April 18, 1939. J. B. JOHNSON 2,155,192

SIGNALING

Filed July 7, 1930

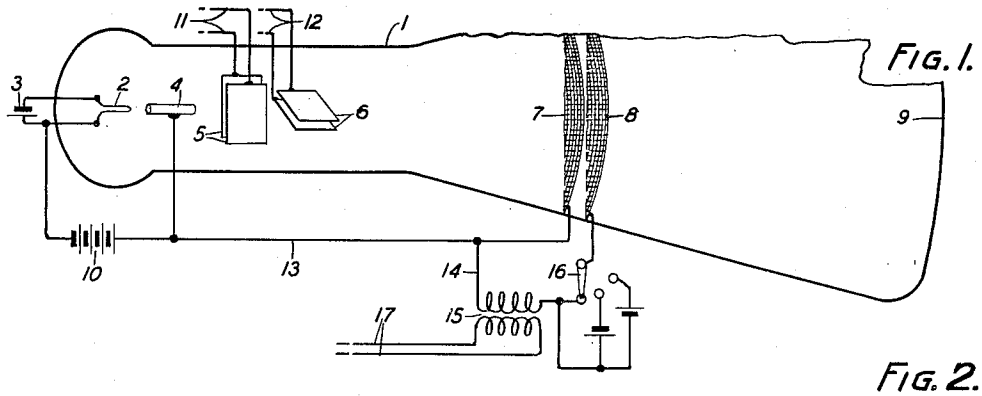

FIG. 1.

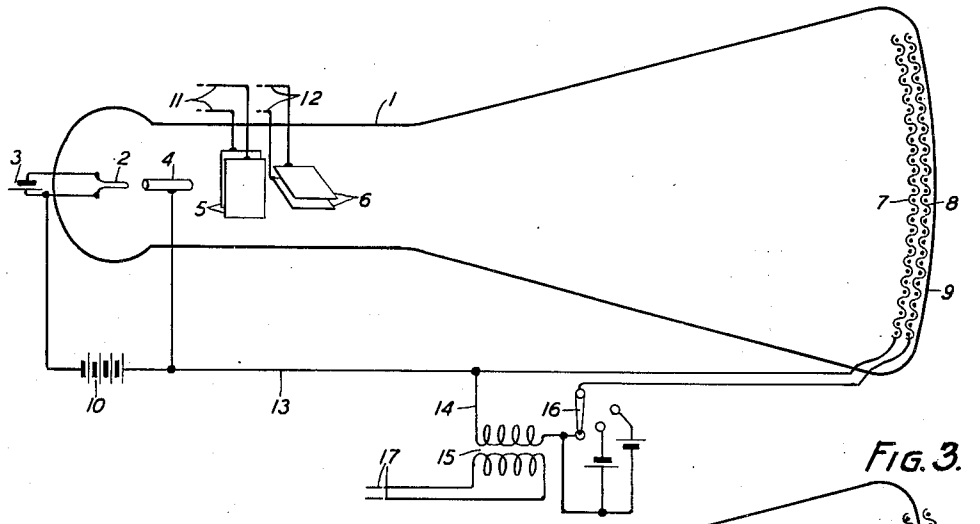

FIG. 2.

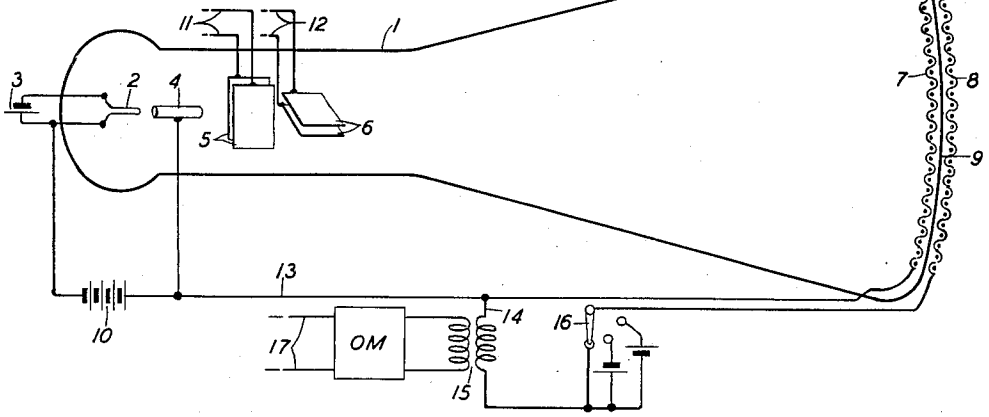

FIG. 3.

INVENTOR
J. B. JOHNSON
BY J. P. Neville
ATTORNEY

Patented Apr. 18, 1939

2,155,192

UNITED STATES PATENT OFFICE

2,155,192

SIGNALING

John B. Johnson, Maplewood, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application July 7, 1930, Serial No. 466,067

29 Claims. (Cl. 178—7.5)

This invention relates to signaling and more particularly to cathode ray devices for producing television images.

An object of the invention is to provide an improved method of and means for modulating in accordance with signaling voltages, the cathode beam of a cathode ray device of the Braun type.

Another object of the invention is to modulate a cathode beam in a discharge tube of the Braun type so as to better adapt it for the production of images.

Cathode ray tube discharge devices of the Braun or oscillograph type have heretofore been employed in telephotographic and television systems for reproducing the image at a receiving station. Many suggestions have been made for modulating the cathode beam in accordance with incoming signaling currents. One method of doing this is to place a grid between the cathode and the anode and impress the signaling potentials upon the grid. In accordance with another suggestion the grid or control element is placed between the cathode and screen. The present invention is an improvement upon the latter type of device and provides for improved control of the cathode beam.

In accordance with the present invention in its preferred form, two parallel grid elements are provided between the anode and screen. The grid nearest the anode is maintained at substantially the same potential as the anode, and the signaling potentials are impressed on a circuit connecting the two grids. These grids are preferably very near to each other and are in the form of segments of a spherical surface the center of which is in the neighborhood of the beam deflecting means which causes the beam to scan the screen. Since the first grid is at the same potential as the anode, the electrons after leaving the anode are unaffected by the field set up by the signaling currents until they enter that field, that is, the region between the two grids. In this region a very strong field is set up which very efficiently controls the cathode beam.

It is preferred to place the pair of grids close to the screen. Both grids may be on the side of the screen toward the anode, or the screen may be placed between the grids. In the latter arrangement the signaling potentials are applied in the form of high frequency modulated current, the frequency being so high that no appreciable charge accumulates on the screen.

While the invention is particularly well adapted to the production of television images the same principles are applicable to cathode ray devices of the Braun tube type wherever employed for signaling, whether the cathode beam is stationary or movable.

The invention may be understood by reading the following description in conjunction with the attached drawing, consisting of Figures 1, 2 and 3 which illustrate three different embodiments of the invention.

The apparatus shown in each of the three figures comprises a cathode ray or Braun tube 1, including a cathode 2, adapted to be heated by a source 3, a tubular anode 4, two pairs of deflecting plates 5 and 6, a pair of grid or control electrodes 7 and 8 and a fluorescent screen 9.

The grids 7 and 8 may be either perforated plates or be made of fine wire netting. They should be close to each other and are preferably in the form of segments of spheres, having centers close to the centers of the deflecting fields produced by the plates 5 and 6.

The source 10 maintains the anode 4 at a positive potential with respect to the cathode 2.

As thus far described, the operation of tube 1 is that of a Braun tube. The cathode 2 is heated by current from the source 3 to emit electrons, which travel across the space within the tube by virtue of the positive potential applied to the anode 4 by the source 10.

While some of the electrons strike the anode 4 and tend to neutralize the positive potential applied by the source 10, the vast majority pass through the opening in the anode 4 to produce a narrow cathode beam or pencil which passes through the interstices of the grids 7 and 8 and excites to fluorescence a spot upon the screen 9.

The cathode beam may be caused to trace a pattern on or to impinge upon any desired area of the screen 9 by applying suitable electrostatic charges to the two pairs of deflecting plates 5 and 6 through the respective circuits 11 and 12.

To produce a television image upon the screen 9, an alternating potential of relatively high frequency is applied to one pair of plates, for example, plates 5 and a similar potential of low frequency is applied to the other pair of plates 6.

The frequencies of the respective deflecting potentials should be so chosen that the cathode beam is caused to excite successive parallel lines on the screen to constitute a continuous area forming the image field.

The deflecting potentials may be supplied from the transmitting station, or they may be supplied by local sources which are held in synchronism with the scanning mechanism used at the transmitting station. When the system is used for

producing television images, any well known synchronizing means capable of synchronizing closely enough may be used.

The positive terminal of the source 10 is connected by a conductor 13 to the grid 7, whereby this element is maintained at the same potential as the anode thereby preventing any strong electrostatic field being set up between the deflecting plates 6 and the grid 7.

The grids are connected together by an external circuit 14, including the secondary winding of a transformer 15. This circut is provided with a switch 16 for controlling the static potential relationship between the grids 7 and 8.

The incoming image currents are supplied through the circuit 17 and transformer 15 to the grids 7 and 8. The effective potential of grid 8 is thereby caused to vary in accordance with the amplitudes of the image current wave. The velocity of the electrons, constituting the cathode beam which passes through the grid 8, is changed to vary the intensity of the excitation produced upon the screen.

At successive instants the intensity of the excitation is determined by the amplitudes of the image currents, consequently an image of the subject or field scanned at the transmitting station will be produced upon screen 9.

By modulating the cathode beam at a point between the deflecting plates 6 and the screen 9, the velocity of the electrons may be controlled without changing their direction of travel. In other words, the deflection of the cathode beam is not affected by the image current potentials but is determined solely by the electrostatic fields between the pairs of plates 5 and 6. Modulation of the brightness by varying the speed of the electrons must be accomplished after the ray has passed the deflecting field, otherwise the sweep would depend on the modulation.

As shown in Fig. 2, the grids 7 and 8 are within the tube and close to the screen 9 and are supplied with image current through the circuit 17 and transformer 15. The grid 7 and screen 9 being close together the amount of distortion or loss of focus, which occurs while the cathode beam traverses this short intervening distance, will be small.

In Fig. 3, the grid 7 is adjacent to the screen 9 within the tube, while the grid 8 is also close to the screen 9 but outside the tube.

Image currents are supplied through the circuit 17 to an apparatus in which they are combined with high frequency oscillations to cause the amplitude of the oscillations to be modulated in accordance with the image currents.

The modulated wave is supplied through the transformer 15 to the grid 8 to vary the velocity of the electrons of the beam traversing the screen 9. The intensity of the illumination of the screen is thereby controlled in accordance with amplitudes of the incoming image currents.

By providing oscillations of such high frequency that no electrostatic charge is accumulated upon the screen 9, this method of operation permits the grid 8 to be mounted externally of the tube. The grid 7 may therefore be placed closer to the screen 9, than in the construction shown in Fig. 2 and hence distortion and loss of focus of the beam will be reduced.

Except for the differences above noted the apparatus shown in the last two figures operates in the same manner as that of Fig. 1.

What is claimed is:

1. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a screen activated by said beam, a conductive open-work element between said screen and said anode maintained at substantially the potential of said anode, a second conductive element on the opposite side of said open-work element from said anode, and circuit means for impressing a varying signaling potential between said first and second conductive elements to control the activation of said screen.

2. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a screen activated by said beam, a conductive open-work element between said screen and said anode maintained at substantially the potential of said anode, a second conductive element on the opposite side of said open-work element from said anode, cathode-beam deflecting means for causing said beam to sweep said screen, and circuit means for impressing a varying signaling potential between said first and second conductive elements to control the activation of said screen.

3. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a screen activated by said beam, a conductive open-work element between said screen and said anode maintained at substantially the potential of said anode, a second conductive element on the opposite side of said open-work element from said anode, and circuit means for impressing a varying signaling potential between said first and second conductive elements to control the activation of said screen, said open-work element and said second conductive element both being on the side of said screen nearest said anode.

4. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a screen activated by said beam, a conductive open-work element between said screen and said anode maintained at substantially the potential of said anode, a second conductive element on the opposite side of said open-work element from said anode, and circuit means for impressing a varying signaling potential between said first and second conductive elements to control the activation of said screen, said second conductive element being on the side of said screen opposite said anode.

5. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a screen activated by said beam, a conductive grid element between said screen and said anode maintained at substantially the potential of said anode, a second conductive grid element close to and substantially parallel to said first grid element, and circuit means for impressing a varying signaling potential between said first and second conductive elements to control the activation of said screen.

6. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a fluorescent screen upon which said beam impinges, a conductive grid element between said screen and said anode maintained at substantially the potential of said anode, a second conductive element on the opposite side of said grid from said anode, a transformer, means for connecting

the secondary of said transformer between said first and second conductive elements, and means for impressing a varying signaling potential upon the primary of said transformer to control the activation of said screen.

7. A cathode ray image producing device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a fluorescent screen upon which said beam impinges, a cathode-beam deflecting means for causing said beam to sweep said screen, a grid element between said screen and said anode maintained at substantially the potential of said anode, a second conductive element on the opposite side of said grid element from said anode, said grid element and said second conductive element being each in the form of a segment of a spherical surface having its center of curvature in the neighborhood of the deflecting means, a circuit connecting said grid element and said second conductive means, and means to cause image currents to flow in said circuit between said elements for controlling the activation of said screen.

8. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a fluorescent screen upon which said beam impinges, two substantially parallel grid elements between said screen and said anode, one of the grid elements being maintained at substantially anode potential, said elements being near each other, a circuit connecting said grid elements, and means for causing varying signaling current to flow between said grid elements in said circuit for controlling the activation of said screen.

9. A cathode ray image producing device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a fluorescent screen upon which said beam impinges, cathode-beam deflecting means for causing said beam to sweep said screen, a pair of conductive grid elements between said anode and said screen, said grid elements being near together and substantially parallel to each other and in the form of segments of spherical surfaces having their centers of curvature in the neighborhood of said deflecting means, means for maintaining the grid element nearest said anode at substantially the same potential as said anode, a circuit connecting said grid elements, and means for impressing image currents upon said circuit for controlling the activation of said screen.

10. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a screen activated by said beam, a pair of control elements in the immediate proximity of the screen, and circuit means for impressing a varying signaling potential between said control elements to vary the velocity of the unmodulated beam in accordance with signals.

11. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a screen activated by said beam, a pair of grids coextensive with the field of said screen and adjacent thereto, and circuit means for impressing a varying signaling potential between said grids to vary the velocity of the unmodulated beam in accordance with signals.

12. A cathode ray image producing device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a fluorescent screen upon which said beam impinges, cathode-beam deflecting means for causing said beam to scan said screen, a pair of control electrodes coextensive with the field of said screen and adjacent thereto, and circuit means for impressing image signaling potentials between said control electrodes to control the activation of said screen.

13. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a screen activated by said beam impinging thereon, a conductive open-work element between said screen and said anode maintained at substantially the potential of said anode, a second conductive element on the opposite side of said open-work element from said anode, and means for producing potential variations controlled by varying signals received from a transmitting station and for impressing said potential variations between said first and second conductive elements.

14. The method of operating a cathode ray signaling device which method comprises maintaining the axial velocity component of the electrons substantially uniform throughout at least a considerable portion of their path from the anode to the screen and then subjecting them, within a restricted zone and up to that stage still unmodulated, to a field for modulating their velocity in accordance with varying signals to change the intensity of the excitation of a screen on which the electrons impinge.

15. A cathode ray signaling device which comprises a screen, means for producing an unmodulated beam of electrons and for projecting it toward said screen, means for deflecting said unmodulated beam to direct it toward different elemental portions of said screen in succession without changing its velocity component along the axis of the device, and means for subjecting said deflected beam, within a restricted zone, to a field for modulating the velocity of the electrons in accordance with varying signals to change the intensity of the excitation of said screen.

16. A cathode ray signaling device which comprises a screen, means for producing an unmodulated beam of electrons and for projecting it toward said screen, means relatively far removed from said screen for deflecting said unmodulated beam to direct it toward different elemental portions of said screen in succession without changing its axial velocity component, and means for subjecting said deflected beam, within a restricted zone, to a field for modulating the velocity of the electrons in accordance with varying signals to change the intensity of the excitation of said screen, said zone being relatively near to said screen.

17. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel and for directing it toward the end wall of the device, a conductive element between said end wall and said anode maintained at substantially the potential of said anode, a second conductive element on the side of said first mentioned conductive element opposite said anode, and means for impressing a varying signaling potential between said first and second conductive elements to modulate said beam.

18. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel and for directing it toward the end wall of the device, a conductive element between said end wall and said anode maintained at substan-

tially the potential of said anode, a second conductive element on the side of said first mentioned conductive element opposite said anode, cathode beam deflecting means for causing said beam to sweep said end wall, and means for impressing a varying signaling potential between said first and second conductive elements to modulate said beam after it has been deflected.

19. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel, a screen activated by said beam, a conductive element between said screen and said anode maintained at substantially the potential of said anode, a second conductive element close to and substantially parallel to said first mentioned conductive element, and means for impressing a varying signaling potential between said first and second conductive elements to control the activation of said screen.

20. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel and for directing it toward the end wall of the device, two substantially parallel conductive elements between said end wall and said anode, one of the conductive elements being maintained at substantially anode potential, and means for impressing a varying signaling potential between said first and second conductive elements to modulate the beam which up to that point is unmodulated.

21. A cathode ray signaling device comprising a vessel, means comprising a cathode and an anode for producing a beam of electrons in said vessel and for directing said beam toward the end wall of the device, a conductive element between said end wall and said anode maintained at substantially the potential of said anode, a second conductive element on the side of said first mentioned conductive element opposite said anode, and means for producing potential variations controlled by varying the signals received from a transmitting station and for impressing said potential variations between said first and second conductive elements.

22. The method of operating a cathode ray discharge device, which comprises producing a substantially constantly accelerated beam of cathode rays, deflecting the constantly accelerated beam, modulatedly accelerating said beam by passing it through a space across which is applied a potential varying in accordance with the modulation to be effected, and then producing illumination by applying the modulated beam to a screen.

23. In a cathode ray oscillograph, a source of a beam of cathode rays, means directing said beam to effect scanning, a fluorescent screen producing illumination when scanned by said beam, a plurality of grids superimposed upon said screen and insulated from each other, and means for applying varying potentials to said grids to modulate the effect of said beam upon said screen.

24. A cathode ray oscillograph comprising, in combination with a constant potential current source and a current source of modulating frequencies, a source of a beam of cathode rays, means directing said beam to effect scanning, a screen visually radiating where struck by said beam, a plurality of grids superimposed upon said screen, and means for connecting said source of modulating frequencies and said current source of a constant potential to different ones of said grids, respectively.

25. In a television system, the combination of a cathode ray image producing device and a receiver, means to deflect the cathode ray to cause the ray to impinge successively upon each elemental area of the viewing screen portion of the cathode ray device, and means operable from said receiver to control subsequent to deflection the velocity of impact of the electron stream flowing in said cathode ray tube upon the fluorescent screen thereof to produce varying intensity illumination.

26. In the art of television reception utilizing cathode ray apparatus having screen structure on which a picture is developed, the method of developing a picture on said structure which comprises deflecting the cathode ray, and subsequently varying the velocity of the electrons in the ray in accordance with the received picture signals.

27. In the art of communication by television, the method which comprises developing a cathode ray wherein the electrons forming the ray travel at relatively low velocity, producing electrical fields to deflect the ray, applying the field to deflect the ray at periods when the electrons are traveling at relatively low velocity, and increasing the velocity of the electrons to a relatively high and variable value under the influence of received signals after the electron stream has passed beyond the influence of the deflecting fields.

28. In the art of television reception wherein the cathode ray tube is used as the image reconstructing medium, the method of developing varying intensity observable effects which comprise the steps of producing and accelerating an electron stream at constant rate, deflecting the electron stream during the period of constant acceleration, and subsequently varying the velocity of the electron stream under the control of image signals.

29. In a cathode ray device, a source of electrons, a fluorescent screen for producing luminous effects upon the bombardment thereof by said electrons, an electron accelerating means normally maintained at a positive potential relative to the electron source, an electron beam positioning system located so as to be effective within a portion of the device within which the electron acceleration from the source is substantially constant, a second accelerating electrode also maintained at a positive potential relative to the source and the first accelerating means, and means for varying the potential on the second of the accelerating means relative to the first accelerating means for varying the velocity of the electron flowing within the device subsequent to the positioning of impact thereof upon the fluorescent screen as controlled by the beam positioning system so that the intensity of the luminous effects upon the screen is varied.

JOHN B. JOHNSON.