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(54) IN-LINE ELECTRON GUN ASSEMBLY FOR COLOR PICTURE TUBE

(71) We, HITACHI LTD., a Japanese Body Corporate of 5-1, 1-chome, Marunouchi, Chiyoda-ku, Tokyo, Japan, 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:—

The present invention relates to an electron gun assembly for a color picture tube and, more particularly, to an in-line electron gun assembly used for the same.

Generally, an electron gun assembly is comprised of three electron guns, each of them being provided with a plurality of grid electrodes, wherein the electron beam emerging from each electron gun is focussed through a main electron lens formed in the electron gun and is further controlled through a dynamic convergence means to correctly impinge upon the screen of the color picture tube. In the in-line electron gun assembly, three electron guns are arranged in a line when viewed in a plane perpendicular to the tube axis, and the axes of the electron guns disposed at both sides of the centrally located one are each slanted so as to crossover at a point on the shadow mask corresponding to the center of the picture. In the thus constructed electron gun assembly, errors are inevitable in the slant of the electron guns and the interval among the electron guns, due to the errors peculiar to the parts and/or the instrument to construct and assembly the electron gun.

There has been proposed a main electron lens constructed by employing cup-shaped electrodes to be described later, for the purpose of overcoming such disadvantage. That is, the main electron lens is constructed in such a way that two cup-shaped electrodes are disposed facing each other, each of them is provided with a plurality of holes through its bottom in a line, each

hole corresponds to its corresponding or related electron gun. The improvement aimed at by this electron lens also has problems to be solved of poor focussing characteristic due to astigmatism caused therein. That is, the beam spot on the screen is different from a true circle.

According to the present invention, there is provided an in-line electron gun assembly for a color picture tube comprising three electron guns for producing electron beams the guns being in an in-line arrangement such that the electron beams emitted, in use, from the guns lie in side by side relation in a common plane and a plurality of electrodes for controlling the passage of the electron beams, said electrodes including first and second cup-shaped electrodes supported relative to one another with their bottoms facing each other, each cup-shaped electrode being provided with a flange at its open end and with a respective hole through its bottom for the electron beam from each electron gun for forming a main electron lens, the wall of each of said holes having a folded edge extending inwardly a small distance into the space in the cup-shaped electrode in which that hole is formed and the central one of the holes in the first cup-shaped electrode being substantially coaxial with the associated central one of the holes in said second cup-shaped electrode, in which a cylindrical auxiliary electrode is provided for each of the holes in at least one of said cup-shaped electrodes, each of said cylindrical auxiliary electrodes being coaxial with its associated hole, having one end of its wall in electrical and mechanical contact with said folded edge of the wall of its associated hole and extending into the cup-shaped electrode in which that hole is formed.

The application of embodiments of the present invention to the manufacture of

color picture tubes enables the electric field forming the main electron lens to be uniformly distributed and thus any astigmatism can be eliminated from the main lens.

The present invention will be fully understood from the following description taken in connection with the accompanying drawings, showing an illustrative embodiment of the present invention, in which:

Fig. 1 is a side view of a conventional electron gun assembly;

Fig. 2 is a perspective view of a part of the focussing electrode of the electron gun assembly shown in Fig. 1;

Fig. 3 is a view showing partly in section the electron gun assembly shown in Fig. 1;

Figs. 4a and 4b are respectively a plan view of an illustrative embodiment of a in-line electron gun assembly in accordance with the present invention, and a partially sectional view of the same; and

Fig. 5 is a perspective view of an exemplar of a cylindrical auxiliary electrode used in the present invention.

The electron gun assembly of the prior art will first be described with reference to Figs. 1 to 3. Referring now to Fig. 1, the reference numeral 1 designates a first grid electrode aligned in a plane provided with three cathodes and three heaters. A second grid electrode 2 is disposed adjacent to the first electrode. These first and second grid electrodes 1 and 2 have the same construction as those of the conventional integral in-line electron gun assembly. A third grid electrode 34 consists of a first portion 3 and a second portion 4. The second portion 4 of the third electrode is a cup-shaped electrode or member "b" having three holes 4h arranged in a line through the bottom "g" and provided with a flange 7 at its open end, as shown in Fig. 2. A fourth grid 5 is almost in the same construction as the cup-shaped electrode "b" shown in Fig. 2, except that the diameter of each of the holes 5h in the fourth grid electrode and the interval between the adjacent holes 5h is slightly larger than those of the upper portion in the third grid electrode in order to converge three electron beams on the fluorescent screen of the picture tube. The cup-shaped electrodes are coupled with their apertured bottoms facing each other, so that the central hole 5h in the fourth grid 5 is arranged so as to be substantially coaxial with the corresponding central hole 4h in the second portion 4 of the third grid electrode 34. Thus, the distance between the axes of the corresponding side holes 5h and 4h is, e.g., 0.2-0.3 mm. By this arrangement, main electron lenses are formed between the holes 4h and their associated holes 5h. Bead glass members

6 for supporting the grid electrodes mentioned above are fixed into the flanges 7 of the grid electrodes. The wall of each of the holes 4h and 5h in the cup-shaped electrodes 4 and 5 has a folded end inwardly extending a small distance "l" into the space therein. The folded end forming a cylinder "x" is provided for the purpose of rendering the electric field established in the holes more uniform and is arranged in such a way that the paths or passages of the electron beams are substantially coaxial with the axes of their associated holes 4h and 5h in the cup-shaped electrodes 4 and 5.

However, in the thus constructed electron gun assembly, the electric field to be established in and near the holes 4h and 5h to form the main electron lenses is greatly affected in the distribution by the walls of the cup-shaped members 4 and 5. The reason for this is that since each of the cup-shaped member is integrally formed, it is difficult to obtain a sufficient height for "l" of the folded end "x" in the physical formation. Additionally, the holes except the centrally positioned holes of those 4h and 5h are inequally spaced from the various portions of the side walls of the cup-shaped members 4 and 5. Accordingly, the distribution of the electric fields contributing to form the main electron lenses are uneven and eccentric with the result that the main electron lenses have the astigmatism and thus the focussing characteristics thereof are deteriorated.

With a view to overcoming such defect, in the embodiment of Figures 4a, 4b and 5 an auxiliary cylindrical electrode is provided within each of the holes in at least one of the cup-shaped electrodes 4 and 5 so that the folded end "x" of each of the holes is electrically contacted with the wall of the auxiliary electrode for the purpose of removing the influence of the wall of the cup-shaped electrode on the electrical field forming the main lens, and thus obtaining the main electron lens free from the astigmatism.

Figs. 4a, 4b and 5, like reference numerals refer to like elements in Figs. 1 and 3. As shown in Fig. 5, an auxiliary electrode 8 may consist of a cylindrical portion 81 adapted to be telescopically fitted into the folded end "x" (Fig. 4b) and a mounting portion 82 formed at one end of the cylindrical portion. More particularly, the cylindrical portion 81 may be constructed in a manner that it has such an inner diameter as to permit the folded end to be acceptable in the hollow of the cylindrical portion 81 while the mounting portion 82 may have a pair of L-shaped legs extending from one end of the cylindrical portion 81 perpendicularly to and

then in parallel with the axis of the portion 81. A flange may be provided radially extending normal to the axis of the cylindrical portion 81 for carrying the legs. In

5 Figs. 4a and 4b, each of the auxiliary electrodes 8 is attached such that the mounting portion 82 is in pressure engagement with the inner wall of the corresponding cup-shaped electrode such as the second portion 10 4 of the third grid electrode or the fourth grid electrode 5 while the other end of the cylindrical portion 81 is telescopically fitted to the folded cylindrical end "x".

Thus, the folded end "x" of the holes 15 can be regarded as being substantially elongated in the axial longitudinal direction so that the electrical field in and near the space where the holes 4h and 5h are facing each other is not affected by the 20 walls of the cup-shaped electrode, thereby eliminating the astigmatism in the main electron lens and thus avoiding the deterioration of the focusing characteristic.

It was experimentally verified that the 25 length "m" of the cylindrical portion 81 must be selected to be greater than or equal to about 60% of the diameter of the holes 4h and 5h in order to eliminate the influence of the wall of the cup-shaped 30 electrode.

An experiment also showed that when the height or length "l" of the folded cylindrical end "x" is less than or equal to 23% of the inner diameter of the hole 4h, 35 it was required accurately to align the center of the holes 4h and 5h with the axis of the cylindrical portion 81. In an embodiment in which the length "l" of the folded end "x" is 1.6 mm and the inner 40 diameters of the holes 4h and 5h are 5.5 mm and 5.9 mm, respectively, a relatively great allowance of 0.15 mm was obtained which is an amount of the shift allowable in alignment of the axis of the cylindrical 45 portion 81 of the auxiliary electrode 8 with the axis of the holes 4h and 5h.

While a specific embodiment has been described many modification are possible within the scope of the present invention. 50 For example, the mounting portion 82 has been described as being in pressure engagement with the inner wall of its associated cup-shaped electrode. However, it is to be noted that the mounting portions may take any appropriate form for fixing the cylindrical portion 81 in place. The effect 55 obtained by the above disclosed embodiment may also be attained if the auxiliary electrode 8 abuts to the folded cylindrical end of the hole with accurate alignment, 60 the auxiliary electrode and the holes being of the same diameter. Although, in the above described embodiment, both the third and the fourth grid electrodes are 65 provided with the auxiliary electrodes, it

may be allowed to provide auxiliary electrodes for either one of the third and the fourth grid electrodes though the performance of the electron gun assembly is somewhat lowered as compared with that 70 of the electron gun assembly described above. Furthermore, although the above described embodiment of electron gun assembly is of the bipotential type, other 75 embodiments may be of the unipotential type.

WHAT WE CLAIM IS:

1. An in-line electron gun assembly for a color picture tube comprising three electron guns for producing electron beams, the guns being in an in-line arrangement such that the electron beams emitted, in use, from the guns lie in side by side relation in a common plane and a plurality of electrodes for controlling the passage of the electron beams, said electrodes including first and second cup-shaped electrodes supported relative to one another with their bottoms facing each other, each cup-shaped electrode being provided with a flange at its open end and with a respective hole through its bottom for the electron beam from each electron gun for forming a main electron lens, the wall of each of said holes 95 having a folded edge extending inwardly a small distance into the space in the cup-shaped electrode in which that hole is formed, and the central one of the holes in the first cup-shaped electrode being substantially coaxial with the associated 100 central one of the holes in said second cup-shaped electrode, in which a cylindrical auxiliary electrode is provided for each of the holes in at least one of said cup-shaped electrodes, each of said cylindrical auxiliary electrodes being coaxial with its associated hole, having one end of its wall in electrical and mechanical contact with said folded edge of the wall of its associated hole and extending into the cup-shaped electrode in which that hole is formed. 110

2. An in-line electron gun assembly according to claim 1, in which a respective cylindrical auxiliary electrode is provided 115 for each of the holes in both of said cup-shaped electrodes.

3. An in-line electron gun assembly according to claim 1 or 2, in which each cylindrical auxiliary electrode is provided 120 with a pair of legs for pressure engagement with the cup-shaped electrode in which that auxiliary electrode is formed.

4. An in-line electron gun assembly according to claim 1, 2, or 3, in which the length of said cylindrical auxiliary electrode is at least 60% of the diameter of the associated hole in the associated cup-shaped electrode. 125

5. An in-line electron gun assembly sub- 130



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then in parallel with the axis of the portion 81. A flange may be provided radially extending normal to the axis of the cylindrical portion 81 for carrying the legs. In Figs. 4a and 4b, each of the auxiliary electrodes 8 is attached such that the mounting portion 82 is in pressure engagement with the inner wall of the corresponding cup-shaped electrode such as the second portion 4 of the third grid electrode or the fourth grid electrode 5 while the other end of the cylindrical portion 81 is telescopically fitted to the folded cylindrical end "x".

Thus, the folded end "x" of the holes can be regarded as being substantially elongated in the axial longitudinal direction so that the electrical field in and near the space where the holes 4h and 5h are facing each other is not affected by the walls of the cup-shaped electrode, thereby eliminating the astigmatism in the main electron lens and thus avoiding the deterioration of the focusing characteristic.

It was experimentally verified that the length "m" of the cylindrical portion 81 must be selected to be greater than or equal to about 60% of the diameter of the holes 4h and 5h in order to eliminate the influence of the wall of the cup-shaped electrode.

An experiment also showed that when the height or length "l" of the folded cylindrical end "x" is less than or equal to 23% of the inner diameter of the hole 4h, it was required accurately to align the center of the holes 4h and 5h with the axis of the cylindrical portion 81. In an embodiment in which the length "l" of the folded end "x" is 1.6 mm and the inner diameters of the holes 4h and 5h are 5.5 mm and 5.9 mm, respectively, a relatively great allowance of 0.15 mm was obtained which is an amount of the shift allowable in alignment of the axis of the cylindrical portion 81 of the auxiliary electrode 8 with the axis of the holes 4h and 5h.

While a specific embodiment has been described many modification are possible within the scope of the present invention. For example, the mounting portion 82 has been described as being in pressure engagement with the inner wall of its associated cup-shaped electrode. However, it is to be noted that the mounting portions may take any appropriate form for fixing the cylindrical portion 81 in place. The effect obtained by the above disclosed embodiment may also be attained if the auxiliary electrode 8 abuts to the folded cylindrical end of the hole with accurate alignment, the auxiliary electrode and the holes being of the same diameter. Although, in the above described embodiment, both the third and the fourth grid electrodes are provided with the auxiliary electrodes, it

may be allowed to provide auxiliary electrodes for either one of the third and the fourth grid electrodes though the performance of the electron gun assembly is somewhat lowered as compared with that of the electron gun assembly described above. Furthermore, although the above described embodiment of electron gun assembly is of the bipotential type, other embodiments may be of the unipotential type.

WHAT WE CLAIM IS:

1. An in-line electron gun assembly for a color picture tube comprising three electron guns for producing electron beams, the guns being in an in-line arrangement such that the electron beams emitted, in use, from the guns lie in side by side relation in a common plane and a plurality of electrodes for controlling the passage of the electron beams, said electrodes including first and second cup-shaped electrodes supported relative to one another with their bottoms facing each other, each cup-shaped electrode being provided with a flange at its open end and with a respective hole through its bottom for the electron beam from each electron gun for forming a main electron lens, the wall of each of said holes having a folded edge extending inwardly a small distance into the space in the cup-shaped electrode in which that hole is formed, and the central one of the holes in the first cup-shaped electrode being substantially coaxial with the associated central one of the holes in said second cup-shaped electrode, in which a cylindrical auxiliary electrode is provided for each of the holes in at least one of said cup-shaped electrodes, each of said cylindrical auxiliary electrodes being coaxial with its associated hole, having one end of its wall in electrical and mechanical contact with said folded edge of the wall of its associated hole and extending into the cup-shaped electrode in which that hole is formed.

2. An in-line electron gun assembly according to claim 1, in which a respective cylindrical auxiliary electrode is provided for each of the holes in both of said cup-shaped electrodes.

3. An in-line electron gun assembly according to claim 1 or 2, in which each cylindrical auxiliary electrode is provided with a pair of legs for pressure engagement with the cup-shaped electrode in which that auxiliary electrode is formed.

4. An in-line electron gun assembly according to claim 1, 2, or 3, in which the length of said cylindrical auxiliary electrode is at least 60% of the diameter of the associated hole in the associated cup-shaped electrode.

5. An in-line electron gun assembly sub-

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stantially as hereinbefore described with reference to and as shown by Figures 4a, 4b and 5 of the accompanying drawings.

6. A color picture tube including an electron gun assembly according to any one of the preceding claims.

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