

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) APPARATUS COMPRISING A CATHODE-RAY TUBE PROVIDED WITH AN
 ELECTRON GUN SYSTEM FOR PRODUCING A NUMBER OF ELECTRON BEAMS

(71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to cathode ray tube apparatus comprising a cathode-ray tube provided with an electron gun system for producing a plurality of electron beams which are subjected to a first focusing action along a first portion of their paths, said system including first and second common, substantially circular-cylindrical and substantially coaxial electrodes. The cathode-ray tube may be provided with a display screen comprising a number (corresponding to the number of electron beams) of substances capable of luminescing in different colours in response to electron-bombardment, and a colour selection electrode (which may be a shadow-mask) adjacent and on the gun side of the display screen, said substantially circular-cylindrical electrodes being capable of producing a lens field for causing said beams to converge in the plane of the colour selection electrode. The cylindrical electrodes may comprise one free-standing substantially circular-cylindrical electrode and a conductive coating on the tube envelope, or they may comprise two free-standing substantially circular-cylindrical electrodes which may have substantially equal diameters. If desired, further free-standing substantially circular-cylindrical electrodes may be provided to make up the complete lens. Such an electrostatic convergence system is preferably used when the beams are situated close together because there is then little space available to accommodate the pole shoes which would be required for magnetic convergence. This may be the case, for example, when the various electron beams are produced by a single gun. Each of the electron beams will normally also be focused on the display

screen or in a plane adjacent thereto, for example, the plane of the colour selection electrode. This can be effected partly by the lens effect between successive electrodes of the gun or guns, which thus produces a first focusing action, and partly by the lens effect of the convergence system which thus produces a second focusing action.

The focusing action of the convergence system will be the same for each beam if the axis of the beams are situated at substantially equal distances from the axis of the circular-cylindrical electrodes. This will be the case, for example, when three electron beams are produced, the centres of which lie at the corners of an equilateral triangle. However, when the beams are deflected, the convergence will not be maintained and this makes dynamic convergence necessary. In principle it is possible, however, to converge the electron beams over the whole screen without using dynamic convergence means, provided that the axes of the beams are situated substantially in one plane and a special type of deflection coil is used. However the axes of the beams will then no longer be situated at substantially equal distances from the axis of the circular-cylindrical electrodes, and consequently the second focusing action will not be the same for each beam. Actually the second focusing action will then be stronger for the beams whose axes within the circular-cylindrical electrodes are situated furthest from the axis of said electrodes, due to the fringing field of the convergence lens.

Thus the first focusing action on the beams should be different so that the overall focusing formed by the first and second focusing actions is substantially equal for each beam. Accordingly, the invention provides cathode ray tube apparatus comprising a cathode-ray tube provided with an electron gun system for producing a plurality of electron beams which are individually subjected to a first focusing action along a first portion of their paths, said tube including first and sec-

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ond common, substantially circular-cylindrical and substantially coaxial electrodes for subjecting said beams to a common second focussing action along a second portion of their paths subsequent to the first portion and for converging said beams, the distance of the axis of at least one electron beam path from the axis of the said electrodes being different from that distance for another of the electron beam paths, the apparatus being constructed and arranged so that the relative said first focusing action on each electron beam will be weaker as said distance is larger.

If the electron beams are produced by different guns, the difference in the first focusing action can be obtained by differences between the voltages of the electrodes which produce this focusing action. This may be done, for example, when the various electron guns are constructed in the same manner structurally. However, it may be a drawback that the number of voltages to be supplied to the system of electron guns has then to be increased. Therefore it is preferable to obtain the different first focusing action while using the same voltages in the various electron guns. This may be done by making the constructions of the electrodes produce different focusing for the beam from each gun. When one gun is used for producing the various beams and the gun electrodes, except for one, are common for all beams, it is not then possible to give different voltages to the electrodes. In this case the cathode-ray tube may be provided with an electron gun for producing at least three electron beams, the axes of which lie in a plane containing the axis of the substantially circular-cylindrical electrodes.

In order that the invention may be readily carried into effect, embodiments thereof will now be described in greater detail, by way of example, with reference to the accompanying diagrammatic drawing, in which:—

Figure 1 is a longitudinal section of a cathode-ray tube,

Figure 2 shows certain parts of the section of Figure 1 on an enlarged scale, and

Figure 3 shows another possible construction of certain parts of the section of Figure 1 on an enlarged scale.

A cathode-ray tube 1 in Figure 1 comprises an electron gun 2 which produces three electron beams the centres of which are situated in a plane containing the axis of the gun, the axis of the central electron beam coinciding with this axis. The three electron beams are converged at a shadow-mask 3 after which they each impinge upon certain parts of a luminescent screen 4 which comprises phosphors capable of luminescing in three different colours in response to electron bombardment. Scanning of the screen

is effected by a deflection device 5 shown diagrammatically.

Figure 2 is a longitudinal section of part of the neck of the tube through the axis of the gun. The gun comprises three cathodes 6, 7 and 8, a common first grid electrode 9 which is provided with apertures 10, 11 and 12 for the beams originating from the cathodes 6, 7 and 8 respectively, a common second electrode 13 which is provided with apertures 14, 15 and 16 for these beams, and a common third electrode 17 which is provided with apertures 18, 19 and 20 for these beams. The aperture 19 is smaller than the apertures 18 and 20. The centres of the apertures 11, 15 and 19 are situated on the axis 21 of the gun, the centres of the apertures 10, 14 and 18 are situated on a line 22 parallel to the axis 21 and the centres of the apertures 12, 16 and 20 are situated on a line 23 also parallel to the axis 21. The line 22 coincides with the axis of the cathode 6, the axis 21 coincides with the axis of the cathode 7, and the line 23 coincides with the axis of the cathode 8. The tube also includes common circular-cylindrical fourth and fifth electrodes 24 and 25. The fourth electrode consists of two interconnected circular-cylindrical portions 26 and 27. The plate-shaped third electrode 17 has an annular bulge 28 on the side thereof which faces the fourth electrode. A second focusing action takes place in the converging lens which is an accelerating lens comprising the fourth electrode 24 and the fifth electrode 25, the lens field being produced between the circular-cylindrical portion 27 and the circular-cylindrical electrode 25 which have the same diameters.

The distance from the cathodes 6, 7, 8 to the first grid 9 may be 0.09 mm, from the first grid 9 to the second electrode 13 1.0 mm and from the second electrode 13 to the third electrode 17 1.5 mm. The first grid 9 may have a thickness of 0.20 mm, the second electrode 13 a thickness of 0.50 mm and the third electrode 17 also a thickness of 0.50 mm. The circular apertures 10, 11 and 12 in the first grid 9 may have a diameter of 0.75 mm, the circular apertures 14, 15 and 16 in the second electrode 13 a diameter of 0.75 mm, the circular apertures 18 and 20 in the third electrode 17 a diameter of 2.0 mm, and the circular aperture 19 in the third electrode 17 a diameter of 1.5 mm. The distance from the line 22 to the axis 21 of the gun may be 3.5 mm and the distance from the line 23 to the axis 21 of the gun may also be 3.5 mm. The inside diameter of the portion 26 of the fourth electrode 24 may be 14 mm and that of the portion 27 may be 20 mm. The diameter of the annular bulge 28 may be 14 mm, i.e. equal to the inside diameter of the portion 26 of the fourth electrode 24. The inside diameter of

the fifth electrode 25 may also be 20 mm. The height of the bulge 28 in the axial direction of the gun may be 1.5 mm, the length of the portion 26 in said direction may be 7 mm, that of the portion 27 in said direction may be 18 mm, and that of the fifth electrode 25 in said direction may be 10 mm. The distance between the bulge 28 and the portion 26 may be 2 mm and between the portion 27 and the fifth electrode 15 may also be 2 mm. This gun can be operated at the following voltages:

	cathodes	between 0 volt and 140 volt
	first grid	0 volt
15	second electrode	1700 volt
	third electrode	350 volt
	fourth electrode	4300 volt
	fifth electrode	25000 volt

The variable voltages on the cathodes can individually control the intensities of the beams.

In the case quoted of a common third electrode which is short in the axial direction of the tube and has a lower voltage than the second and fourth grids, a first focussing action takes place between the second and fourth grids, and this focussing action is stronger when the voltage in the centre of the corresponding aperture in the third grid is lower. Since the diameter of the aperture 19 is smaller than that of the apertures 18 and 20, the first focussing action on the central beam is made stronger than that on the other two.

Figure 3 is a similar section of the neck portion of the tube of Figure 1 to that of Figure 2, but shows another electrode construction. Similar components have been given the same reference numerals as their counterparts in Figure 2. In Figure 3 the gun comprises a common second electrode 30 which is provided with apertures 31, 32 and 33 and a common third grid 34 which is provided with apertures 35, 36 and 37 which all have the same diameters. The surface of the second electrode 30 which faces the first grid is flat. The other surface of the electrode 30 is such that its thickness at the aperture 32 is greater than at the apertures 31 and 33. As a result of this the distance between the second electrode 30 and the third electrode 34 near the central beam is smaller than that near the other beams, as a result of which the first focussing action on the central beam is made stronger than that on the other beams.

WHAT WE CLAIM IS:—

1. Cathode ray tube apparatus comprising a cathode-ray tube provided with an electron gun system for producing a plurality of electron beams which are individually subjected to a first focussing action along

a first portion of their paths, said tube including first and second substantially circular-cylindrical and substantially coaxial electrodes for subjecting said beams to a common second focussing action along a second portion of their paths subsequent to said first portion and for converging said beams, the distance of the axis of at least one electron beam path from the axis of said electrodes being different from that distance for another of the electron beam paths, the apparatus being constructed and arranged so that the relative said first focusing action on each electron beam will be weaker as said distance is larger.

2. Apparatus as claimed in Claim 1, wherein the cathode-ray tube is provided with a display screen comprising a number corresponding to the number of electron beams, of substances capable of luminescing in different colours in response to electron bombardment, and a colour selection electrode adjacent and on the gun side of the display screen, said common, substantially circular-cylindrical electrodes being capable of producing a lens field for causing said beams to converge in the plane of the colour selection electrode.

3. A cathode-ray tube provided with an electron gun system for producing a plurality of electron beams which are subjected to a first focussing action along a first portion of their paths said electron gun system comprising a separate cathode for each electron beam, a common first grid which is provided with an aperture for each beam, a common second accelerating grid electrode provided with an aperture for each beam, and a common third grid provided with an aperture for each beam, said tube including substantially circular-cylindrical fourth and fifth substantially coaxial electrodes for subjecting said beams to a common second focussing action along a second portion of their paths subsequent to said first portion and for converging said beams, the distances from the centres of the apertures in each grid to the axis of said fourth and fifth electrodes being not the same for all the beams and the apertures in the third grid being larger as the distance from the centre of the corresponding aperture to said axis is larger.

4. A cathode-ray tube provided with an electron gun system for producing a plurality of electron beams which are subjected to a first focussing action along a first portion of their paths said electron gun system comprising a separate cathode for each electron beam, a common first grid which is provided with an aperture for each beam, a common second accelerating grid electrode provided with an aperture for each beam, a common third grid provided with an aperture for each beam, said tube including

the fifth electrode 25 may also be 20 mm. The height of the bulge 28 in the axial direction of the gun may be 1.5 mm, the length of the portion 26 in said direction may be 7 mm, that of the portion 27 in said direction may be 18 mm, and that of the fifth electrode 25 in said direction may be 10 mm. The distance between the bulge 28 and the portion 26 may be 2 mm and between the portion 27 and the fifth electrode 15 may also be 2 mm. This gun can be operated at the following voltages:

	cathodes	between 0 volt and 140 volt
	first grid	0 volt
15	second electrode	1700 volt
	third electrode	350 volt
	fourth electrode	4300 volt
	fifth electrode	25000 volt

The variable voltages on the cathodes can individually control the intensities of the beams.

In the case quoted of a common third electrode which is short in the axial direction of the tube and has a lower voltage than the second and fourth grids, a first focusing action takes place between the second and fourth grids, and this focusing action is stronger when the voltage in the centre of the corresponding aperture in the third grid is lower. Since the diameter of the aperture 19 is smaller than that of the apertures 18 and 20, the first focusing action on the central beam is made stronger than that on the other two.

Figure 3 is a similar section of the neck portion of the tube of Figure 1 to that of Figure 2, but shows another electrode construction. Similar components have been given the same reference numerals as their counterparts in Figure 2. In Figure 3 the gun comprises a common second electrode 30 which is provided with apertures 31, 32 and 33 and a common third grid 34 which is provided with apertures 35, 36 and 37 which all have the same diameters. The surface of the second electrode 30 which faces the first grid is flat. The other surface of the electrode 30 is such that its thickness at the aperture 32 is greater than at the apertures 31 and 33. As a result of this the distance between the second electrode 30 and the third electrode 34 near the central beam is smaller than that near the other beams, as a result of which the first focusing action on the central beam is made stronger than that on the other beams.

WHAT WE CLAIM IS:—

1. Cathode ray tube apparatus comprising a cathode-ray tube provided with an electron gun system for producing a plurality of electron beams which are individually subjected to a first focussing action along

a first portion of their paths, said tube including first and second substantially circular-cylindrical and substantially coaxial electrodes for subjecting said beams to a common second focussing action along a second portion of their paths subsequent to said first portion and for converging said beams, the distance of the axis of at least one electron beam path from the axis of said electrodes being different from that distance for another of the electron beam paths, the apparatus being constructed and arranged so that the relative said first focusing action on each electron beam will be weaker as said distance is larger.

2. Apparatus as claimed in Claim 1, wherein the cathode-ray tube is provided with a display screen comprising a number corresponding to the number of electron beams, of substances capable of luminescing in different colours in response to electron bombardment, and a colour selection electrode adjacent and on the gun side of the display screen, said common, substantially circular-cylindrical electrodes being capable of producing a lens field for causing said beams to converge in the plane of the colour selection electrode.

3. A cathode-ray tube provided with an electron gun system for producing a plurality of electron beams which are subjected to a first focussing action along a first portion of their paths said electron gun system comprising a separate cathode for each electron beam, a common first grid which is provided with an aperture for each beam, a common second accelerating grid electrode provided with an aperture for each beam, and a common third grid provided with an aperture for each beam, said tube including substantially circular-cylindrical fourth and fifth substantially coaxial electrodes for subjecting said beams to a common second focussing action along a second portion of their paths subsequent to said first portion and for converging said beams, the distances from the centres of the apertures in each grid to the axis of said fourth and fifth electrodes being not the same for all the beams and the apertures in the third grid being larger as the distance from the centre of the corresponding aperture to said axis is larger.

4. A cathode-ray tube provided with an electron gun system for producing a plurality of electron beams which are subjected to a first focussing action along a first portion of their paths said electron gun system comprising a separate cathode for each electron beam, a common first grid which is provided with an aperture for each beam, a common second accelerating grid electrode provided with an aperture for each beam, a common third grid provided with an aperture for each beam, said tube including



- substantially circular-cylindrical fourth and fifth substantially coaxial electrodes for subjecting said beams to a common second focussing action along a second portion of their paths subsequent to said first portion and for converging said beams, the distances from the centres of the apertures in each grid to the axis of said fourth and fifth electrodes being not the same for all the beams and the distance between the second and third grid at each aperture being larger as the distance from the centre of the corresponding aperture to said axis is larger.
5. A cathode-ray tube as claimed in Claim 3 or 4, wherein the electron gun system is constructed for producing at least three electron beams, the axes of which are situated in a plane which contains the axis of the fourth and fifth electrodes.
6. A cathode-ray tube as claimed in

Claim 3, 4 or 5, including a display screen comprising a number, corresponding to the number of electron beams, of substances capable of luminescing in different colours in response to electron-bombardment, and a colour selection electrode adjacent and on the gun side of the display screen, said common, substantially circular-cylindrical electrodes being capable of producing a lens field for causing said beams to converge in the plane of the colour selection electrode.

7. A cathode-ray tube substantially as described herein with reference to Figures 1 and 2, or to Figures 1 and 3 of the drawing.

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