electron shadow effects of said permeable electrode upon said picture area.

4. A cathode ray tube comprising means for continuously projecting a main beam of electrons, a perforated electrode interposed in the path of said main beam, an electron gun obliquely positioned with respect to the means for projecting the main beam of electrons for projecting a concentrated cathode ray beam upon said electrode, means adapted to cause said concentrated beam to scan said electrode, and means adapted to be operated by image signals for effecting modulation of the concentrated scanning beam, said interposed electrode being so constructed that the potentials of the different elemental areas thereof may be controlled by the scanning cathode ray beam whereby the electron intensity in corresponding parts of the main beam passed by said electrode may be correspondingly controlled, and an anode constituted as a luminescent screen to receive the main beam of the electrons projected through the interposed electrode.

5. A cathode ray tube comprising means for continuously projecting a main beam of electrons, a perforated electrode interposed in the path of said main beam, an electron gun obliquely positioned with respect to the means for projecting the main beam of electrons for projecting a concentrated cathode ray beam upon said electrode, means adapted to cause said concentrated beam to scan said electrode, and means adapted to be operated by image signals for effecting modulation of the concentrated scanning beam, said interposed electrode being so constructed that the potentials of the different elemental areas thereof may be controlled by the scanning cathode ray beam whereby the electron intensity in corresponding parts of the main beam passed by said electrode may be correspondingly controlled, and an anode constituted as a mesh-like electrode through which the said beam passes for receiving the main beam projected through the interposed electrode so that the beam passes to a screen constituted by a series of particles adapted to emit light when heated to glowing temperature by electron bombardment.

6. A cathode ray tube comprising means for continuously projecting a main beam of electrons, a perforated electrode interposed in the path of said main beam, an electron gun obliquely positioned with respect to the means for projecting the main beam of electrons for projecting a concentrated cathode ray beam upon said electrode, means adapted to cause said concentrated beam to scan said electrode, and means adapted to be operated by image signals for effecting modulation of the concentrated scan-

ning beam, said interposed electrode being so constructed that the potentials of the different elemental areas thereof may be controlled by the scanning cathode ray beam whereby the electron intensity in corresponding parts of the main beam passed by said electrode may be correspondingly controlled, said interposed electrode comprising a perforated or open-work metal plate coated at least on one side with a layer of insulation which is in turn coated with a layer of conductive material, said last-mentioned layer being cross-ruled to divide it into a mosaic of elemental conductive areas.

7. A cathode ray tube comprising means for continuously projecting a main beam of electrons, a perforated electrode interposed in the path of said main beam, an electron gun obliquely positioned with respect to the means for projecting the main beam of electrons for projecting a concentrated cathode ray beam upon said electrode, means adapted to cause said concentrated beam to scan said electrode, and means adapted to be operated by image signals for effecting modulation of the concentrated scanning beam, said interposed electrode being so constructed that the potentials of the different elemental areas thereof may be controlled by the scanning cathode ray beam whereby the electron intensity in corresponding parts of the main beam passed by said electrode may be correspondingly controlled, said interposed electrode comprising a series of conductive rings set in an insulating compound.

8. A cathode ray tube comprising means for continuously projecting a main beam of electrons, a perforated electrode interposed in the path of said main beam, an electron gun obliquely positioned with respect to the means for projecting the main beam of electrons for projecting a concentrated cathode ray beam upon said electrode, means adapted to cause said concentrated beam to scan said electrode, and means adapted to be operated by image signals for effecting modulation of the concentrated scanning beam, said interposed electrode being so constructed that the potentials of the different elemental areas thereof may be controlled by the scanning cathode ray beam whereby the electron intensity in corresponding parts of the main beam passed by said electrode may be correspondingly controlled, said interposed electrode constituted by a mesh-like electrode through which the said beam passes to a screen consisting of a plurality of finely divided carbon particles adapted to emit light when heated by electron bombardment.

9. A cathode ray tube comprising means for continuously projecting a main beam of electrons, a perforated electrode interposed in the path of said main beam, an electron gun obliquely positioned with respect to the means for projecting the main beam of electrons for projecting a concentrated cathode ray beam upon said electrode, means adapted to cause said concentrated beam to scan said electrode, and means adapted to be operated by image signals for effecting modulation of the concentrated scanning beam, said interposed electrode being so constructed that the potentials of the different elemental areas thereof may be controlled by the scanning cathode ray beam whereby the electron intensity in corresponding parts of the main beam passed by said electrode may be correspondingly controlled, said interposed electrode comprising a perforated aluminum plate coated on one face with a layer of aluminum oxide, which is in turn coated with a layer of conductive material, said last-mentioned layer being cross-ruled to divide it into a mosaic of elemental conductive areas whereby a leakage path between the aluminum plate and the elemental conductive areas is obtained through the aluminum oxide.

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