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ELECTRON TUBE

Filed Sept. 17, 1932

Fig. 1

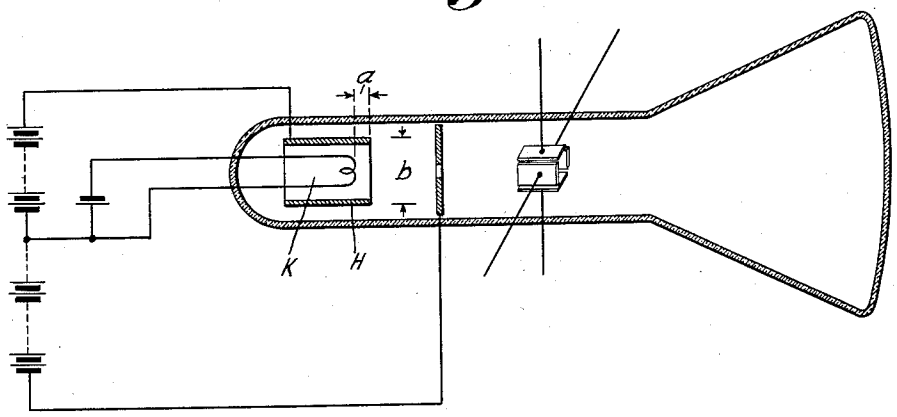
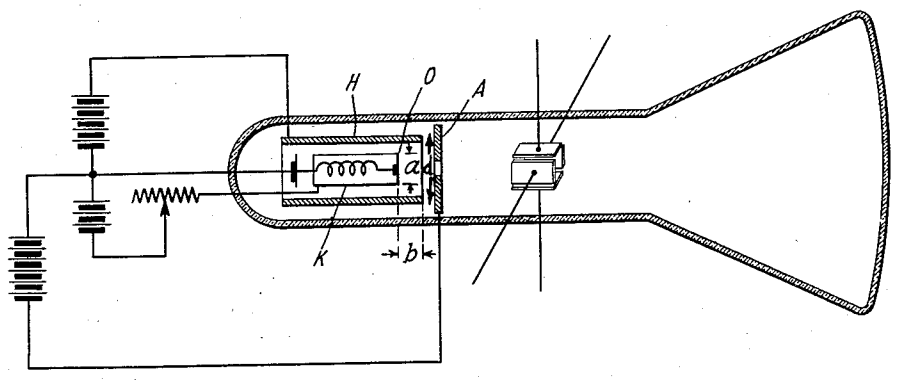


Fig. 2



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ELECTRON TUBE

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Application September 17, 1932, Serial No. 633,556
In Germany November 30, 1931

2 Claims. (Cl. 250—27.5)

The present invention relates to an arrangement for producing concentrated pencil of electron rays within an electron tube, and more particularly, in a Braun or cathode ray tube.

More specifically, the invention relates to the construction of electrodes, particularly for use in cathode ray or Braun tubes by which a concentration of the electron ray is obtained which is as sharp as possible. It is known that the concentrating action of a gas under suitable pressure in the discharge tube can be enhanced considerably by means of separate negatively biased concentrating electrodes. Such an electrode is for instance a cylinder including the electron source, as has been suggested by Wehnelt. It has also been suggested to provide between the source of electrons and the anode having the shape of a shutter, a flat or curved electrode with an opening enabling the reaction of the anode potential upon the cathode.

It has been found that with the application of such concentration electrodes an optimum effect of the electrode potentials upon the sharpness of the ray is secured if the distance of the source of electrons from the opening edge of the concentration electrode arranged in front of the anode is approximately half the diameter of the opening as explained in copending application of the applicant Michelssen, Serial No. 627,927, filed August 8, 1932.

This rule is practically applicable in particular when considering the source of electrons as being approximately point like in regard to its effect upon the course of the lines of force within the cylinder. This assumption may in some cases be practically approached, as in the case of directly heated electron sources. In most cases, however, this assumption does not practically hold true, particularly for instance when indirectly heated oxide cathodes are used. It has been found that in order to attain an optimum effect of concentration of the cathode rays a further requirement must be fulfilled whereby the special extension of the body of the cathode is considered. Such an arrangement forms the subject matter of the present invention.

The invention is illustrated by the accompanying drawing, wherein:

Fig. 1 shows one arrangement of electrodes; and Fig. 2 shows a preferred form according to the present invention.

Referring now to the drawing, and first to Fig. 1, the cathode K, for example, is surrounded by the enclosure electrode H. The anode electrode is designated as A. The distance a of the cathode from the opening edge of the Wehnelt cylinder H facing the anode A must be less than half the diameter of the cylinder b, as is shown by the expression

$$a < \frac{b}{2}.$$

The invention is further explained with reference to Fig. 2. A negatively biased enclosure electrode H, which is the Wehnelt cylinder, is shown again. Inside of this cylinder or electrode H is arranged an indirectly heated cathode K. The heating of the cathode body K can, for instance, be effected by heat conduction, heat radiation, or by electron bombardment. The anode having the shape or a shutter is again arranged in front of the anode of the cylinder H of which the diameter may be designated as d. While it is easily possible to form the actual emitting material, for instance, the oxide spot O, upon the cathode with point like dimensions, the metallic surface upon which the emitting oxide point is arranged and which simultaneously acts as an equi-potential cathode, has still a cross section having a certain surface extension. This potential surface produces within the Wehnelt cylinder a change in the course of the lines of force, as compared with a potential point. In place of the Wehnelt cylinder H a surface like, even, or curved concentration electrode may be disposed between the cathode and the anode.

If now, in spite of the surface like cross section of the cathode, a sharp electron ray should be obtained by the concentrating action of the concentration electrode it is necessary according to the present invention that the distance b of the emitting point from the edge of the concentration electrode disposed in front of the anode is greater than the dimension obtained from the square root of the surface area of the cross section of the cathode body. So designed, the relationship between the various dimensions may be expressed as follows:—The distance of the emitting points from the edge of the Wehnelt cylinder is less than half the diameter of the Wehnelt cylinder but greater than the dimensions obtained from the square root of the surface area of the cross-section of the emitter. Mathematically expressed, this is

$$\frac{d}{2} > b > \sqrt{\frac{\pi a^2}{4}}.$$

If, for instance, the concentration electrode has an opening or the Wehnelt cylinder has a diameter of 11 mm. and the cylindrical cathode body has a diameter of 3 mm., for example, tests have

shown that, by the mentioned dimensions, the optimum dimension for the distance *b* is about 5 mm. Smaller distances increase the requirement of the negative biasing potential of the cylinder in order to attain the most favorable concentration. For larger distances the course of the lines of force becomes unfavorable to such an extent that a formation of a sharp ray is no longer possible.

For cylindrical cathode bodies the invention may also be defined in that the distance *b* must be greater than the diameter of the cathode body at right angle to its axis.

Having now described our invention, we claim and desire to secure by Letters Patent the following:

1. A cathode ray tube having means to produce a concentrated electron ray pencil comprising an envelope including a source of cathode rays, an anode electrode, a concentrating electrode surrounding the source of cathode rays and protruding beyond the source in the direction of the anode, said concentrating electrode member having its edge portion nearest the anode protruding beyond the source of cathode rays for a distance which is greater than the dimension obtained from the square root of the surface area of the cross-section of the cathode source taken at right angles to its axis and less than half the aperture diameter of said concentrating electrode.

2. A cathode ray tube having means to produce a concentrating electron ray pencil comprising an envelope including a cylindrical source of cathode rays having an emitting surface coating at one end thereof, an anode electrode, a tubular concentrating electrode surrounding the source and protruding beyond the source in the direction of the anode, said concentrating electrode protruding beyond the source of the cathode rays for a distance such that its edge portion nearest the anode is spaced a greater distance from the source than the diameter of the source and less than half the aperture diameter of said concentrating electrode.

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