

The invention relates to a process and to a device for detecting whether the getter material has been correctly evaporated during the manufacture of a cathode ray tube, particularly for colour television.

A cathode ray tube consists of a glass envelope in which there is a vacuum with a frontal part forming a screen connected via a flared part to the cylindrical rear part, termed neck, at the end of which is housed the electron gun (or guns).

The last stages of manufacture of the tube are as follows: the electron gun to which is securely attached a cup containing the getter material to be evaporated, is installed in the envelope which is then exhausted by pumping; the getter material is then evaporated by heating using an induction coil, following which the cathode (or cathodes) is (or are) heated to a temperature higher than the normal working temperature in order to form and stabilise the material forming this cathode, and to the grids of the gun are applied some voltages intended to clean the tube, i.e. to eliminate the undesirable gas particles which are absorbed by the getter material. If the getter material has not been evaporated, the tube thus constructed will not be able to function correctly owing, on the one hand, to the poor quality of the vacuum, and on the other hand, especially, to the presence of positive ions which will be attracted by the cathode and will damage it.

It has been found that on mass production lines for about 1% of tubes the evaporation of the getter material is not performed correctly. The tubes which have this defect must then be re-treated, i.e. they must be removed from the production line and brought back to the getter evaporation station. This incident may have different causes: operator error, wrong positioning of the coil used for the induction heating to cause the evaporation, fault in this coil or in its power supply, etc...

Hitherto the evaporation of the getter material has been checked by visual observation of the walls of the tube. Such a type of inspection is not fully reliable since an evaporation defect may fail to be detected through the operator's inattention. Furthermore visual observation is arduous.

In the patent US-4,485,872 a process and a device were proposed derived from visual observation which have also shown themselves to be of an unsatisfactory reliability and complex to implement.

The invention remedies these disadvantages.

It is characterised in that:

- potentials of opposite sign are applied to two grids, distinct from the cathode, of the electron gun;
- the charge of positive ions in the tube is measured, this charge being measured, after a time t following the start of the operation of forming the cathode material, by the intensity of the current circulating between the grid of negative potential and the earth; and
- the intensity of the current measured is compared with a predetermined value and the tube is brought back to the getter material evaporation station if the intensity of the current is higher than the predetermined value, for example 150 nanoamperes.

The charge of positive ions is measured since only the latter are dangerous to the cathode.

Measurement of the charge of negative ions could also be envisaged; but this measurement would be difficult to perform since, during the stabilisation of the cathode material, the latter produces some electrons and the charge coming from these electrons is added to those of the negative ions and cannot be separated from them; for this reason the negative charge measured would not correctly represent the pressure in the tube.

The intensity of the electric current circulating between the electrode brought to a negative potential and the earth represents the charge of positive ions in the tube and therefore the pressure. It is important to note that, for the measurement, use is not made of the cathode; in fact, if a negative potential were applied to the latter, it would attract positive ions, and this would damage it. If the negative potential applied to the electrode G_3 is of -22.5 V, it has been found that after a time of 10 to 15 minutes following the formation of the cathode material, the intensity of the current circulating in the grid G_3 exceeds 150 nanoamperes, which corresponds to a pressure of 2×10^{-4} Torr, if the getter material has not evaporated to spread

itself onto the walls of the tube and is of the order of 25 nanoamperes - i.e. 4 to 5×10^{-5} Torr - in the opposite case. The tube being treated is thus brought back to the getter material evaporation station if the intensity between the electrode G_3 and the earth exceeds 150 nanoamperes.

It is preferable for the generator applying a positive potential to one of the electrodes to be a constant current generator so that the intensity of the measurement current is unaffected, or not greatly affected by the differences in characteristics between individual tubes, these differences or dispersions being inherent in mass production.

Other characteristics and advantages of the invention will become apparent with the description of certain of its embodiments, this being given with reference to the attached drawings in which:

- figure 1 is a diagram of a part of a cathode ray tube during its manufacture.

- figure 2 shows an electron gun of a cathode ray tube and some current sources and voltage sources used to implement the process of the invention,

- figure 3 is a diagram explaining the process of the invention and,

- figure 4 is a diagram of the rear part of a cathode ray tube during one stage of its manufacture.

The example to be described relates to the manufacture of a colour television tube of the shadow mask type.

During the last stages of the manufacture of a cathode ray tube 10, just after the exhausting of the glass envelope 11, the evaporation of the getter material is performed so that it is distributed over all the glass walls. This getter material consists of a barium pellet arranged in a cup 12 situated in the conical or flared part 13 of the envelope 11 attached by a stem 14 to the casing of the electron gun block 15.

The heating of the barium in order to evaporate it is performed using an induction coil 16 arranged outside the envelope 11 but close to the cup 12. The frequency and the power of the supply to the coil 16 are such that they enable a temperature of this cup to be reached of between 800 and $1,100^{\circ}\text{C}$.

After this evaporation of the barium the formation and the stabilisation of the material forming the cathode 20 are performed (figure 2). This cathode 20 usually comprises a tube of nickel and the material emitting the electrons consists of a mixture of oxides of barium, of strontium and of calcium.

To form and stabilise the cathode material the filament 21 for heating the latter is raised to a temperature higher than the normal working temperature.

The forming, or activation, of the cathode is performed during a period of approximately 4 minutes duration; this period of activation is itself divided into two stages of more or less equal duration: during the first the cathode material is raised to a temperature of approximately 1,000°C and during the second stage this material is raised to a higher temperature of the order of 1070°C.

The stabilisation of the cathode material is performed during approximately 14 minutes. During this stabilisation the cathode material is raised to a temperature of approximately 1,000°C. During these stages of the manufacture of the tube some gases are given off, into the latter, in particular during the activation, such gases as carbon monoxide CO, carbon dioxide CO₂, methane CH₄, etc... these gases contain in equal proportions, from the electrical point of view, some positive ions and some negative ions. The positive ions (+) are particularly harmful to the cathode since, this being brought to a negative potential, it attracts the positive charges, and this risks damaging it. The getter material distributed onto the walls of the envelope 11 absorbs the gases given off both during the forming of the cathode material and during subsequent degassing treatments.

To check that the barium contained in the cup 12 has been correctly evaporated, according to the invention, the gas pressure in the tube is measured after the forming of the cathode material, during the period of stabilisation of this material. This pressure is measured before the subsequent degassing or controlled ageing operation. For this measurement the charge of positive ions is determined. To this end, about 10 minutes after the start of the activation of the cathode material, i.e. during the stabilisation period, a positive

potential is applied to the second grid 22, termed G_2 , by connecting the latter to the terminal 25 of positive potential of a constant current generator 24 and a negative potential is applied to the third grid 23, termed G_3 , by connecting the negative terminal of a voltage generator 26 to this grid G_3 . The source 26 delivers a voltage of 22.5 Volts in the example.

Between the positive potential terminal of the source 26 and the earth is arranged a resistance 27 of value $100\text{ K}\Omega$ for example. In parallel with this resistance 27 is connected a voltmeter 28. The voltage measured by this voltmeter represents the intensity of the current passing through the resistance 27, i.e. leaving the grid G_3 . During this stage of checking pressure by measuring the charge of positive ions in the tube, the first grid, termed G_1 , is connected to the earth, as is the cathode 20.

The positive ions are attracted by the grid 23 brought to a negative potential, whereas the negative ions are attracted to the grid G_2 , 22, brought to a positive potential. Thus the current - measured by the voltmeter 28 - circulating in the resistance 27 represents the charge in positive ions in the envelope 11 and therefore the total pressure.

The connection, to the respective grids, of the source 26 and of the generator 24 is performed via a socket 30 (figure 4), that which is normally used to make the connections in order to form the cathode material and to perform the degassing treatments.

If the barium has been correctly evaporated the intensity i of the current in the resistance 27 varies in terms of the time t as shown by the solid line curve 31 (figure 3). Immediately after the forming of the cathode, at time $t = 0$, the current has an intensity of the order of 300 nanoamperes. After a time of the order of 10 minutes this intensity has fallen to the value of 25 nanoamperes. Conversely if the barium has not been evaporated the intensity i varies according to the broken line curve 32; after time $t = 10$ minutes approximately, this intensity has a value of the order of 200 nanoamperes.

In this way if the intensity i of the current in the resistance 27 exceeds 150 nanoamperes the tube is brought back to the induction heating station to evaporate the barium pellet. Conversely if the intensity is less than 150 nanoamperes, the tube remains on the production line to undergo the degassing treatment. In one example if the intensity i of the current exceeds 150 nanoamperes the socket 30 is separated from the tube 10 but the latter remains on the production line with the other tubes until the end of the degassing treatment. But the tube which does not comprise any socket 30 undergoes neither the end of the stabilisation of the cathode material nor the degassing or ageing. In this example the tube is brought back to the induction heating station after the degassing period which it has however not undergone.

The comparison with the value of 150 nanoamperes may be made by an operator. A comparator may equally be provided to deliver a signal when the intensity exceeds the said predetermined value. This signal can activate visual or audio means of warning. This signal may also be used to control a mechanism for extracting socket 30.

CLAIMS

1. Process for checking the evaporation of the pellet of getter material, such as barium, onto the walls of the envelope (11) of a cathode ray tube during its manufacture, characterised in that:

- potentials of opposite sign are applied to two grids (22, 23), distinct from the cathode, of the electron gun (15);

- the charge of positive ions in the tube is measured, the said charge being measured, after a time t following the start of the operation of forming the cathode material, by the intensity of the current flowing between the grid at negative potential and the earth; and

- the intensity of the current measured is compared with a predetermined value and the tube is brought back to the getter material evaporation station if the intensity of the current is higher than the predetermined value.

2. Process according to claim 1, characterised in that a positive potential is applied to the grid G_2 (22) and a negative potential is applied to the grid G_3 (23), the intensity measured being that of the current which flows between the grid G_3 (23) and the earth.

3. Process according to claim 1 or 2, characterised in that the application of the said potentials to the grids of the electron gun is performed via a socket (30) which is also used to make the electrical connections when forming the cathode material and performing the degassing treatments.

4. Process according to any of claims 1 to 3, characterised in that the positive potential applied to one of the grids of the electron gun is supplied by a constant current generator (24).

5. Process according to any of the above claims, characterised in that the measurement of the current is performed about 10 minutes after the start of the operation of forming the cathode material.

6. Process according to claim 3, characterised in that if the intensity of the current is higher than the predetermined value



the socket is separated from the tube and the latter is subsequently brought back to the getter material evaporation station.

7. Process according to any of the above claims, characterised in that the predetermined value is of the order of 150 nanoamperes.



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