

Description

The invention relates to a cathode-ray tube comprising in an evacuated envelope an electron gun to generate an electron beam which is focused on a target, which electron gun comprises, centred along an axis, a cathode, a grid having a substantially circular aperture, a first anode having an aperture, and a magnetic lens of a permanent magnetic material in the vicinity of the aperture in said grid.

Such cathode-ray tubes are used to display television pictures or are used as an oscilloscope tube. In such cases the target is a display screen having a phosphor layer, for example in a black-and-white display tube or in an oscilloscope tube, or having a pattern of phosphor elements luminescing in different colours in a colour display tube.

Such a cathode-ray tube may also be a camera tube. In that case the target is a photosensitive layer, for example a photoconductive layer.

In all applications the spot formed when the electron beam impinges on the target must have predetermined, generally small, dimensions and the haze surrounding the target should be minimum.

A cathode-ray tube described in the opening paragraph is known from the United States Patent Specification 3,217,200. This patent discloses a cathode-ray tube in which a thin permanent magnetic plate is mounted against the first anode of the electron gun. This plate maintains a strong magnetic field through the aperture in the plate of the first anode, which magnetic field is toroidal and forms a rotationally symmetrical magnetic lens for the electron beam. Since with increasing and decreasing beam current the cross-over moves away from the cathode and more towards the cathode, respectively, the cross-over in this magnetic lens will move along the beam axis and the focusing influence of said lens on the beam and cross-over will vary in accordance with the beam current and, because the cross-over is displayed on the display screen, will result in varying spot dimensions on the display screen.

The article "30AX Self-aligning 110" in-line color TV display" in IEEE Transactions on Consumers Electronics, Vol. CE-24 No. 3, August 1978, pp. 481—7, describes a triple electron gun in a colour television display tube in which the grid of each gun consists of two plates arranged against each other, one plate having a horizontal slot and one plate having a vertical slot. Through these slots the grid, in cooperation with the cathode, forms a first electrostatic quadrupole lens field, and in cooperation with the first anode, forms a second electrostatic quadrupole lens field rotated 90° with respect to the first electrostatic quadrupole lens field. The electron beam is focused in two focal lines by said lens fields so that the mutual space charge repelling of the electrons becomes less than in the case of one concentrated stigmatic cross-over. The strength of the fields between the grid and the cathode and

between the grid and the anode and as a result of this the shape of the spot on the display screen, however, depend on the voltage variations at the grid. Moreover, in a grid of such a construction electron emission occurs from a non-circular region of the emissive layer of the cathode, which is experienced to be less favourable in a number of applications.

It is the object of the invention to provide a cathode-ray tube of the type mentioned in the opening paragraph in which the haze around the spot is minimum, in which the shape of the spot depends only slightly on the voltage at the grid and on the beam current and from which emission takes place from a circular region of the emissive layer of the cathode.

According to an aspect of the invention a cathode-ray tube comprising in an evacuated envelope an electron gun to generate an electron beam which is focussed on a target, which electron gun comprises centered along an axis, a cathode, a grid having circular aperture, a first anode having an aperture and a magnetic lens of a permanent magnetic material in the vicinity of the aperture in said grid, is characterized in that said magnetic lens is a magnetic quadrupole lens the field lines of which are perpendicular or substantially perpendicular to the electron beam, the lens exhibiting 180° rotational symmetry about said axis and having on the beam, in two mutually perpendicular directions, a converging and diverging effect respectively which in combination with the stronger converging effect of the electric fields in the gun induces an astigmatic cross-over in the electron beam.

As a result of the 180° rotational symmetry of the lens the electron beam is not focused in one point only. This magnetic field of the lens intensifies the convergence of the beam in one direction and weakens it in the direction perpendicular thereto. As a result of this two focal lines occur as in the cathode-ray tube from the above-mentioned article. The space charge repelling, that is the repelling of the electrons mutually, in these focal lines is less than in one stigmatic cross-over. An important advantage of such a magnetic lens against or near the first grid is in addition that the lens strength is less dependent on the voltage at this grid. Moreover, the aperture in the first grid is substantially circularly symmetrical so that electrons emit from a substantially circular symmetrical region of the emissive surface of the cathode which is attractive in a number of applications, for example in camera tubes.

A very suitable embodiment of the invention is characterized in that the magnetic quadrupole lens is formed by a magnetised plate which also has an aperture and which is secured against the grid said plate being magnetised as a quadrupole along the edge of the central aperture, so that cyclically a north pole, a south pole, a north pole and a south pole are present. Before this plate is secured against the grid, it can be magnetised to the desired strength and with the desired polarity. However, it is alternatively possible first to secure

the plate against the grid and then to magnetise it. In this case there is no risk that the adjusted magnetic field is de-arranged by the connection (for example spot welding).

A second preferred embodiment of a cathode-ray tube in accordance with the invention is characterized in that the magnetic quadrupole lens is formed by at least two bar magnets which are secured against the grid and which extend radially away from the aperture in the grid and are provided with their corresponding poles facing each other.

It is possible for these bar magnets to extend to near the inner wall of the neck of the envelope so that the magnetisation becomes simpler to perform from without.

A third preferred embodiment of a cathode-ray tube in accordance with the invention is characterized in that four bar magnets are used of which two face each other with their north poles and two face each other with their south poles.

A fourth preferred embodiment of a cathode-ray tube in accordance with the invention is characterized in that the grid is manufactured at least partly from magnetic material and forms the magnetic lens which is magnetised as a quadrupole along the edge of the aperture in the grid so that cyclically a north pole, a south pole, a north pole and a south pole are present.

A fifth preferred embodiment of a cathode-ray tube according to the invention is characterized in that the magnetic quadrupole lens is formed by a ring of magnetic material magnetised as a quadrupole which ring is secured against the grid around the aperture.

According to a second aspect of the invention a cathode-ray tube comprising in an evacuated envelope an electron gun to generate an electron beam which is focussed on a target, which electron gun comprises centered along an axis, a cathode, a grid having a circular aperture, a first anode having an aperture and a magnetic lens of a permanent magnetic material in the vicinity of the aperture in said grid, is characterized in that the magnetic lens is disposed against the grid and constituted by a disc having a central aperture with two north poles located at opposite sides of the aperture on one face of the disc and two south poles on the other face of the disc opposite the north poles providing a magnetic field exhibiting 180° rotational symmetry about said axis and consisting of two oppositely located sectors the field lines of which extend between the opposed poles via the aperture, the combined effect on the beam of this field and the beam converging electric fields in the gun being to induce an astigmatic cross-over in the beam.

Since the grid is situated near the cathode it has a temperature of approximately 400°C during operation of the cathode-ray tube. So a permanent magnetic material should be used which maintains its magnetic properties at this temperature. Suitable materials are, for example, the materials known by the commercial names Ferroxdur and Ticonal. Many types of steel are

also suitable, for example, etchable steel containing, for example, in % by weight: 20% iron, 20% Ni, 60% copper of 56% iron, 27% chromium, 15% cobalt, 1% niobium and 1% aluminium.

The invention will be described in greater detail, by way of example, with reference to a drawing, in which

Fig. 1 is a sectional view of a cathode-ray tube according to the invention,

Fig. 2 shows an electron gun system for a cathode-ray tube shown in Fig. 1,

Fig. 3 is a longitudinal sectional view of one of the electron guns of the system shown in Fig. 2,

Figs. 4 to 7 show a number of possible non-rotationally symmetrical magnetic lenses for use in an electron gun for the cathode-ray tube in accordance with the invention,

Figs. 8 to 10 further illustrate the operation of these magnetic lenses, and

Fig. 11 is a diagrammatic longitudinal sectional view of an integrated electron gun,

Fig. 12 is an elevation of the common grid of the electron gun shown in Fig. 11, and

Fig. 13 shows a second embodiment of this grid.

Fig. 1 is a diagrammatic sectional view of an example of a cathode-ray tube in accordance with the invention, in this case a colour display tube of the in-line type. In a glass envelope 1 which is composed of a display window 2, a funnel-like part 3 and a neck 4 are provided in said neck three electron guns 5, 6 and 7 generating the electron beams 8, 9 and 10, respectively. The axes of the electron guns are situated in one plane, the plane of the drawing. The axis of the central electron gun coincides substantially with the tube axis 11. The three electron guns open into a sleeve 16 which is situated coaxially in the neck 4. The display window 2 is provided on its inside with a large number of triplets of phosphor lines. Each triplet comprises a line consisting of a green luminescing phosphor, a line of a blue luminescing phosphor and a line of a red luminescing phosphor. All triplets together constitute the display screen 12. The phosphor lines extend perpendicularly to the plane of the drawing. The shadow mask 13 in which a very large number of elongate apertures 14 are provided through which the electron beams 8, 9 and 10 emerge is positioned in front of the display screen 12. The electron beams are deflected in the horizontal direction (in the plane of the drawing) and in the vertical direction (perpendicular thereto) by the system of deflection coils 15. The three electron guns are assembled so that the axes thereof enclose a small angle with each other. As a result of this the electron beams pass through the apertures 14 under said angle, the so-called colour selection angle, and each impinge only on phosphor lines of one colour.

Fig. 2 is a perspective view of the three electron guns 5, 6 and 7. The electrodes of this triple electron gun system are positioned relative to each other by means of metal strips 17 which are sealed in the glass assembly rods 18. Each gun

consists of a cathode (not visible), a grid (21) a first anode (22) and electrodes 23 and 24 against the grid 21. Along the edge of said aperture the plate is magnetised so that cyclically a north pole, a south pole, a north pole and a south pole are present. These poles induce a quadrupole field in the aperture 30, the field lines of which extend perpendicularly to the axis of the electron beam. For the operation of the invention it is not necessary for the poles to be situated on the bisectors between the horizontal and vertical deflection directions.

Fig. 3 is a longitudinal sectional view of one of the electron guns. The emissive surface 31 of cathode 19 is situated opposite to aperture 30. A heating element 28 is provided in the usual manner within the cathode shaft 29. The plate 32 is magnetised as a quadrupole around the aperture 30 which is shown in Fig. 4.

Fig. 4 is an elevation of the magnetised plate 32. Four magnet poles are provided around the aperture 30. The field lines 33 are substantially perpendicular to the axis of the electron beam. (This axis is perpendicular to the plane of the drawing.)

Figs. 5a and b shown another possibility of obtaining a 180° rotationally magnetic field in the aperture 34 of a plate 35 of magnetic material placed against the grid. Since two north poles are provided on one side of the plate 35 by magnetisation and two south poles on the other side which are situated opposited to the north poles a 180° rotationally symmetrical magnetic field is formed in the aperture 34 formed by two parts of a toroidal field passing through the aperture and the field lines 36 of which are shown.

Fig. 6 shows how the 180° rotationally symmetrical magnetic field can be obtained near aperture 39 in grid 40 by means of two bar magnets 37 and 38. The bar magnets are provided with their north poles facing each other.

Fig. 7 shows how the 180° rotationally symmetrical magnetic field can be obtained near aperture 45 in grid 46 by means of four bar magnets 41, 42, 43 and 44.

According to the embodiments shown in Figs. 4, 6 and 7 a magnetic quadrupole lens is formed in or near the aperture in the grid. The known principle of a magnetic quadrupole lens will be explained again with reference to Fig. 8. Four magnet poles which are cyclically magnetised north-south-north-south (N-S-N-S) constitute a magnetic field a few field lines 47, 48, 49 and 50 of which are shown. An electron beam the axis of which coincides with the axis of the quadrupole lens and the electrons of which move backwards perpendicularly to the plane of the drawing experiences the forces denoted by the arrows 52, 53, 54 and 55. As a result of this the converging electron beam vertically becomes more weakly converging and horizontally becomes more strongly converging.

Fig. 9 shows how an electron beam 57 passing through the grid 56 is focused in one cross-over

58 if no 180° rotationally symmetrical magnetic lens according to the invention is provided against the grid 56.

Fig. 10 shows diagrammatically how two focal lines 60 and 61 are formed in the electron beam 62 by means of the provision of a 180° rotationally symmetrical magnetic lens in the grid 59. By the convergence-intensifying action of the magnetic lens on the electron beam in a horizontal direction, the overall focusing in the horizontal direction is obtained sooner and the focal line 60 hence is closer to the grid. By the convergence-weakening action of the magnetic lens on the electron beam in a vertical direction, the overall focusing in a vertical direction is weakened and the focal line 61 is situated farther away from the grid 59 than in the situation shown in Fig. 9.

The invention may be used in electron guns of the integrated type as known from United States Patent Specification 3,610,991 (PHN 3800).

Fig. 11 is a longitudinal sectional view of such an integrated electron gun system. Three cathodes 64, 65 and 66 are assembled in a common grid 63. The first anode 67 and the electrodes 68, 69 and 70 are also common for the three integrated electron guns. The electrodes 69 and 70 together constitute the so-called main lens of the system. The first grid is manufactured from an already mentioned steel and magnetised around each aperture in the manner as shown in the elevation of Fig. 12. Each electron beam experiences the influences described with reference to Fig. 8.

Fig. 13 shows a second preferred embodiment of a grid as shown in Fig. 11. The grid has three rings 71 which are magnetised as a quadrupole and consist of an Fe, Co, V and Cr-alloy known by the tradename Vicalloy. The magnetisation of the 180° rotationally symmetrical magnetic lens can be carried out in a number of manners.

Very suitable is the magnetisation method in which by means of the magnetisation device a sufficient strong magnetic field is induced in the material to be magnetised, after which by also generating a decaying magnetic alternating field which initially drives the material to be magnetised on both sides of the hysteresis curve into saturation, a hard permanent magnetisation remains in the material which neutralizes the externally applied magnetisation field and hence is oriented oppositely thereto. After switching off the magnetisation device the magnetic lens remains. The strength of the magnetic lens differs for each individual part of the electron gun and may be determined experimentally. This method is elaborately described in the Netherlands Patent Application No. 7707476 which is equal to GB-A2,000,635 published January 10, 1979.

Claims

1. A cathode-ray tube comprising in an evacuated envelope (1) an electron gun (5, 6, 7) to



consists of a cathode (not visible), a grid (21) a first anode (22) and electrodes 23 and 24 against the grid 21. Along the edge of said aperture the plate is magnetised so that cyclically a north pole, a south pole, a north pole and a south pole are present. These poles induce a quadrupole field in the aperture 30, the field lines of which extend perpendicularly to the axis of the electron beam. For the operation of the invention it is not necessary for the poles to be situated on the bisectors between the horizontal and vertical deflection directions.

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Claims

1. A cathode-ray tube comprising in an evacuated envelope (1) an electron gun (5, 6, 7) to



generate an electron beam (8, 9, 10) which is focussed on a target (12), which electron gun comprises centered along an axis, a cathode (19), a grid (21) having a circular aperture, a first anode (22) having an aperture and a magnetic lens of a permanent magnetic material in the vicinity of the aperture in said grid, characterized in that said magnetic lens is a magnetic quadrupole lens (32) the field lines (33) of which are perpendicular or substantially perpendicular to the electron beam, the lens exhibiting 180° rotational symmetry about said axis and having on the beam (8, 9, 10) in two mutually perpendicular directions, a converging and diverging effect respectively which in combination with the stronger converging effect of the electric fields in the gun induces an astigmatic cross-over in the electron beam.

2. A cathode-ray tube as claimed in claim 1, characterized in that the magnetic quadrupole lens is formed by a magnetised plate which also has an aperture (30) and which is secured against the grid (21), said plate being magnetised as a quadrupole along the edge of the central aperture, so that cyclically a north pole, a south pole, a north pole and a south pole are present.

3. A cathode-ray tube as claimed in claim 1, characterized in that the magnetic quadrupole lens is formed by at least two bar magnets (37, 38) which are secured against the grid (40) and which extend radially away from the aperture (39) in the grid and are provided with their corresponding poles facing each other.

4. A cathode-ray tube as claimed in claim 3, characterized in that four bar magnets (41, 42, 43, 44) are used of which two face each other with their north poles and two face each other with their south poles.

5. A cathode-ray tube as claimed in claim 1, characterized in that the grid (63) is manufactured at least partly from magnetic material and forms the magnetic lens which is magnetised as a quadrupole along the edge of the aperture in the grid so that cyclically a north pole, a south pole, a north pole and a south pole are present.

6. A cathode-ray tube as claimed in claim 1, characterized in that the magnetic quadrupole lens is formed by a ring (71) of magnetic material magnetised as a quadrupole which ring is secured against the grid (63) around the aperture.

7. A cathode-ray tube comprising in an evacuated envelope (1) an electron gun (5, 6, 7) to generate an electron beam (8, 9, 10) which is focussed on a target, which electron gun comprises centered along an axis, a cathode (19), a grid (21) having a circular aperture, a first anode (22) having an aperture and a magnetic lens (35) of a permanent magnetic material in the vicinity of the aperture in said grid, characterized in that the magnetic lens is disposed against the grid and constituted by a disc (35) having a central aperture (34) with two north poles located at opposite sides of the aperture on one face of the disc and two south poles on the other face of the disc opposite the north poles providing a magnetic field exhibiting 180° rotational symmetry about

said axis and consisting of two oppositely located sectors the field lines (36) of which extend between the opposed poles via the aperture (34), the combined effect on the beam of this field and the beam converging electric fields in the gun being to induce an astigmatic cross over in the beam.

Patentansprüche

1. Kathodenstrahlröhre mit einem Elektronenstrahlerzeuger (5, 6, 7) in einem evakuierten Kolben (1) zum Erzeugen eines Elektronenstrahls (8, 9, 10), der auf einem Target (12) fokussiert wird, wobei dieser Strahlerzeuger, um eine Achse zentriert, eine Kathode (19), ein Gitter (21) mit einer kriesförmigen Öffnung, und eine erste Anode (22) mit einer Öffnung und einer Magnetlinse aus einem dauermagnetischen Material in der Nähe der Öffnung im Gitter enthält, dadurch gekennzeichnet, dass die Magnetlinse eine magnetische Quadrupollinse (32) ist, deren Feldlinien (33) senkrecht oder im wesentlichen senkrecht zum Elektronenstrahl verlaufen, wobei die Linse eine 180° Rotationssymmetrie um die Achse aufweist, und auf den Strahl (8, 9, 10) in zwei gegenseitig senkrecht verlaufenden Richtungen eine konvergierende bzw. divergierende Auswirkung aufweist, die in Zusammenarbeit mit der grösseren konvergierenden Auswirkung der elektrischen Felder im Strahlerzeuger eine astigmatische Überkreuzung im Elektronenstrahl induziert.

2. Kathodenstrahlröhre nach Anspruch 1, dadurch gekennzeichnet, dass die magnetische Quadrupollinse durch eine magnetisierte Platte gebildet wird, die ebenfalls eine Öffnung (30) hat und am Gitter (21) befestigt ist, wobei die Platte aus Quadrupol entlang des Randes der zentralen Öffnung magnetisiert wird, so dass zyklisch einen Nordpol, einen Südpol, einen Nord- und einen Südpol vorhanden sind.

3. Kathodenstrahlröhre nach Anspruch 1, dadurch gekennzeichnet, dass die magnetische Quadrupollinse wenigstens durch zwei Stabmagnete (37, 38) gebildet wird, die am Gitter (40) befestigt sind und sich in radialer Richtung weg von der Öffnung (39) im Gitter erstrecken und mit ihren entsprechenden Polen einander zugewandt sind.

4. Kathodenstrahlröhre nach Anspruch 3, dadurch gekennzeichnet, dass vier Stabmagneten (41, 42, 43, 44) verwendet werden, von denen zwei mit ihren Nordpolen gegenübereinander und zwei mit ihren Südpolen gegenübereinander angeordnet sind.

5. Kathodenstrahlröhre nach Anspruch 1, dadurch gekennzeichnet, dass das Gitter (63) wenigstens teilweise aus Magnetmaterial hergestellt ist und die magnetische Linse bildet, die als Quadrupol entlang des Randes der Öffnung im Gitter magnetisiert wird, so dass zyklisch ein Nordpol, ein Südpol, ein Nord- und ein Südpol vorhanden sind.

6. Kathodenstrahlröhre nach Anspruch 1, dadurch gekennzeichnet, dass die magnetische



Quadrupollinse durch einen Ring (71) aus magnetischem Material gebildet und als Quadrupol magnetisiert ist, und dieser Ring ist am Gitter (63) um die Öffnung befestigt.

7. Kathodenstrahlröhre mit einem Elektronenstrahlerzeuger (5, 6, 7) in einem evakuierten Kolben (1) zum Erzeugen eines Elektronenstrahls (8, 9, 10), der auf einem Target fokussiert wird, wobei der Strahlerzeuger, um eine Achse zentriert, eine Kathode (19), ein Gitter (21) mit einer kreisförmigen Öffnung und eine erste Anode (22) mit einer Öffnung und einer Magnetlinse (35) aus einem dauermagnetischem Material in der Nähe der Öffnung im Gitter enthält, dadurch gekennzeichnet, dass die Magnetlinse am Gitter angebracht ist und durch eine Scheibe (35) mit einer Zentrallöffnung (34) gebildet wird, von der zwei Nordpole an gegenüberliegenden Seiten der Öffnung auf einer Fläche der Scheibe und zwei Südpole auf der anderen Fläche der Scheibe gegenüber den Nordpolen angeordnet sind, wodurch ein Magnetfeld mit einer 180° Rotationssymmetrie um die Achse erzeugt wird und aus zwei einander gegenüberliegenden Abschnitten der Feldlinien besteht, dessen Feldlinien (36) sich zwischen den einander gegenüberliegenden Polen über die Öffnung (34) erstrecken, wobei die Kombinierte Auswirkung auf den Strahl dieses Feldes und auf die strahlkonvergierenden elektrischen Felder im Strahlerzeuger zum Induzieren einer astigmatischen Überkreuzung im Strahl dient.

Revendications

1. Tube à rayons cathodiques comportant, dans une enveloppe vidée d'air, un canon électronique (5, 6, 7) pour engendrer un faisceau d'électrons (8, 9, 10) que est focalisé sur une cible (12), canon électronique qui comporte d'une façon centrée suivant un axe, une cathode (19), une grille (21) présentant une ouverture circulaire, une première anode (22) présentant une ouverture et une lentille magnétique d'un matériau magnétiquement permanent à proximité de l'ouverture dans ladite grille, caractérisé en ce que ladite lentille magnétique est une lentille quadripolaire magnétique (32) dont les lignes de champ (33) sont perpendiculaires ou pratiquement perpendiculaires au faisceau d'électrons, la lentille présentant une symétrie de révolution de 180° autour dudit axe et présentant, sur le faisceau (8, 9, 10), selon deux directions perpendiculaires entre elles, respectivement un effet de convergence et un effet de divergence qui, en combinaison avec l'effet de convergence plus intense du champ électrique dans le canon induisent un croisement astigmatique dans le faisceau d'électrons.

2. Tube à rayons cathodiques selon la revendication 1, caractérisé en ce que la lentille quadripolaire magnétique est formée par une plaque

magnétisée qui présente également une ouverture (30) et qui est fixée contre la grille (21), ladite plaque étant magnétisée comme quadripole le long du bord de l'ouverture central, de façon que de façon cyclique, un pôle nord, un pôle sud, un pôle nord et un pôle sud soient présents.

3. Tube à rayons cathodiques selon la revendication 1, caractérisé en ce que la lentille quadripolaire magnétique est formée par au moins deux aimants en barre (37, 38) qui sont fixés contre la grille (40) et qui s'étendent radialement à partir de l'ouverture (39) dans la grille et qui sont disposés de façon que leurs pôles correspondants se situent vis-à-vis l'un de l'autre.

4. Tube à rayons cathodiques selon la revendication 3, caractérisé par l'utilisation de quatre aimants en barre (41, 42, 43, 44) dont deux s'opposent par leurs pôles nord et deux par leurs pôles sud.

5. Tube à rayons cathodiques selon la revendication 1, caractérisé en ce que la grille (63) est au moins partiellement réalisée en matériau magnétique et constitue la lentille magnétique qui est magnétisée comme quadripole le long du bord de l'ouverture dans la grille, de façon qu'un pôle nord, un pôle sud, un pôle nord et un pôle sud soient présents de façon cyclique.

6. Tube à rayons cathodiques selon la revendication 1, caractérisé en ce que la lentille quadripolaire magnétique est formée par un anneau (71) en matériau magnétique magnétisé comme quadripole, anneau qui est fixé contre la grille (63) autour de l'ouverture.

7. Tube à rayons cathodiques comportant, dans une enveloppe vidée d'air (1), un canon électronique (5, 6, 7) pour engendrer un faisceau d'électrons (8, 9, 10) qui est focalisé sur une cible, canon électronique qui comporte, d'une façon centrée suivant un axe une cathode (19), une grille (21) présentant une ouverture circulaire, une première anode (22) présentant une ouverture et une lentille magnétique (35) d'un matériau magnétiquement permanent à proximité de l'ouverture dans ladite grille, caractérisé en ce que la lentille magnétique est disposée contre la grille et est constituée par un disque (35) présentant une ouverture centrale (24) comportant deux pôles nord situés sur des bords opposés de l'ouverture sur une face du disque et deux pôles sud sur l'autre face du disque, opposés aux pôles nord de façon à réaliser un champ magnétique présentant une symétrie de révolution de 180° autour dudit axe et constitué par deux secteurs situés de façon opposée dont les lignes de champ s'étendent entre les pôles opposés par l'intermédiaire de l'ouverture, l'effet combiné exercé sur le faisceau par ce champ et par les champs électriques de convergence de faisceau dans le canon provoquant un croisement astigmatique dans le faisceau.