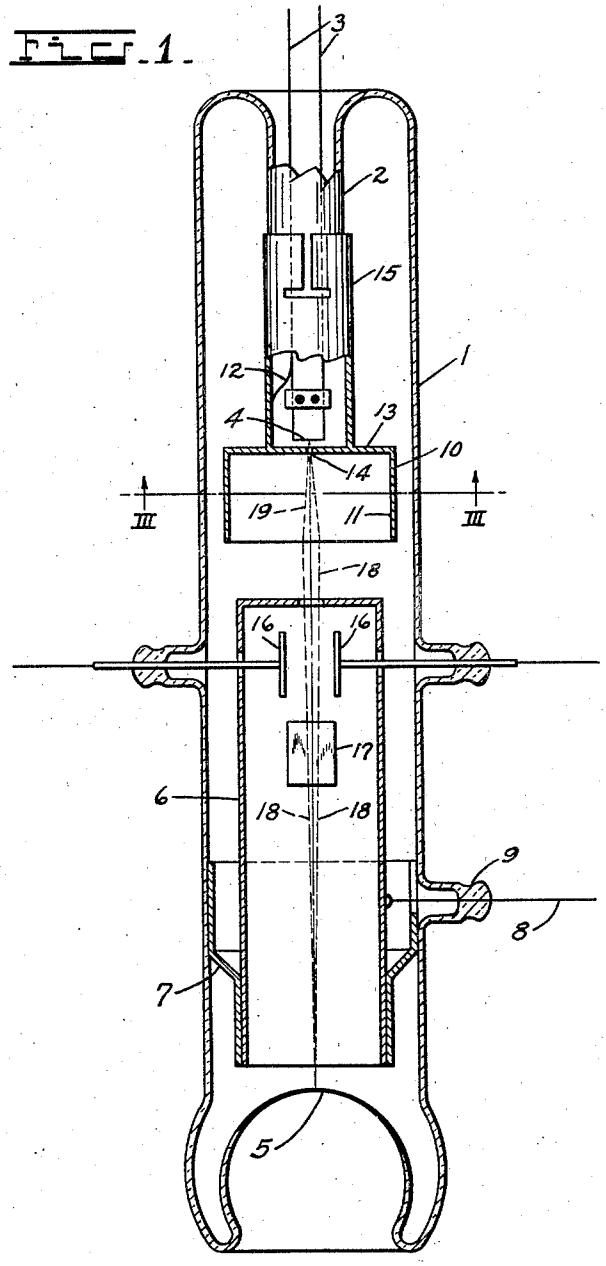
Dec. 5, 1933. C. M. SLACK 1,937,849

FOCUSING DEVICE FOR CATHODE RAYS

Filed Nov. 30, 1929

Fig. 1.



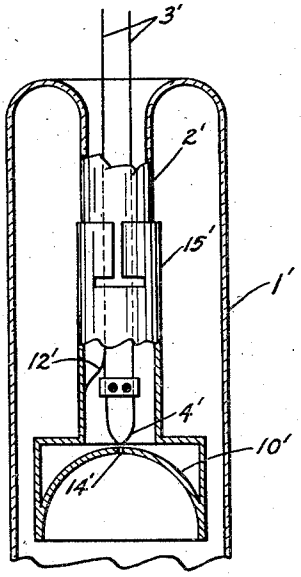
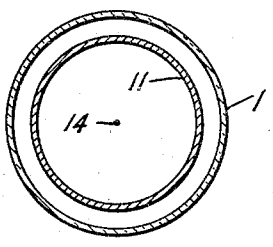


Fig. 2.

Fig. 3.



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Patented Dec. 5, 1933 1,937,849

UNITED STATES PATENT OFFICE

1,937,849

FOCUSING DEVICE FOR CATHODE RAYS

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Application November 30, 1929
Serial No. 410,686

5 Claims. (Cl. 250—27.5)

My invention relates to cathode ray tubes and more particularly to means therein for obtaining a narrow beam of rays which may be used for oscillographic, television, photographic or other purposes.

Objects of my invention are: to provide an efficient means for concentrating the electrons emitted from a cathode on a screen located a considerable distance from said cathode; to concentrate said rays on said screen so that they will produce a small, sharp and distinct image; and to provide means whereby substantially all the electrons are directed to said focal point.

In carrying my invention into effect I provide a point source of cathode rays comprising an electron emitting filament closely spaced from and in electrical connection with a focusing means which may take the form of a cylindrical, spherical, parabolic, or other desired shape, the focusing means having a minute opening along its central longitudinal axis and closely adjacent to said cathode filament.

For the purpose of illustrating the genus of my invention typical concrete embodiments are shown in the accompanying drawing, in which

Fig. 1 is a central longitudinal section of a tube constructed in accordance with my invention;

Fig. 2 is a central sectional view of a modified form of focusing device which may be used in the tube shown in Fig. 1, and

Fig. 3 is a section taken on line 3—3 of Fig. 1.

The particular embodiment of my invention shown in Fig. 1 comprises a cathode ray oscillograph tube in which 1 is an envelope either exhausted to a high vacuum or containing a rare gas at a slight pressure so that the tube will operate in the absence of appreciable gas ionization and which has a reentrant stem 2 through which lead wires 3 project and support a cathode 4 in the form of a ribbon filament. Tube 1 is provided at the opposite end from said reentrant stem with a thin glass window 5 permeable to high velocity ions and constructed in accordance with the disclosure of Patent No. 1,735,302 issued to the present applicant November 12, 1929, entitled Lenard ray tube, and assigned to the same assignee as the present invention.

A tubular anode 6 is supported in said envelope 1 by means of a constricted sleeve 7, or other suitable means, so as to dispose said tubular anode longitudinally of the envelope and between said cathode filament 4 and the thin glass window 5. The lead wire 8 fixed to said anode may project through a press knob 9 and provide a conductor between said anode and the exterior of the tube. A focusing means 10 illustrated in Fig. 1 in the form of a cup shaped member of comparatively large diameter is supported longitudinally of said tube and adjacent the cathode 4 by means of a sleeve 15. One of the cathode lead wires 3 is connected to the focusing means 10 by a conductor 12.

The cup shaped focusing means designated generally as 10 comprises a cylindrical tube 11 and an end closure disc 13 which has a minute opening 14 along the central longitudinal axis of the focusing means.

The diameter of the cylinder 11 is made relatively large, for example, a tube 11 operating at from 50,000 to 70,000 volts and having a diameter of 4 cm. or more is used for focusing a beam through a window 5 which is separated a distance of about 25 cm. from the opening 14. The diameter of the focusing cup 10 for focusing a beam 18 to an object 25 cm. away is made approximately one and fifty-three one hundredth times the depth of the cup. The opening 14 is made forty mils in diameter. With this construction a spot of from one to two mm. in diameter and currents of 25 microamperes are obtainable.

In general the diameter of the focusing cup should be as large as the tube will permit, as the larger the cylinder the finer the spot which may be obtained. The diameter of opening 14 should be from 3 to 60 mils. The size of the spot is approximately proportional to the size of the opening 14.

I provide a point source of cathode rays by disposing the cathode filament 4 very close to the opening 14 in the closure plate or disc 13. With the focusing means 10 in electrical connection with the cathode 4 the electrons emerging from the opening are in an electrical field which is normal to the surface of the disc 13. They travel in straight lines save for their mutual repulsion which tends to cause them to diverge slightly as shown at 19. Cylinder 11 is at the same potential as cathode 4 and causes the electrons to converge as shown by the dotted lines 18 and strike the window 5 or other desired body such as a screen or film located at a point 25 cm. or more from the cathode to form a spot of suitable size for oscillographic or other purposes.

The screen or film may be disposed either inside or outside the envelope or made a part thereof. With this arrangement all of the current through the tube will be utilized. The generating outfit can have a current capacity of microamperes in-

stead of one of a few milliamperes usually obtained. The capacity of the condensers employed to maintain constant voltage can thus be reduced a thousand fold.

Two pair of plates 16 and 17 are disposed within the tube with their surfaces parallel to and equidistant from the beam of cathode rays, the surfaces of plates 16 being at right angles to the surfaces of plates 17. The function of these plates for deflecting the beam of cathode rays in accordance with the wave form of the applied voltage or current is well understood in the art.

The embodiment illustrated in Fig. 2 comprises an envelope 1', a reenterant stem 2', leading in wires 3', a wedge-shaped ribbon filament 4' which serves as a cathode, a forcusing cup 10' in the form of a semispherical metal reflector having a minute opening 14' along its central longitudinal axis and connected through a reduced sleeve 15' and wire 12' to one of the cathode leading-in wires 3'. This construction is arranged and functions similar to that shown in Fig. 1.

The cathode filament 4' is made in wedge form to bring the same into very close proximity to the opening 14' in order to increase the electron emission through said opening. The focusing device 10' has a diameter approximately one and fifty-three one hundredth times its length to focus the beams on a spot twenty-five centimeters or more from the cathode 4'.

The diameter of the focusing device 10' is made as large as the tube will permit in order to obtain a fine spot on a film or screen placed adjacent the opposite end of envelope 1 in the same manner as that described relative to Fig. 1. The minute opening 14' is of the same order as that of the opening 14 in Fig. 1 and in conjunction cathode 4' forms a point source of cathode rays. Focusing device 10' being at the same potential as cathode 4' causes the electrons to travel in converging paths to the screen, film or other described point as shown by the dotted lines 18 of Fig. 1.

In accordance with the provisions of the patent statues, I have described the principle of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electron discharge device operable in the absence of appreciable gas ionization to produce a narrow beam of electrons comprising an envelope containing an anode, electron emitting cathode, means electrically connected to said cathode and located between said anode and said cathode, said means having an opening for limiting the size of the electron stream emerging through said means and a focusing means adapted to be maintained at approximately the same potential as said cathode, said focusing means having a diameter approximately one and a half times its length.

2. An electron discharge device operable in the absence of appreciable gas ionization to produce a narrow beam of cathode rays comprising an envelope containing an apertured anode, an electron emitting cathode, means to obtain a point source of electrons, said means being located between said electron emitting cathode and said anode and a focusing means adjacent said means to obtain a point source of electrons, said focusing means having a diameter approximately one and a half times its length and being electrically connected to the cathode.

3. A Lenard ray tube operable in the absence of appreciable gas ionization to project rays into the atmosphere comprising an envelope, a source of electrons therein, an anode having an aperture therethrough, a disc disposed adjacent to said source of electrons and having a minute opening in alignment with said aperture through which opening electrons may emerge and focusing means adjacent said disc for causing said electrons to concentrate at a predetermined point, said disc and focusing means being electrically connected to said cathode, said focusing means having a diameter approximately one and a half times its length.

4. A Lenard ray tube comprising an evelope, a source of electrons therein, a window in said envelope transparent to cathode rays, an anode for projecting a stream of high velocity electrons against said window, means to obtain a relatively small beam of electrons from said source, said means being electrically connected to said cathode and located between said source of electrons and said anode and means adjacent said first mentioned means to focus the small beam of electrons to a point adjacent said window, said focusing means being electrically connected to said source of electrons and comprising a tubular shaped conductor having a diameter approximately one and a half times its length.

5. A Lenard ray tube comprising an envelope, an electron emitting cathode extending from one end thereof, a window permeable to high velocity electrons at the opposite end of said envelope, an anode for directing electrons upon said window at a sufficiently high rate of speed to pass through the window, a disc having a minute opening therethrough and disposed adjacent said cathode and between said anode and cathode and means integral with said disc for focusing the electrons emitted by said cathode through said opening therein to a point adjacent said window, said focusing means being a tubular electrically conductive member having a diameter approximately one and a half times its length, said disc and focusing means being electrically connected to said cathode.

CHARLES M. SLACK.