

The invention relates to a process for manufacture of a cathode ray tube. It relates especially to the heating of electrodes of electrostatic lenses of the electron gun, this heating being for the purpose of eliminating the gas particles from the evacuated tube.

It is known that a cathode ray tube, particularly a colour television tube, comprises at least one electron gun to excite cathodo-luminescent materials on the screen. This (or these) electron gun(s) is arranged at the rear of the tube in a narrow cylindrical part.

Such an electron gun comprises an emissive cathode heated by a filament and a set of electrodes, generally termed grids, certain of which constitute electrostatic lenses. This set comprises one electrode, or Wehnelt,  $G_1$  brought to a variable potential, usually negative in relation to the cathode, to control the extraction of the electrons, particularly their quantity, a second electrode  $G_2$  for acceleration of the beam of electrons and two electrostatic lenses for concentration of the beam.

The invention relates to the case in which each lens is of the bi-potential type, the first of the latter comprising two electrodes  $G_3$  and  $G_4$  one of which,  $G_3$ , being in sequence (towards the screen) immediately after electrode  $G_2$  is of elongated shape and is brought to a potential of the order of +7 KV and the other,  $G_4$ , of relatively flat shape in the example, is brought to a potential of the order of +25 KV. The second beam concentration lens is formed of two electrodes of elongated shape the first of which,  $G_5$ , immediately following the electrode  $G_4$  is brought to the same potential as the first electrode  $G_3$  of the first lens and the second of which,  $G_6$ , is brought to the same potential of the order of +25 KV, as the electrode  $G_4$  of the first lens.

During the manufacture of the tube, after the installation of the gun and the evacuation of the tube, the cathode or cathodes is or are heated to a temperature greater than the normal working temperature so as to form and to stabilise the material forming this cathode and voltages are then applied to the electrodes with the purpose of heating them in order to clean the tube, by eliminating undesirable gas particles, particularly the particles included in the metal forming the electrodes, all of these particles being absorbed by a pellet termed Getter.

It is important for this cleaning to be performed effectively because, otherwise, the phenomenon of "after-glow" occurs during normal working of the tube, which is perceived by an emission of light for an appreciable time after the switching-off of the television receiver (or other visual display device) fitted with the tube.

The invention results from the finding that the particles responsible for this phenomenon are particularly those which are included in the metal of the grids  $G_3$  and  $G_5$  close to the grids  $G_4$  and  $G_6$  respectively, since, in these regions, the accelerating electrical field is of high intensity. It is therefore necessary, according to the invention, to localise the heating of the grids  $G_3$  and  $G_5$  in order to clean them in these positions, ie at their ends close to the grids,  $G_4$  and  $G_6$  respectively.

For heating an electrode, it is already known (US Patent 4,395,242), that the electrons produced by the cathode may be used and therefore that a voltage may be applied between this cathode and the grid to be heated. In the invention, use is made of this heating process. But to localise this heating as desired on one end of the electrode  $G_3$  or of the electrode  $G_5$  it is necessary according to the invention to make special arrangements. These consist of applying a same negative potential to the electrodes  $G_4$  and  $G_6$ ; the value of

this potential determines the location of the heating. Thus, in one example, there is applied to the grids  $G_3$  and  $G_5$ , which are electrically interconnected, a potential of 800 to 1000 volts and the electrodes or grids  $G_4$  and  $G_6$ , which are also electrically interconnected, are brought to the potential of -1300 volts approximately to heat the end of the grid  $G_3$  close to  $G_4$  and to the potential of -900 volts to heat the end of the grid  $G_5$  close to  $G_6$ .

Thus the invention relates to a process of heating of the first electrodes of two bi-potential type electrostatic lenses of an electron gun forming part of a cathode ray tube, this heating being performed at the time of manufacture of the tube, these first electrodes, which are in the form of tubes each having two end walls, being brought to a same potential, but having a value different from the first, in which process for the heating use is made of the electrons produced by the gun, and which is characterised in that the heating of the first electrode of each lens is being localised at its end close to the second electrode of this same lens, to localise the heating on the end of the first electrode of the first lens which is close to the second electrode of this same lens, there is applied to this second electrode a negative potential of sufficiently high absolute value to prevent the electrons from passing through this second electrode, and in that to localise the heating of the end of the first electrode of the second lens close to the second electrode of this same lens, there is applied to the second electrodes of both lenses a same negative potential, which as an absolute value, is low enough for the electrons to be able to pass through the second electrode of the first lens, but high enough for the second electrode of the second lens to repel the electrons.

Other characteristics and advantages of the invention will appear with the description of certain of its modes of

construction, given with reference to the attached drawings in which:

- figure 1 is a diagram of an electron gun of a colour television tube in the course of treatment according to the invention, and

- figure 2 is a diagram showing the various stages of the treatment.

The example to be described with reference to the figures relates to the manufacture of a colour television tube of the type having a mask with three electron guns. However, for simplicity, only one gun has been shown in figure 1.

This gun comprises an emissive K cathode 10 with which is associated a heating filament 11, an electrode 12 or Wehnelt  $G_1$  brought to a variable potential, generally negative in relation to that of the cathode, to control the extraction of the electrons, and following this electrode  $G_1$ , an electrode  $G_2$ , reference 13, to accelerate the beam.

These electrodes  $G_1$  and  $G_2$  are of metal with a flat shape, each having an opening of restricted dimensions to allow the beam to pass through.

Following the electrode 13 ( $G_2$ ) in the direction of emission of the beam, along the axis 14 of the tube, the gun comprises two electrostatic lenses 15 and 16 for concentration of the beam. Each of the latter is of the bi-potential type.

The first lens 15 comprises a first electrode  $G_3$  reference 17, which is tube-shaped with two end walls 18 and 19, the opening of the wall 18, close to the grid  $G_2$  being of section smaller than that of the opening of the wall 19, close to the grid  $G_4$ . The second electrode  $G_4$  (20) has a flat shape. Its opening has the same section as that of the opening of the

wall 19.

The second electrostatic lens 16 also has two electrodes the first of which  $G_5$ , immediately following the electrode  $G_4$ , has an elongated tubular shape, longer than the electrode  $G_3$ , with two end walls the first of which 22, close to the electrode  $G_4$ , has an opening of same section as that of this electrode  $G_4$  and the second of which 23 also has an opening of same section but has an offset 24 towards the inside of the tubular part 21, the opening of the wall 23 thus being recessed inwards in relation to the end of the tube 21.

The second electrode  $G_6$  of the lens 16 also has a tubular shape with one end face 25 having an opening of same section as that of the face 23; the face 25 is recessed towards the inside of the tube 26 constituting the electrode  $G_6$ .

An electrical connection 27 links the electrodes  $G_3$  and  $G_5$ . Similarly the electrodes  $G_4$  and  $G_6$  are connected by an electrical conductor 28.

In normal operation the electrodes  $G_3$  and  $G_5$  are brought to a potential of the order of +7000 volts whereas the electrodes  $G_4$  and  $G_6$  are brought to a potential of the order of +25000 volts.

During the manufacture of the colour television tube, the electrodes  $G_3$  and  $G_5$  are connected to an appliance for heating the electrodes similar to that described in French Patent 83 10503 in the name of the applicant. This appliance comprises a voltage source applying, to a terminal 30, a potential of the order of +1800 volts. This terminal 30 is connected to the electrode  $G_3$  via a resistance 31 of value  $38k$ . The terminal 32 common to the resistance 31 and to the electrode  $G_3$  is connected to the electrode  $G_2$  via a resistance 33 of value  $470K$  and this resistance is itself connected to the earth via a resistance 34 of value  $350k$ .

According to an important provision of the invention during the manufacture of the tube the conductor 28 and/or the electrodes  $G_4$  and  $G_6$  is linked to a terminal 35 itself connected to a generator 36 which delivers, to this terminal 35, a negative potential of value variable between -900 volts and -1300 volts in the example.

For the formation and stabilisation of the cathode material and for the cleaning the procedure is as set out in figure 2 which shows the various operations with their respective durations. First of all a spark-over is formed which consists of applying a high tension, of between 38kV and 52kV, between the grids  $G_4$  and  $G_6$  and the other grids and the cathode which are earthed. Immediately after this spark-over the filament of the cathode is pre-heated for a period of 2 minutes; to this end the voltage applied to this filament 11 is 9.5 volts whereas its nominal voltage is slightly higher: 9.7 volts. After this pre-heating the cathode or cathodes is or are heated to a temperature higher than the normal working temperature in order to form and to stabilise the material constituting the cathode. For this operation the filament is supplied at a voltage of 11 volts for 2 minutes. After a 10 minute stabilisation period during which the filament is supplied with a voltage of 9.7 volts, the heating of the grid  $G_3$  and then of the grid  $G_5$  is performed by bombarding with electrons.

To this end the filament 11 is under a voltage of 9.7 volts, the cathode 10 is earthed, a potential of the order of +400 volts is applied to the grid  $G_2$  and a potential of the order of +800 to +1000 volts to the grid  $G_3$  (and therefore also to the grid  $G_5$ ), the potential of the terminal 30 being of the order of 1800 volts.

It has been found that if the electrodes  $G_4$  and  $G_6$  are floating, ie if the terminal 35 is not connected to a source, the electrons reach the electrode  $G_5$  in the neighbourhood of its end 22 close to the electrode  $G_4$ . In this case it is mainly

this end which is heated whereas the more sensitive parts of the electrodes  $G_3$  and  $G_5$  are brought to a temperature too low to allow the elimination of the harmful particles, which are the source of the after-glow phenomenon.

To localise the heating of the electrode  $G_3$  (17) in the neighbourhood of its end wall 19, close to the electrode  $G_4$ , there where the electrical field is most intense, a potential of -1300 volts is applied to the terminal 35, and therefore to the electrodes  $G_4$  (20) and  $G_6$  (26). With this negative potential value the electrode  $G_4$  constitutes a barrier for the electrons which thus cannot reach the electrode  $G_5$ .

To perform the heating of the end of the electrode  $G_5$  close to its wall 23, and therefore close to the electrode  $G_6$ , the potential applied to the terminal 35 is of approximately -900 volts. In these conditions, the negative potential applied to the electrode  $G_4$  has a sufficiently low absolute value not to prevent the electrons from passing through this electrode  $G_4$ . These electrons which have passed through the electrode  $G_4$  are then repelled by this negative potential. This is why they can reach the opposite end of the electrode  $G_5$  to heat it. These electrons are also repelled by the negative potential on the electrode  $G_6$ .

In both of these cases, ie with the terminal 35 at the potential of -1300 volts and then at the potential of -900 volts, the zones hit by the electrons reach temperatures of the order of 800°C, sufficient to achieve a degassing of good quality.

The grid  $G_3$  is heated for about 10 minutes. Similarly the duration of the heating of the grid  $G_5$  is of about 10 minutes.

It should be noted that owing to the value of the voltage applied to the terminal 30 and owing also to the values of the

resistances 31, 33 and 34 it is possible, as described in French Patent 83 10503, to escape the effects of variations on the dimensions of the cathodes and grids or electrodes as well as variations on the distances between the cathode and the various grids, inevitable during a mass production run. In other words despite variations on the dimensions the zones in question of the electrodes  $G_3$  and  $G_5$  will always reach at least the temperature of  $800^{\circ}\text{C}$ . To escape the effects of variations, it is sufficient to choose a high enough value for the voltage applied to the terminal 30 and to place in series with the generator connected to the terminal 30 a resistance of high enough value, for example at least of the same order of magnitude as the average dynamic resistance between cathode and grid  $G_3$ .

The appliance and the process described are particularly simple to implement. They do not involve any major modification of the installation for manufacture of the colour television tubes. To change over from the heating of the grid  $G_3$  to the heating of the grid  $G_5$  it is sufficient to perform a simple switching of the potential applied to the terminal 35.

CLAIMS

1. Process of heating first electrodes ( $G_3, G_5$ ) of two bi-potential type electrostatic lenses (15,16) of an electron gun forming part of a cathode ray tube, this heating being performed during the manufacture of the tube, the first electrodes ( $G_3$  and  $G_5$ ), which are in the form of tubes each having two end walls (18,19;22,23), being brought to a same potential and the second electrodes ( $G_4$  and  $G_6$ ) being also brought to a same potential, but of different value from the first, in which process, for the heating, use is made of the electrons produced by the gun, characterised in that the heating of the first electrode ( $G_3, G_5$ ) of each lens (15,16) being localised at its end (19,23) close to the second electrode ( $G_4, G_6$ ) of this same lens, to localise the heating on the end of the first electrode ( $G_3$ ) of the first lens (15) which is close to the second electrode ( $G_4$ ) of this same lens there is applied to this second electrode ( $G_4$ ) a negative potential of sufficiently high absolute value to prevent the electrons from passing through this second electrode, and in that, to localise the heating on the end of the first electrode ( $G_5$ ) of the second lens close to the second electrode ( $G_6$ ) of this same lens, there is applied to the second electrodes ( $G_4, G_6$ ) of the two lenses a same negative potential which, as an absolute value, is sufficiently low for the electrons to be able to pass through the second electrode ( $G_4$ ) of the first lens but sufficiently high for the second electrode of the second lens to repel the electrons.

2. Process according to claim 1, characterised in that the potential of the first electrode ( $G_3$ ) of the first lens being of the order of 800 to 1000 volts, the potential of the second electrode ( $G_4$ ) of this first lens is of the order of -1300 volts during the heating of this first electrode ( $G_3$ ).



3. Process according to claim 2, characterised in that, for the heating, the potential of the first electrodes of the electrostatic lenses being of the order of 800 to 1000 volts, during the heating of the first electrode ( $G_5$ ) of the second lens the potential applied to the second electrodes of these lenses is of the order of -900 volts.

4. Process according to claim 2, characterised in that the heating of the first electrode of the first lens is performed during a period of approximately 10 minutes.

5. Process according to claim 3, characterised in that the heating of the first electrode of the second lens is performed during a time of the order of 10 minutes.

6. Process according to any of the above claims, characterised in that the heating of the first electrodes of the electrostatic lenses is performed immediately after the operation of forming and stabilising the cathode material of the electron gun.

7. Process according to any of the above claims, characterised in that the parameters of the supply circuit are chosen in such a way that the intensity of the current heating the electrodes is practically insensitive to variations in dimensions of the cathode and of the electrodes and to variations in distances between cathode and electrodes so that the temperature reached by the electrodes stays higher than a given threshold, for example of the order of 800°C.

