May 20, 1941. R. K. McCLINTOCK 2,243,041

TELEVISION TUBE

Filed May 7, 1938

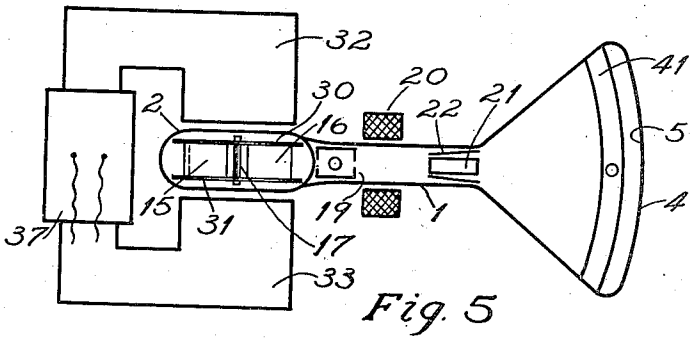


Fig. 5

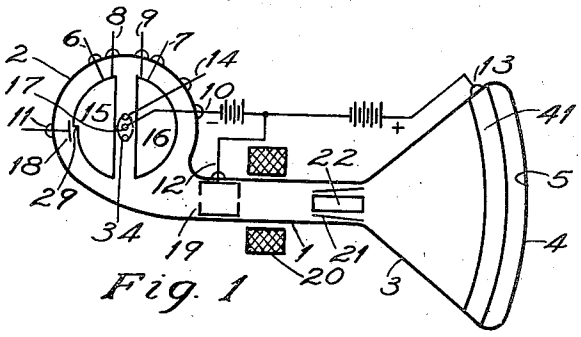


Fig. 1

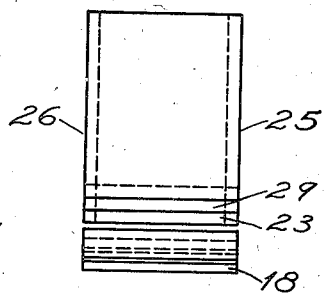


Fig. 4

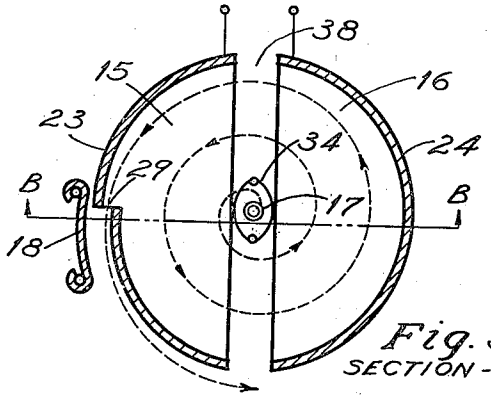


Fig. 3
SECTION - A-A

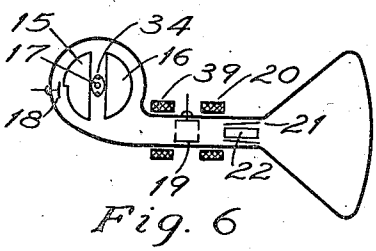


Fig. 6

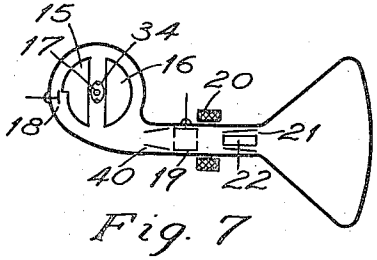


Fig. 7

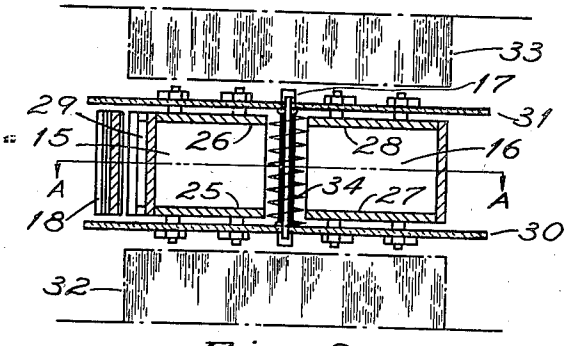


Fig. 2
SECTION - B-B

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UNITED STATES PATENT OFFICE

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TELEVISION TUBE

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3 Claims. (Cl. 250—155)

This invention relates to electron discharge tubes and more especially to such devices as cathode-ray tubes and the like.

An object of the invention is to provide an improved electron discharge tube of the type employing high speed electrons which are acted upon by signal modulations to produce corresponding electrical or electro-optical signal reproductions.

Another object is to provide an improved form of cathode-ray tube for oscillographs, for television receiving and transmitting purposes such as in "Iconoscopes," image-dissectors and the like, wherein a beam of high speed electrons is employed for electro-optical translation purposes, but without the use of the very high accelerating voltages ordinarily required for this purpose.

A further object is to provide an improved form of cathode-ray tube without the use of high accelerating voltages and thus prevent the destructive effect of positive and negative ions upon the screen and cathode of such devices.

An additional object is to provide an improved source of a beam of high speed electrons of high current density for use in projection type cathode-ray tubes and the like.

A feature of the invention relates to a cathode-ray tube that may be used in home television receivers and similar locations without the personal danger attendant upon the use of very high accelerating voltages.

Another feature relates to a cathode-ray tube for television and similar purposes employing an electron emitting member and a magnetic resonance accelerator for developing a cathode-ray beam of high speed electrons.

A further feature relates to the novel organization, arrangement and relative location and interconnection of parts which constitute an improved cathode-ray tube for television and similar purposes.

Heretofore in such devices as cathode-ray tubes for television and similar purposes, it has been customary to develop a beam of high speed electrons by employing one or more accelerating anodes disposed successively along the beam path so as to exert successively increasing accelerating fields on the electrons. It is well known in the art that certain difficulties beset the production of high speed electrons by this method. In order to achieve the necessary electron velocity high D. C. voltages are required on the accelerating electrodes.

Apart rfom the difficulty and cost of obtaining these voltages and the attendant personal danger from their use, various problems involving suitable insulation and the prevention of the destructive effect of positive and negative ions upon the cathode and fluorescent screen remain yet to be solved. In addition, the forces acting on particles of carbon and the like that may be disposed within the tube have caused considerable trouble from destructive arcing under the influence of the high voltage gradients in the ordinary cathode-ray tube. Because of these limitations, the television art has been for many years endeavoring to produce a cathode-ray tube which is not open to the above objections. Again, it is recognized in the art that beams of electrons of both high velocity and high current density are desirable, if not necessary, in the development of projection type cathode-ray tubes. Any innovation that might provide a new means of producing such a beam free from the disadvantages inherent in the present methods is obviously of considerable interest and value. In accordance with the present invention, by developing the high speed electrons in the cathode-ray beam by employing a magnetic resonance accelerator, it is possible to reduce the maximum working voltages and to simplify the tube structure with its associated auxiliary equipment in as much as the cathode-ray tube constructed in accordance with my invention does not require the usual first and second accelerating anodes.

Accordingly in the drawing,

Fig. 1 is a longitudinal plan view of a cathode-ray tube embodying features of the invention.

Fig. 2 is an enlarged cross sectional view of the ray developing unit of Fig. 1.

Fig. 3 is a cross sectional view of Fig. 2 taken along the line A—A thereof.

Fig. 4 is a detail of the electrode spacing means of Figs. 2 and 3.

Fig. 5 is a side elevation of Fig. 1.

Fig. 6 is a modification of Fig. 1.

Fig. 7 is a modification of Fig. 1.

Referring to Fig. 1 there is shown in diagrammatic form a cathode-ray tube comprising an evacuated enclosing envelope having an elongated neck 1 joining a cylindrical portion 2 to a frusto-conical portion 3, the latter being closed off by a window 4 which is provided on its inner face with a coating 5 of suitable fluorescent material. Sealed into the envelope are a plurality of lead-in and support wires 6 to 14 inclusive. Wires 6, 7 are connected respectively to the hollow metal electrodes 15, 16 of the ray developing means as will be described in detail subsequently. The ray de-

veloping means also includes a thermionic cathode or filament 17 of any type well known in the electron discharge tube art, and may consist of a tubular metal cathode sleeve coated on its exterior with electron emitting material and having on its interior, but insulated therefrom, the usual heater filament, the terminals of the filament being connected to wires 8, 9 and the cathode to 10. The ray developing means also includes a deflector electrode 18 insulatingly mounted outside the electrode 15 as will be described in detail, the said deflecting electrode being connected for example to wire 11.

Mounted adjacent to the ray developing means is a focusing diaphragm 19 of any well known construction with a lead-in wire 12 connected to this electrode to impress a suitable potential thereon. Preferably a magnetic focusing coil 20 may be used at this point in place of, or conjointly with, this focusing diaphragm. Mounted adjacent to the diaphragm or coil, or both, are the usual beam deflecting means either in the form of coordinately arranged electrostatic deflector plates or electromagnetic deflector coils or a combination of both. The ray developing means is so designed that the electrons attain substantially their final velocity before reaching the diaphragm 19 thus eliminating the usual first and second anodes ordinarily required for this purpose.

The ray developing means of Fig. 1 is shown in detail in Figs. 2 and 3, and utilizes magnetic resonance phenomena. Electrodes 15 and 16 are preferably in the form of substantially semicircular hollow metal chambers having their opposed edges in substantial circular continuity. Each electrode is formed of a curved lateral wall 23, 24 closed off by top and bottom walls 25, 26, 27, 28. The lateral wall 23 of electrode 15 has its lower half of different curvature from the remainder thereof, thereby providing a radial slit 29 in said electrode to allow the high speed electrons to emerge.

Electrodes 15, 16 are mounted so that their electrode chambers face each other and both electrodes when so mounted define a substantially circular chamber along the axis of which is mounted the cathode sleeve 17, it being understood that the cathode is conductively insulated from both electrodes 15, 16 and that these latter electrodes are insulated from each other. For this purpose circular spacers 30, 31 of a suitable insulating material, mica for example, are disposed above and below these electrodes and fastened thereto by means of side rods and mica anchors or other well known means. These insulating spacers are perforated to receive the ends of the cathode 17, thus preventing shifting thereof.

The deflector electrode 18 is insulatingly mounted outside the wall of electrode 15 near the electron exit 29. Electrode 18 is positioned so as to form a channel with the lateral wall 23 of electrode 15, deflecting the electrons of nearly maximum velocity into a larger radius of curvature as they emerge from the exit opening.

In order to cause the electrons emitted by the cathode to describe curved paths around the cathode, there are disposed on the opposite flat sides of electrodes 15, 16 a pair of magnetic pole members 32, 33 which are arranged so that member 32 is a north pole and member 33 a south pole, or a pair of electromagnetic coils so connected as to produce a magnetic field of similar direction. By this arrangement a magnetic field of uniform intensity exists transversely across each electrode and parallel to the axis of the cathode sleeve. The winding of the electromagnet is connected to a suitable source (not shown) of direct current, although if desired a permanent magnet may be employed. The electrodes 15, 16 are arranged to be alternately energized from a source of high frequency potential (not shown) which is coordinated, as to frequency, with the magnetic flux density of the ray developer unit so that the time required for an electron to leave gap 38 and return thereto is in resonance with the high frequency source.

The manner of operation of the ray developer is believed to be along the following lines; the cathode 17 having been heated to emitting temperature; the source of high frequency potential having been connected to the lead-in wires 6, 7; and the magnetizing current having been applied to winding 37. The electrons leave the cathode with an average uniform velocity and considering a given electron, the action of the transverse magnetic field by itself would constrain it to move in a circular path. Assuming that the electrode 15 is at this time at a maximum positive potential, it attracts the electron causing it to describe a curved path into the interior of electrode 15, thereafter the positive potential of electrode 15 gradually decreases and under the influence of the constantly acting magnetic field the electron will eventually return to the gap 38 between the electrodes. The time required for such an electron to enter and leave the electrode 15 is a function of the magnetic flux density which can be adjusted so that just as the electron returns into the gap 38, electrode 16 is at its maximum positive potential. Thus just as the electron is about to enter the electrode 16 it receives an accelerating force in the direction of its motion by said electrode 16, and by the conjoint action of the electrostatic and magnetic fields the electron is constrained to move in a path of greater radius. The electron therefore eventually reaches the gap 38 at the instant that electrode 15 is again at a maximum positive potential. Since the angular velocity of a charged particle in a uniform magnetic field is constant, the time of arrival of the electron at gap 38 will stay in phase with the frequency of the potential applied to electrodes 15, 16 and will experience an increase in velocity each time it crosses the gap. In other words the electron describes a spiral path of constant angular velocity, being accelerated each time it passes from one electrode to the other under the influence of the high frequency electrostatic field between the electrodes. Consequently the electrons eventually describe a path of maximum radius which is in close proximity to the curved walls of the electrodes, and at this time they are moving at or near their maximum velocity. As these high velocity electrons approach a radius equal to that of electrode 15 they emerge from this electrode through the opening 29 and are deflected into paths of greater radii by electrode 18 which is maintained at a suitable positive potential. Because of the stray field of the magnet the electrons after they emerge, may follow a path substantially perpendicular to that which they followed immediately after emergence. It will be understood, of course, that any well known manner of bending the electron beam in any desired direction after emergence, may be employed. However, as will be seen from Fig. 1 the emergent beam after leaving the ray developer, is directed along the

longitudinal axis of the cathode-ray tube. A better focusing of the electron beam emerging from the accelerator may be accomplished by electrode 19 which is provided with two small apertures e. g. one at either end. These apertures allow only the central part of the original beam to pass into the neck of the tube. The peripheral section of the beam is absorbed by the discs at either end of electrode 19, which are maintained at a potential slightly higher than the accelerator. The beam may be modulated by means of grid 34 which is mounted coaxially with the cathode 17 and insulated therefrom by means of the mica spacers 30, 31. The modulating signal may be applied between the grid 34 and the cathode 17 in the usual manner. If the ray developer is applied to a television receiving tube, velocity modulation is preferred. The modulated high velocity beam is then deflected in the desired scanning pattern over the fluorescent screen by the beam deflecting means 21, 22 in the well known manner, eventually modified in case of velocity modulation. If desired the beam may be modulated by means of a magnetic coil 39 positioned between the ray developer and the focusing diaphragm 19, as shown in Fig. 6. Coil 39 acts, in this case, as a magnetic focusing coil of variable focal length which increases or decreases the cross section of the electron beam when it enters the first aperture of electrode 19. The modulating signal is applied to coil 39. Similarly the modulating signal may be applied to a pair of electrostatic deflecting plates 40, disposed inside the envelope at the same point as coil 39 and in place of said coil. In this case the modulation is attained by allowing a larger or small part of the substantially constant cross section of the electron beam to enter the apertures of electrode 19. If desired, suitable electrostatic screening means may be provided between the electrostatic modulating plates 40 and the ray developer to prevent undesirable reaction between these elements. Any of the three methods of intensity control described above in connection with modulation, and listed below, may be used as a means for manually adjusting the average intensity of the beam, viz: (1) adjustment of the D. C. bias on grid 34; (2) adjustment of the electrostatic field between plates 40; (3) adjustment of the magnetic field of coil 39. The modulation best suited for this tube according to the invention is "velocity modulation," in which the variations in brightness at the fluorescent screen are produced by a variation in scanning speed. Removal of the electrostatic charge on the fluorescent screen is accomplished by means of a band coating 41 of suitable conducting material, for example carbon. A positive potential with respect to the cathode is applied to this band coating by means of lead-in wire 13.

If it is desired to produce a beam having electron velocities of the order of 10,000 electron volt energy for example, the magnetic flux density would be of the order of 337 gauss, and the outer or maximum radius of the electron path within the developer would be approximately 1 cm., and the resonant frequency of the potential applied to the electrodes would be 945 megacycles per second.

While certain embodiments of the invention have been disclosed, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention. Thus instead of employing a cathode-ray tube with external magnetic field for the ray developer, the magnetic means may be contained within the tube envelope. Permanent magnets would be preferable in this instance. Likewise, the ray developer might be constructed as a separate vacuum tight chamber with the electron exit sealed to the elongated neck of the cathode-ray tube. This would facilitate the application of the magnetic field and the high frequency. Again, the means for producing the high frequency may be contained in the same envelope as the cathode-ray tube along with the magnetic resonance accelerator.

What I claim is:

1. A cathode-ray tube for television and the like which employs a high speed electron beam and with relatively low accelerating voltages, said tube comprising an evacuated envelope enclosing a pair of hollow curved trough-like electrodes with their open ends facing each other but in spaced relation to define a gap, a thermionic emitting cathode mounted centrally of and symmetrically with respect to both said electrodes, a pair of insulator spacer members between which said cathode and said pair of electrodes are mounted, means to fasten said pair of electrodes to said spacers whereby the cathode and said electrodes are maintained in fixed relation thereto, a foraminous control grid surrounding said cathode for controlling the intensity of the electron stream in accordance with signals, an electrostatic focussing electrode for focussing said stream, and a fluorescent screen upon which the focussed stream is projected.

2. A cathode-ray tube according to claim 1 in which said pair of electrodes are spaced apart by a rectangular frame of insulation.

3. A cathode-ray tube according to claim 1 in which the cathode is of the indirectly heated type and extends perpendicularly to the flat walls of said pair of electrodes.

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