July 5, 1938. K. SCHLESINGER 2,123,160

BRAUN TUBE FOR TELEVISION PURPOSES

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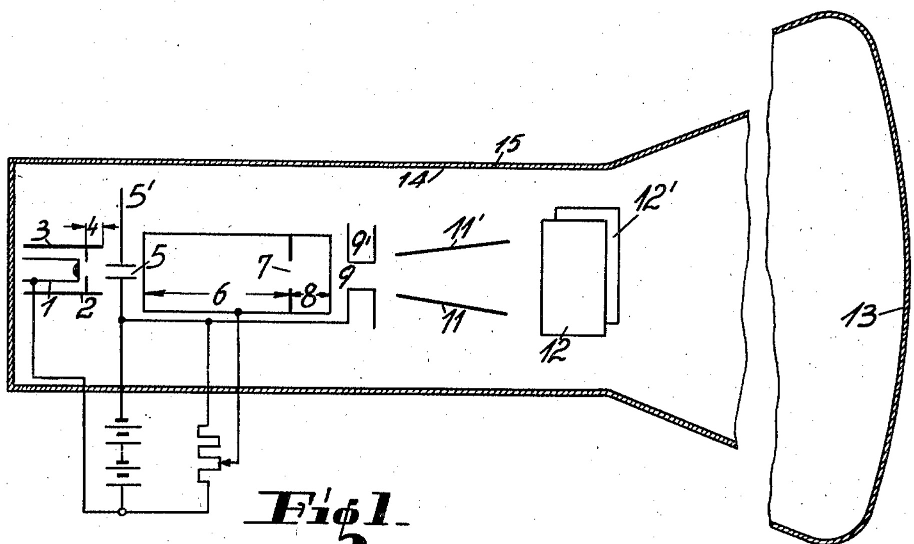

Fig. 1.

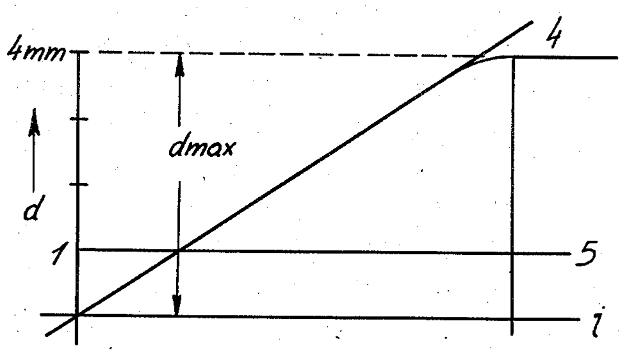

Fig. 2.

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BRAUN TUBE FOR TELEVISION PURPOSES

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7 Claims. (Cl. 250—27.5)

In the elder applications Ser. No. 663,593, filed March 30, 1933, 730,111, filed June 11, 1934, and 756,126, filed December 5, 1934, Braun tubes for television purposes are described and claimed which are provided with an electrostatical electron-optical system producing on the picture receiving screen a sharp image of an electron emissive surface (i. e. of cathode or of the opening of an intermediate diaphragm acting as a cathode) for the purpose of producing sharp image points of small size, the shape and size of which remain constant upon the modulation of the ray intensity.

The present invention relates to Braun tubes of the same type and has for its object to provide a Braun tube which allows of producing very bright image points or image points of very small size, for example of image points having a greatest extension of, say, 0.1 mm.

Further objects of the invention will be seen from the following description.

The invention will be more fully understood with reference to the appended drawings whereof

Fig. 1 shows diagrammatically one embodiment of a Braun tube according to the invention, while

Fig. 2 shows a curve illustrating the dependency of the diameter of the image point of the intensity of the ray.

It must be pointed out that the numerical statements included in the specification are also quoted by way of example, and that the invention is in no way limited to a tube of these dimensions, as well it must be understood said changes in the tube structure are possible with out a departure from the spirit and scope of the invention.

In Fig. 1, an emissive surface 1 of approximately ½ mm. in diameter is arranged at a very short distance behind a control grid 2, and the whole inserted into a cylinder 3, so that the control plate 2 is spaced from the opening of the cylinder 3 for about 3 mm. The cathode ray is concentrated upon the aperture 5 of .5 mm. diameter of a diaphragm 5′, which has a potential of, say, 2000 volts impressed thereon. In front of 5 there is arranged a tubular member 6, which is for example 40 mm. in length and is closed by a wide diaphragm 7 of 7 mm. diameter, furnished with an extension 8, and situated opposite to a main anode 9 having a diaphragm aperture amounting to 7 mm. The anode 9 and diaphragm 5′ may be raised to the same potential. The bias of the tubular member 6 is preferably regulated from the outside with the assistance of a potentiometer 10. Behind the anode 9, which is preferably constructed as tubular member 9′ having a diameter of aperture of 7 mm. and a length of 7 mm., for the purpose of avoiding reactional effects, and is provided with at least one large surface holding plate, there may be provided in sufficiently wide spacing two pairs of deflecting plates 11, 11′ and 12, 12′, whilst the cathode rays impinge against the luminous screen at 13. At the inner surface of the envelope 15 a coating 14 of the tube wall adapted to be grounded is provided adjacent the deflecting plates system and the part of the electron lens facing the deflecting plates system.

Several applications of the applicant, for example the applications Ser. No. 725/35 filed January 7, 1935 and 8660/35, filed February 28, 1935, relate to the convenient embodiment of the diaphragm 5′, the lens 7, 8, 9 and the anode 10, and to the relative spacing between anode and plates, etc.

If there is actuated the light-control element 2 in a high-vacuum tube of this nature, the following phenomenon is observed: The darker the image point is adjusted, i. e. the more the intensity of the cathode ray is decreased, the more the image point is concentrated. This effect is due to the fact that upon the space charge control of the cathode the emissive surface recedes more and more from the edge towards the centre in the same degree as the potential surface S=O (S being the potential relative to the cathode) departs from the cathode surface. The cross-section of the bundle of rays is accordingly reduced to the same extent. If now the opening of the diaphragm is so dimensioned that its diameter is equal to the diameter of the cathode ray of maximum intensity, the aperture of the diaphragm will, therefore, not be wholly filled out by the ray when the ray intensity is decreased, i. e., the actual thickness of the ray in the plane of said aperture will be smaller than the diameter of the diaphragm itself.

In Fig. 2 the conditions are illustrated graphically. As ordinate there is entered the thickness of the image point d on the screen, and as abscissa the emissive current i. The dependency is practically linear up to the maximum intensity values, which are reached at the point 14. From there the diameter of the spot of light at the screen does not additionally increase, as the diameter of the diaphragm is equal to the diameter of the cathode ray. The maximum value is calculated in simple fashion and completely independently of the nature of the optical reproduction as performed in practice, as in the optical art from the distance of object and image, viz,

$$d_{max} = d_{B1} \cdot \frac{b}{T}.$$

In the above d_{B1} is the diameter of the diaphragm, b the spacing of the anode 9 from the screen 13, and T the length G of the tubular member 6.

According to the invention, these spacings are so selected that the thickness d_{max} of the point at the luminous screen in the case of maximum ray intensity would be greater than permissible for good reproduction of the image. For example, for an image 200 mm. in height, which is scanned by 200 lines, the maximum permissible size of image point amounts to approximately 1–1.5 mm., with which size of spot the lines follow exactly one upon the other without intermediate spacing. With a diaphragm of .5 mm. the optical spacing ratio should accordingly be selected as 2:1, i. e., comparatively long tubular members 6 would require to be selected if it were desired to operate in a high vacuum. According to the invention, however, the enlargement ratio is chosen much greater, for example approximately as 1:10. The brightest image point is then in the case of high vacuum 5 mm. thick. Merely an image point is permissible as shown in Fig. 2 by the ordinate according to the line A—B. Now it has been found by experiment that by the introduction of very minute traces of inert gas or inert vapours, for example of helium, argon or mercury of 10^{-5}–$5 \cdot 10^{-6}$ mm. pressure, it may be accomplished that above a certain intensity of the emissive current the optical reproduction no longer obeys the law governing lenses and the spot of light is not additionally increased, but remains sharp. The longer the tubular member has been made in relation to the distance of the lens from the screen, the later, i. e., upon all the greater intensities of current, is the effect of the additional gas concentration required, and all the longer will be high-vacuum reproduction satisfy the claims on quality of image, i. e., the smaller is the pressure of the residual gas which requires to be selected.

With an under-dimensioning of the length of tube in this fashion in accordance with the invention it is possible despite deviation from the law of reproduction to produce and maintain sharp points, although the free length of ray is very large. There is thus obtained the advantage of great deflection sensitivity, if the deflecting means are arranged in the vicinity of the electro-optical system. Since on account of the large distance from the screen at which the deflecting plates 11, 12 may be disposed merely small angles of deflection are required for the purpose of producing an image of a given size, the deflecting potential may be provided in the simple and known manner in single-pole fashion between earth and relaxation generator, and reverse phase operation must not necessarily be employed. Further, it is possible, since there is still a large amount of space between anode and luminous screen, to dispose the plates to such extent apart that they no longer interfere with each other, and that, therefore, the known marginal field errors, such for example as the known trapezoidal distortion, are avoided. The latter is the case when the spacing between the sets of plates is equal to or greater than twice the distance between the plates.

Despite these advantages tubes of this nature do not possess the known disadvantages of gas-filled tubes, or only to slight extent. Owing to the abnormally low gas pressures which are required as compared with gas-filled tubes of the known kind, the question of durability is particularly favourable. Further, the ion cross appears only in the case of extreme brightness, and even then only weakly, so that generally speaking the use of systems for pre-deflecting the ray is unnecessary. Nevertheless it is naturally possible structurally to combine systems of this nature, such for example as the three-plate system, which the applicant has described in the application Ser. No. 694,915, filed October 23, 1933, as deflecting elements with the arrangement according to the present invention.

Summarizing, the construction according to the invention accordingly represents a combination of the high-vacuum and the gas-filled type of tube, which obeys in the small current intensity values the laws of high-vacuum focussing, and in the high current intensity values the laws of gas concentration, having the advantages of a greater sharpness in the black in common with the high-vacuum tube and the advantage of ready and sensitive and also greater free length of ray in common with the gas-filled type, but avoiding or possessing only to slight extent the disadvantages of the gas tubes, viz., short durability and ion cross error.

It is obvious that with equal optical spacing of a high-vacuum tube and a tube of this kind according to the invention the aperture of the diaphragm and accordingly also the thickness of the bundle of rays, the size of the cathode spot and accordingly the energy of the ray may be selected, with equal anode potential, to be several times greater as compared with a corresponding high-vacuum tube, as in the case of the residual gas tube there is a fundamental protection against the attainment of an inadmissibly thick image point. There may accordingly be adjusted a brighter white with the latter tube under conditions and with dimensions which are otherwise the same.

I claim:

1. In a television cathode ray tube comprising means for producing a beam of cathode rays, means for controlling the intensity of the beam of cathode rays, and an image screen, the combination of an electron lens adapted to focus, in the absence of a gas-filling, said beam onto said image screen to produce an image point on a scale of optical reproduction by which a larger size of image point is obtained than is desired, with a gas-filling having a pressure of $5 \cdot 10^{-6}$–10^{-5} mm. mercury which is lower than that necessary for concentrating the beam of cathode ray at every occurring intensity of the beam.

2. In a television cathode ray tube comprising means for producing a beam of cathode rays, means for controlling the intensity of the beam of cathode rays, and an image screen, the combination of an electron lens adapted to focus, in the absence of a gas-filling, said beam onto said image screen to produce an image point on a scale of optical reproduction by which a larger size of image point is obtained than is desired, with a gas-filling of $5 \cdot 10^{-6}$–10^{-5} mm. mercury pressure adapted to concentrate the beam of cathode ray only if the intensity of the beam is at least equal to that producing on said image screen a medium light intensity.

3. In a television cathode ray tube comprising a diaphragm having an aperture, means for producing a beam of cathode rays for lighting said

aperture, means for controlling the intensity of the beam of cathode rays, and an image screen, the combination of an electron lens adapted to electron-optically reproduce, in the absence of a gas-filling, said aperture onto said image screen on a scale of optical reproduction by which a larger size of image point is obtained than is desired, with a gas-filling having a pressure of $5 \cdot 10^{-6}$–10^{-5} mm. mercury which is lower than that necessary for concentrating the beam of cathode rays at every occurring intensity of the beam.

4. A cathode ray tube comprising the combination as claimed in claim 1, and wherein at least one deflecting plates system is provided for causing the beam of cathode rays to scan an area on the image screen, said deflecting plates system being adapted to be operated with the maximum permissible deflecting sensitivity and mounted at a distance from said screen to give the desired scanned area thereon.

5. A Braun tube comprising the combination as claimed in claim 1, and wherein at least one deflecting plates system is provided for causing the beam of cathode rays to scan an area on the image screen, said deflecting plates system being mounted in axial consecution to the electron lens, and wherein a coating of the tube wall adapted to be grounded is provided adjacent the deflecting plates system and the part of the electron lens facing the deflecting plates system.

6. A Braun tube for television purposes comprising an evacuated envelope enclosing means including a cathode for producing a cathode ray, a concentrating and control electrode mounted in front of said cathode for concentrating said cathode ray and controlling the space charge near said cathode, so that the intensity of said cathode ray is controlled, a diaphragm having an opening mounted in front of said concentrating and control electrode, the diameter of said opening being equal to the diameter of said cathode ray in the plane of said opening when having its maximum intensity, an electron-optical system mounted in front of said diaphragm, said electron-optical system comprising a metallic cylinder having an apertured plate inserted therein at a distance of about one half of the diameter of said cylinder from the end of said cylinder remote from the cathode and a plate-shaped member having an aperture and opposed to said cylinder at the side thereof remote from said cathode, a picture receiving screen and deflecting means mounted between said electron-optical system and said screen.

7. A Braun tube for television purposes comprising an evacuated envelope enclosing means including a cathode for producing a cathode ray, a concentrating and control electrode mounted in front of said cathode for concentrating said cathode ray and controlling the space charge near said cathode, so that the intensity of said cathode ray is controlled, a diaphragm having an opening mounted in front of said concentrating and control electrode, the diameter of said opening being equal to the diameter of said cathode ray in the plane of said opening when having its maximum intensity, an electron-optical system mounted in front of said diaphragm, said electron-optical system comprising a metallic cylinder having an apertured plate inserted therein at a distance of about one half of the diameter of said cylinder from the end of said cylinder remote from the cathode and a cylindrical element connected to and supported by at least one large-surface plate mounted near the edge of said cylinder remote from said cathode.

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