April 29, 1969 L. JAVORIK 3,441,333

METHOD OF MANUFACTURING CATHODE RAY TUBE

Filed Sept. 26, 1967

FIG. 1

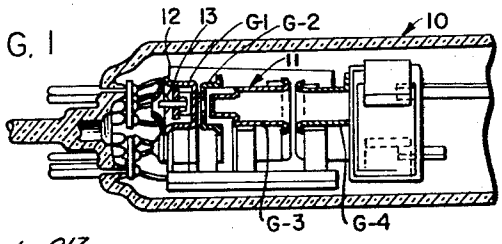


FIG. 2

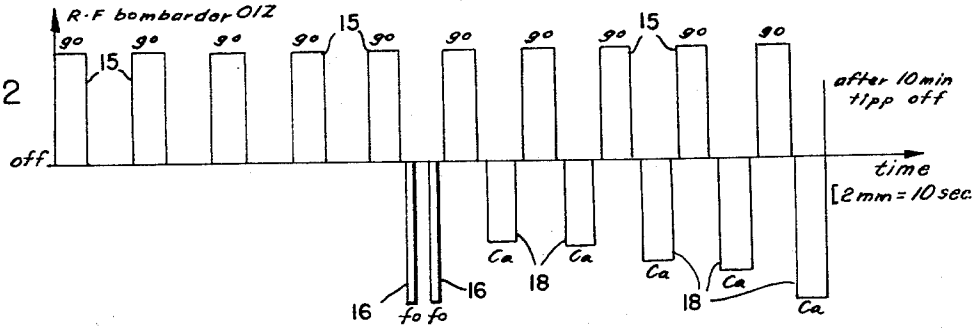
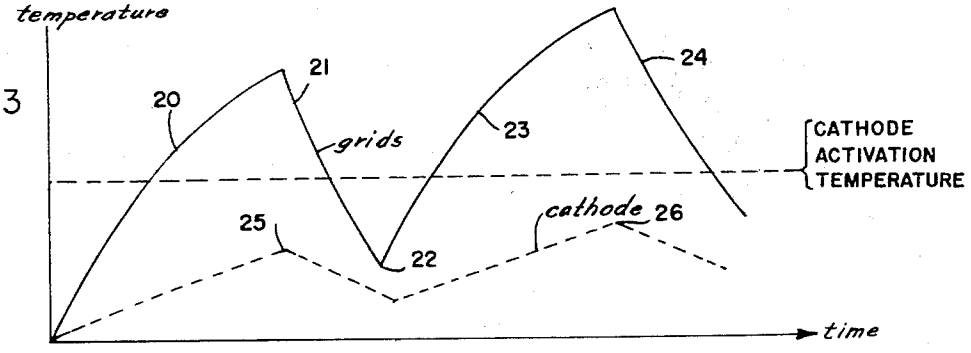


FIG. 3



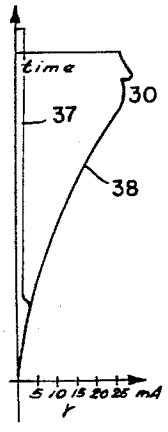


FIG. 4

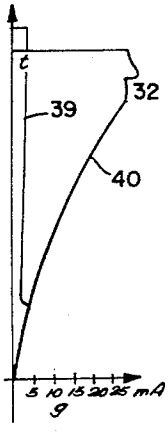


FIG. 5

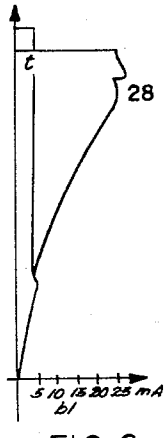


FIG. 6

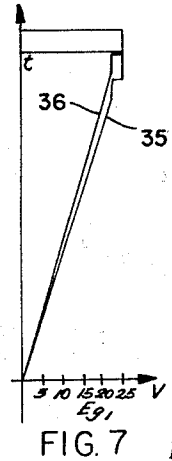


FIG. 7

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METHOD OF MANUFACTURING CATHODE RAY TUBE

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ABSTRACT OF THE DISCLOSURE

During the final stages of manufacture of a cathode ray tube for color television while exhausting the tube for producing a low vacuum, the grids are periodically bombarded with radio frequency energy. This periodic energization intermittently raises the temperature of the grids for outgassing while maintaining the temperature of the cathode below its critical activation temperature. After a number of such cycles of grid outgassing, the filament is outgassed and then the periodic bombardment of the grids is resumed with alternate and progressively increasing, periodic activation of the cathode. The final step is one of cathode activation for driving off remaining gases and enhancing the emissivity of the cathode.

BACKGROUND

The present invention relates to the manufacture of cathode ray tubes for color television; and more particularly, it is concerned with the outgassing of the grids, filament, and cathode during the final stages of pumping the tube to produce a low vacuum and just prior to sealing the tube.

In known methods of outgassing cathode ray tubes, the grids are continuously bombarded with radio frequency (RF) energy to heat them to a sufficient temperature to drive gases out of the metal in the grids. This, of course, takes place during the pumping of the tube to produce a vacuum in it, and toward the end of the pumping process. After the grids are thus outgassed, the cathode is activated by energizing the filament to raise the temperature of the cathode above its activation temperature. This breaks down the calcium carbonate to calcium oxide and releases carbon dioxide and it further expels any gases trapped on the surface of the cathode. Cathode activation always follows the outgassing of the grids since, of the two, the overall performance of the tube is far more sensitive to poisoning of the cathode than it is to poisoning of the grids. If the temperature of the cathode is raised to its activation temperature while the grids are being outgassed, some of the gas expelled from the grids poisons the cathode thereby reducing its emissivity.

SUMMARY

The present invention is based in part upon the realization that in prior methods of grid outgassing, in which the grids were continuously energized with RF energy, the cathode became heated to a point exceeding its activation temperature. It will be appreciated that the cathode is located adjacent the first control grid, so that it absorbs heat from the hot grids by radiation. After the cathode is activated, it becomes very sensitive to poisoning, hence, if it exceeds its activation temperature during the outgassing of the grids, gases expelled from the grids may poison the semi-conductor coatings of the cathode thereby reducing its emissivity.

To overcome this problem, the present invention contemplates a periodic or intermittent RF energization of the grids during grid outgassing with two criteria in mind. First, the temperature of the grids must be raised to a point at which trapped gases (either adsorbed or absorbed) will be expelled during the application of the RF energy; and secondly, the application of the RF energy must be for a duration short enough so that the temperature of the cathode does not approach its activation temperature.

After a number of such cycles of grid outgassing, the filament is outgassed, and then the periodic RF bombardment of the grids is resumed with alternate and progressively increasing activation of the cathode. That is, the periodic outgassing of the grids is continued; however, between the application of the RF energy to the grid, the cathode is activated, and the activation of the cathode is progressively increased to drive off all gases. The final step is an activation of the cathode because, as already mentioned, the overall performance of the tube is much more sensitive to poisoning of the cathode. The above procedure has greatly increased the quality of color television tubes with respect to the emissivity of the cathode.

Other features and advantages of the instant invention will be obvious to persons skilled in the art from the following detailed description of a preferred method accompanied by the attached drawing.

THE DRAWING

FIG. 1 is a close-up view of the electron-beam-producing gun of a typical color television cathode ray tube;

FIG. 2 illustrates the time relationship between grid outgassing, filament outgassing, and cathode activation;

FIG. 3 is a plot of the relative temperature of the grid and the cathode during grid outgassing; and

FIGS. 4–7 illustrate the relative improvement of a color television cathode ray tube manufactured according to the present invention.

DETAILED DESCRIPTION

Referring to FIG. 1, reference numeral **10** generally designates the constricted neck portion of a cathode ray tube for color television. In the illustration of FIG. 1, the viewing area or enlarged screen portion of the tube would be to the right of the figure, and the screen is sometimes referred to as the front of the tube, the electron-beam-producing means being located at the rear of the tube.

The general arrangement of the electron beam gun is well known to the art, and with that in mind, only the various elements with which the present invention is concerned will be described in more detail. However, it will be appreciated that there are three separate electron beams in a color television cathode ray tube, thus requiring three separate guns. These guns are usually arranged in the constricted neck portion of the tube so that the beams define an equilateral triangle transverse of the neck **10**. One of these guns is shown in cross-section in FIG. 1, and it is generally designated by reference numeral **11**.

Beginning at the rear end of the gun **11**, a filament **12** is coiled in proximity to a cathode **13**. A control grid G1 and first and second focusing grid G2 and G3 are arranged in that order immediately in front of the cathode for generating the electron beam. Proceeding toward the front of the tube, the focusing grids are followed by an accelerating grid G4.

The grids are illustrated as conventional Wehnelt cylinders. All of the grids, G1–G4 and the filament **12**, if desired, are outgassed before the cathode **13** is activated.

OUTGASSING SEQUENCE

Referring now to FIG. 2, the sequence of operations for the inventive procedure will now be illustrated. In FIG. 2, the abscissa represents time, the positive-going pulses **15** represent the periodic bombardment of the grids with RF energy for grid outgassing ("g_o"); the negative-going narrower pulses **16** represent filament outgassing

("f_o"); and the negative-going pulses **18** represent cathode activation ("c_a").

The pulses **15** represent a periodic, intermittent RF bombardment of the grids for outgassing. The resulting relative temperature of the grids and cathode due only to these RF pulses are illustrated for two such cycles in FIG. 3. In this figure, the solid line represents the temperature of the grids, and the dash line represents the temperature of the cathode. The solid curve **20** illustrates an exponential rise of the grid temperature toward an equilibrium temperature. However, before this point is reached, the application of RF energy is interrupted and as illustrated at **21**, the grid temperature decreases to a temperature at **22**. During the second cycle of application of RF energy to the grids, the temperature of the grids has a starting point at **22**, and rises according to the curve **23** until the RF energy is again interrupted and the temperature of the grids decreases according to the curve **24**. A corresponding rise and drop of the temperature of the cathode is shown, and it will be noted that all of the resultant peak temperatures, as indicated at **25** and **26** (as well as those not illustrated) are well below the cathode activation temperature.

As this periodic, intermittent bombardment of the grids continues, the grids are effectively outgassed while the cathode is prevented from being contaminated since it does not reach its activation temperature.

Following a suitable number of such periodic outgasings of the grids, the filament **12** is outgassed for two relatively short periods indicated by the pulses **16**. The filament pulses are short so that the filament coating can be outgassed without activating the cathode. In some cases, of course, it may not be necessary or desirable to outgas the filament, in which case this step may be eliminated. After the filament outgassing, the periodic outgassing of the grids continues.

Next, the activation of the cathode **13** begins by applying to the filament; and it can be seen from FIG. 2 that the cathode activation is also periodic and intermittent, and it occurs alternately with the grid outgassing in order to expel any CO_2 the grids may have absorbed from the activation of the cathode. Further, the cathode activation occurs in a progressively increasing manner. After each period of cathode activation there is a short period of inactivity to allow the CO_2 and other gases expelled from the cathode to be evacuated, then the grids are again outgassed by RF bombardment so that any gas adsorbed by them will again be driven out and evacuated. Progressively more power is supplied to the filament in subsequent activation cycles thereby gradually activating the cathode and preventing cracks in it which may be caused by the sudden explosion of CO_2. In addition, this method of step-wise increasing the activation level of the cathode provides a means of achieving just the right amount of cathode activation which is important in obtaining improved emissivity. If the cathode is over activated during this stage (i.e., before the getter is flashed and while a relatively poor vacuum exists), it may be poisoned. If not enough energy is applied, the cathode may be incompletely formed thus resulting in a gassy tube or a low-emissivity cathode.

EXAMPLE

A typical example of the inventive method will now be explained in detail. Still referring to FIG. 2, the grids were outgassed for a period of forty seconds, followed by an interval of sixty seconds in which the RF bombardment was stopped. This pattern was continued throughout the process. The filaments were outgassed for two periods of ten seconds each (interrupted by a twenty second interval), and the cathode activation periods were forty seconds each. During the activation cycles, there were ten second intervals between the end of a grid outgassing cycle and the beginning of a cathode activation cycle. Likewise, there was a ten second interval following

the cathode activation before the grids were outgassed. The cathode activation current increased from 1.0 amp. to 1.8 amps. After the final cathode activation pulse, there was a ten minute delay while the pumping continued and then the tube was sealed.

For this example, the temperature of the bulb at start was around 300° C. Before outgassing the filament (that is when only the grids were being bombarded), the temperature of the cathode did not exceed 450° C. The grid temperature just prior to filament outgassing was about 650° C., and it did not rise above this during the remainder of the process. During the activation cycle, the cathode temperature rises to about 900° C.–1,000° C.

FIGS. 4–7 illustrate the improved quality of a cathode ray tube manufactured according to the inventive procedure. One important figure of quality for a cathode ray tube is the amount of current drawn by the control grid G1 with a positive voltage of 25 volts applied to it. In terms of relative quality, a higher current drawn by G1 indicates a better quality tube since this is indicative of a higher emissivity of the cathode. A corresponding lower current drawn at 25 volts (for instance, below 10 milliamps) would indicate a poor quality tube.

In FIG. 7, the ordinate is time, and the abscissa denotes voltage applied to the first accelerating grid G1. As can be seen, the voltage is a ramp function, and the curve **35** represents the voltage applied to G1 of a tube manufactured according to the inventive procedure whereas the curve **36** represents the application of voltage to G1 of a tube manufactured according to conventional techniques.

FIG. 4 illustrates the improved quality for the electron gun which generates the beam modulated with the video signal representative of the red color component, or simply the red gun. In FIG. 4, the ordinate is again time, and the abscissa represents milliamps drawn from the red gun. In this figure, the curve **37** is for the cathode ray tube manufactured according to conventional techniques, and the curve **38** is for the tube manufactured according to the inventive technique. It can be seen that for the red gun, there is a significant improvement for the tube manufactured according to the present invention. At 25 volts applied to G1, the current from the red grid according to the conventional tube was two milliamps, and the corresponding current drawn at the grid of the improved tube was 30 milliamps.

FIG. 5 represents the same set of parameters for the gun which is modulated with the green video signal, and reference numeral **39** represents the conventional tube and reference numeral **40** represents the characteristic of the improved tube. For the green gun, the improved process yielded 32 milliamps at 25 volts applied to G1 whereas the conventional technique yielded 4 milliamps for the same applied voltage.

In FIG. 6 there is illustrated the same parameters for the blue gun, and the improved tube yielded 28 milliamps whereas the tube manufactured according to conventional techniques yielded only 2 milliamps at 25 volts applied to G1. It can thus be seen that significant improvement has been brought about by the inventive technique.

Having thus described in detail the preferred embodiment of the method of the instant invention, it will be obvious that certain modifications may be made to the specific example given without departing from the principle of the invention; and it is therefore intended that all such modifications and equivalents be covered as they are embraced within the spirit and scope of the appended claims.

What is claimed is:

1. In the process of manufacturing cathode ray tubes for color television, the step comprising; intermittently energizing the grids with RF energy for outgassing the same, the temperature of the grids being sufficient to

expel gases therefrom while maintaining the temperature of the cathode below its activation temperature.

2. The process of claim 1, wherein said step of energizing said grids is periodic, and further comprising the step of periodically and intermittently activating the cathode of the tube alternately with said step of energizing the grids.

3. The process of claim 2 wherein said step of periodically activating said cathode is characterized by a progressively increasing application of heat thereto.

4. The process of claim 2 further comprising the step of intermittently outgassing the filament of the tube prior to activation of the cathode.

5. The process of claim 4 characterized by the final step being a cathode activation sufficient to expel gases from said cathode.

6. A cathode ray tube manufactured according to the method of claim 1.

7. The manufacture of cathode ray tubes for color television, the method comprising: intermittently outgassing the filament of said tube; and intermittently activating the cathode of said tube alternately with and exclusive of said outgassing.

8. The method of claim 7 wherein said step of activating comprises heating said cathode to progressively higher activation temperatures.

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