Aug. 26, 1952 J. DE GIER 2,608,666

BRAUN TUBE FOR USE IN TELEVISION

Filed Dec. 17, 1949

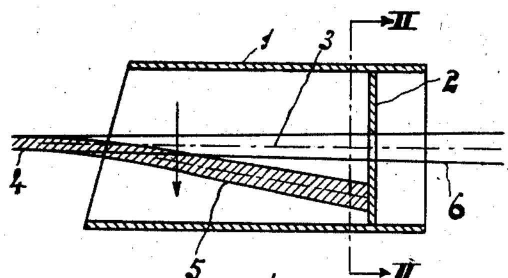


Fig. 1

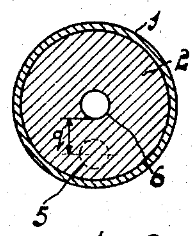


Fig. 2

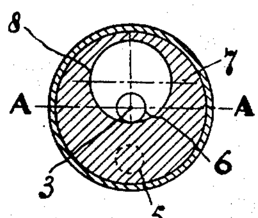


Fig. 3

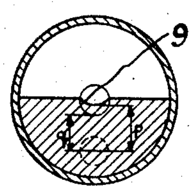


Fig. 4

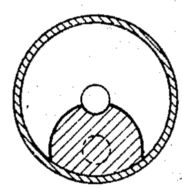

Fig. 5

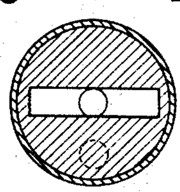

Fig. 6

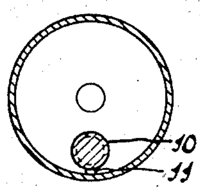


Fig. 7

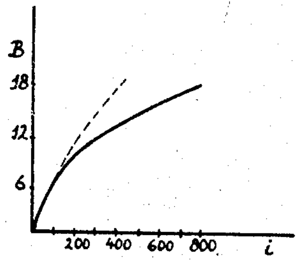


Fig. 8

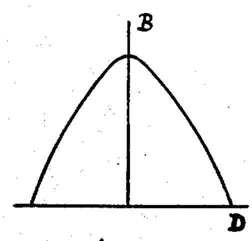


Fig. 9

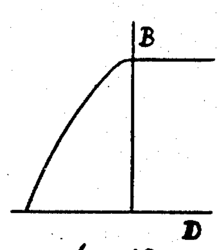


Fig. 10

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# UNITED STATES PATENT OFFICE

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## BRAUN TUBE FOR USE IN TELEVISION

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3 Claims. (Cl. 313—86)

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This invention relates to Braun tubes for use in television receivers.

In such tubes, in order to avoid a so-called "ion burn" of the image screen, use is frequently made of a device operative to remove from the electron beam the negative ions which, together with electrons, are emitted by the cathode of the tube, or which are produced in the discharge space.

Said device may comprise a cylindrical electrode through which the electron beam passes and which collects a beam of negative ions separated from the electron beam by deflection. This electrode, which may be referred to as a negative ion collector, has a transverse wall (collecting plate) which is provided with an aperture to allow the passage of electrons. The cylindrical part of the ion collector may be a metal body arranged in the tube and is not necessarily of circular cross-section; as an alternative, it may be constituted by a conductive coating or a metal part of the tube wall.

The invention relates to Braun tubes for television reception comprising a negative ion collector, in which tubes the negative ions are deflected from their original path and are brought outside the electron beam.

Braun tubes for use in television receivers are known, which comprise an ion collector, in which the ion beam retains its original direction and the electrons are deflected from this direction by a magnetic field. Such a tube is described, for example, in British patent specification No. 538,684. According to said specification, the collecting plate of an ion collector is arranged at or near a point at which the cross-sectional area of the electron beam exhibits a minimum value; the small aperture in the collecting plate is projected by an electron-optical lens onto the image screen. The present invention does not relate to such tubes but concerns only tubes in which the collecting plate lies within the object distance from the projecting lens, such, for example, as the tubes to which Figs. 16 and 17 on pages 375 and 376 of "Reviews of Modern Physics," vol. 18, No. 3, of July 1946 refer.

The plane passing through the axes of the ion collector and the deflected ion beam will be referred to as the meridian plane, the plane passing through the axis of the ion collector at right

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angles to the meridian plane will be referred to as the equatorial plane.

With all the known tubes of this kind, the aperture in the ion collector for passage of the electron beam is circular and concentric with the axis of the ion collector.

According to the invention, a Braun tube for use in television receivers comprising a negative ion collector for intercepting a beam of negative ions which is deflected and thus separated from the electron beam, the collector being constituted by a cylindrical electrode comprising a collecting plate, which plate is not located at or near a point at which the cross-sectional area of the electron beam exhibits a minimum value, is characterized in that the aperture in the collecting plate for passage of the electrons is not both circular and concentric with the cylindrical electrode. If the aperture is asymmetrical with respect to the equatorial plane, the plane figure it forms has its centre of gravity on that side of the equatorial plane opposite that on which the deflected negative ion beam is located. In this case the aperture may be circular. However, as an alternative, the aperture may be symmetrical with respect to the equatorial plane, but in this case it is not circular. Naturally, the aperture must not allow passage of the negative ion beam to be intercepted.

In order that the invention may be more clearly understood and readily carried into effect, it will now be described more fully with reference to the accompanying drawing, in which:

Fig. 1 is an axial sectional view taken on the meridian plane of an ion collector of known construction which collects a beam of negative ions deflected from its initial direction, and

Fig. 2 is a cross-sectional view of the same body taken on the plane II—II;

Figs. 3 to 7 are cross-sectional views, similar to that of Fig. 2, of ion collectors for use in a Braun tube according to the invention.

Figs. 8, 9 and 10 are graphs the meaning of which will be apparent from the description.

Referring now to Fig. 1, a negative ion collector comprises a right circular cylindrical part 1 and a diaphragm 2 which constitutes the collecting plate. The end plane at the left-hand end of cylinder 1 is at an angle with the axis 3 of the cylinder. At this end, at which the beam 4 constituted by electrons and negative ions enters the cylinder, is produced an electric field which, in the region associated with the beam, has a constant component at right angles to the axis 3, parallel to the plane of the figure. The shaded beam 5 of negative ions is deflected by this field in the direction of the arrow and strikes the collecting plate, or the inner wall of the cylinder 1 and the collecting plate. The axis of the deflected beam 5 and that of the collecting plate 2 lie in the plane of the figure.

The deflecting effect of said electric field on the electron beam is neutralized by constant magnetic forces acting at right angles to the meridian plane. It is not of importance whether these magnetic forces act upon the electron beam over the same part of the path of the electron beam as the electric deflecting field or not as long as the axis of the electron beam 6 emerging from the negative ion collector coincides with the axis 3 of the cylinder 1.

Fig. 2 shows the circular aperture in the diaphragm 2. The radius of this aperture determines the diameter of the electron beam 6 allowed to pass. The aperture must be so small as to lie without the region in which the ions have an appreciable density. The region within which the beam 5 of negative ions strikes the collector is indicated by a broken line.

The negative ion collector also collects electrons since the electron beam passing through the collector is not sharply defined. In a radial direction reckoned from the axis 3, the electron density gradually diminishes. However, since the decrease in density is materially smaller close to the axis than that with increase in distance therefrom, a core of great density may be distinguished within a marginal halo of less intensity. The electrons in said halo, which nevertheless constitute a material percentage of the electron current, are in part intercepted by the diaphragm 2. This percentage increases with increase in electron current.

The invention has for its object to reduce the loss in electron current, so as to ensure a greater contrast between the darker and lighter parts of the image projected onto the screen.

Referring now to Fig. 3 the diaphragm 7 of a negative ion collector has a circular aperture 8, the centre of which does not lie on the axis 3, being on the side of the equatorial plane A—A opposite to that towards which the ion beam 5 is deflected. In order to enable comparison with a tube of known construction which is otherwise identical, the minimum spacing between the axis of the cylinder and the edge of the aperture 8 in Fig. 3 is chosen to be equal to the radius of the aperture in the diaphragm 2 in Fig. 2, the diameter of cylinder 1 being equal, or in other words, the aperture 8 in Fig. 3 is larger than that in Fig. 2. Thus, the aperture 8 allows not only the passage of a beam identical to that allowed to pass with the construction shown in Fig. 2 but also of marginal electrons, which in the known tubes are collected by the negative ion collector. It is found that an appreciable improvement is ensured, if the aperture 8 has a surface area equal to 1.25 times that of the beam 6 (Fig. 2). This corresponds approximately to an eccentricity of 10%. It will now be obvious why the invention does not relate to tubes in which the aperture in the diaphragm is projected onto the screen, since in this case the image spot would also be increased, or at least exhibit a lack of definition.

The aperture is not necessarily circular. It may extend as far as the cylinder wall. This results in constructions of which Figs. 4 and 5 are examples.

Referring now to Fig. 8, the full line curve illustrates the relationship between the brightness B, measured in mK./cm.$^2$, of the image spot in a tube having a circular central aperture and the current strength $i$ in $\mu$ amps absorbed by the tube. The broken line curve illustrates the corresponding relationship for a tube comprising a diaphragm as shown in Fig. 4. It will be seen that the effect of the increase in size of the aperture in the diaphragm increases with increase in strength of the current. A collecting plate as shown in Fig. 2 cuts off a greater part of the electron beam producing the brighter parts of the image projected onto a fluorescent screen of a tube than of the less bright parts, since the core of the electron beam increases in size as the current strength increases. The part of the electron beam intercepted by the collecting plate may amount to as much as 35% of the total for the brighter parts. Consequently, the brighter parts of the image are less bright than they should be. The use of the invention, as is shown in Fig. 8, ensures an increase in brightness in the brighter parts and thus an increase in contrast. The maximum intercepted part of the electron current can be reduced to 10%.

Since less electrons are intercepted by the collector in a tube according to the invention the further advantage is obtained that with a given total current strength a smaller amount of heat is developed in the collector. This reduces the risk of the deterioration of the vacuum due to the release of gases from heated metal parts.

Centring the electron beam is facilitated with the tube according to the invention. This operation is required with television apparatus, for example, operative for the first time. The operation is carried out by adjusting the magnetic fields required to neutralize the deflective effect of the electric field on the electron beam. With a central, circular aperture in the diaphragm, it is not easy to determine whether the centre of the electron beam coincides with the centre of the aperture in the diaphragm, since the centre of the beam cannot be observed so long as it lies on the collecting plate. Even, when the the centre of the beam is seen to appear, adjustment must be carried out most cautiously so as to prevent overadjustment, the beam passing the aperture.

If the aperture is as shown in Fig. 4, the centring operation may be carried out as follows: With the beam stationary, an unfocused light spot is caused to appear on the image screen. The brightest part of the spot is at its centre, but it has a large surface area and its boundaries are not sharply defined. In addition, since the object plane of the electron lens is nearer the collecting plate than with a focused beam, an undefined reproduction of the edge of the collecting plate is observed. In these circumstances, the light spot may readily be caused to appear from behind the collecting plate and be shifted to the centre of the edge of the collecting plate, that is to say to the point of this edge which is nearest the axis 3. The latter movement is facilitated if this centre is marked by an elevation or (as shown in Figs. 4 and 5) by a recess.

The increase in size of the aperture is also convenient if the electron beam is caused to describe a raster on the screen, as often occurs in the case of subsequent re-adjustment of a tube. With a circular, central aperture, the brightness of the raster, during the movement of the beam over the aperture, initially increases and immediately after a maximum has been reached it decreases. Fig 9 illustrates this phenomenon by a curve which represents the brightness B of the raster as a function of the shift D of the beam relative to the axis 3 of the collector. Thus, in order to ensure correct centring, the movement of the beam must be ended exactly at the instant when this maximum of brightness is observed. It is very difficult not to overstep this limit.

With a wider aperture, the top of the curve of Fig. 9 is flattened and adjustment is effected more readily. With a collecting plate as shown in Fig. 4 the ascending curve may even terminate in a horizontal part, as shown in Fig. 10. It is not advisable to operate too far into this horizontal part, i. e. the beam must not be shifted too far from the axis 3, since astigmatism would occur. However, less accurate centring of the beam is not so objectionable as with a tube having a conventional circular aperture.

The latter fact results in a further advantage of the tube according to the invention in that the requirement of accurate coincidence of the axis of the electron gun and that of the positive ion collector is less rigid than with the conventional tubes.

Just as the electron beam is not sharply defined so the negative ion beam is not sharply defined and consequently marginal rays of the negative ion beam will escape from the negative ion collector. With a diaphragm having a central circular aperture the amount of this marginal radiation cannot be reduced without also reducing the image maximum brightness and contrast. Since as a matter of fact it is only essential in this case to increase the spacing between the edge of the collecting plate and the centre of the ion beam, in a tube according to the invention the device for removing the negative ions may be rendered more effective without incurring a corresponding loss in electrons. It is true that by shifting the edge of the collecting plate to the axis 3 of the negative ion collector, the part cut away from a centrally adjusted electron beam is slightly increased but this occurs only in a restricted sector and not throughout the circumference, as with a diaphragm of the kind shown in Fig. 2. Consequently, as indicated in Fig. 4 by a small bend 9, the depth of the recess may be slightly reduced, so that the minimum spacing $p$ between the edge and the axis of the negative ion beam becomes larger than is possible in Fig. 2, in which this spacing is $q$, and yet a greater quantity of light may be obtained on the screen than with the known construction. The centre of the electron beam may without objection be slightly moved away from the edge so as to wholly avoid the loss of light which might be produced by reduction of the depth of the recess or by provision of a local elevation to mark the centre of the edge. This movement, which is effected by magnetic means, does not result in any shift of the negative ion beam. Instead of collecting fewer negative ions, as might be expected, the use of a collecting plate in the form shown in Fig. 4 yields a better result.

Fig. 6 illustrates that with a tube according to the invention a non-circular aperture arranged symmetrically with respect to the equatorial plane may be provided.



With a sufficiently sharply defined negative ion beam the increase in size of the aperture may be such that only a circular part of the original diaphragm is left, the centre of which is located in the axis of the negative ion beam. This results in the form shown in Fig. 7, the circular plate 10 being secured to the cylinder wall with the use of a metal strip 11. Such a construction ensures the maximum value of image brightness. The image screen, however, is struck by a greater quantity of marginal rays of the negative ion beam than is the case under similar conditions with the other embodiments.

What I claim is:

1. In a cathode-ray tube having an electron gun for directing an electron beam along a longitudinal axis to a point of initial focus, an ion trap for separating negative ions from electrons in said electron beam comprising a cylindrical electrode adapted to receive therein said focused beam, a masking element arranged transverse to said longitudinal axis and within the object distance of said initial focus, and means to deflect the negative ions from said longitudinal axis along an axis intercepted by said masking element and forming with the longitudinal axis a meridian plane, said masking element having a split aperture which is symmetrical about the meridian plane and an equatorial plane perpendicular to the meridian plane and containing said longitudinal axis, said aperture having a dimension in the equatorial plane which is greater than the largest dimension of the aperture in the meridian plane thereby permitting a greater degree of lateral movement of the electrons in said beam about the longitudinal axis in the said equatorial plane than in said meridian plane.

2. In a cathode-ray tube having an electron gun for directing an electron beam along a longitudinal axis to a point of initial focus, an ion trap for separating negative ions from electrons in said electron beam comprising a cylindrical electrode adapted to receive therein said focused beam, a masking element arranged transverse to said longitudinal axis and within the object distance of said initial focus, and means to deflect the negative ions from said longitudinal axis along an axis intercepted by said masking element and forming with the longitudinal axis a meridian plane, said masking element having a rectangular aperture arranged symmetrically about the longitudinal axis, said aperture having a dimension in an equatorial plane perpendicular to the meridian plane and containing the longitudinal axis which is greater than the largest dimension of the aperture in the meridian plane, thereby permitting a greater degree of lateral movement of the electrons in said beam about the longitudinal axis in the said equatorial plane than said meridian plane.

3. In a cathode-ray tube having an electron gun for directing an electron beam along a longitudinal axis to a point of initial focus, an ion trap for separating negative ions from electrons in said electron beam comprising a right circular cylindrical electrode concentric with the longitudinal axis and adapted to receive therein said focused beam, a masking element arranged transverse to said longitudinal axis and within the object distance of said initial focus, and means to deflect the negative ions from said longitudinal axis along an axis intercepted by said masking element and forming with the longitudinal axis a meridian plane, said mask-

ing element having a rectangular aperture arranged symmetrically about the longitudinal axis, said aperture having a dimension in an equatorial plane perpendicular to the meridian plane and containing the longitudinal axis which is greater than the largest dimension of the aperture in the meridian plane thereby permitting a greater degree of lateral movement of the electrons in said beam about the longitudinal axis in the said equatorial plane than in said meridian plane.

JOHANNES DE GIER.



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