

PATENT SPECIFICATION

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(54) METHOD FOR MAKING A CATHODE-RAY TUBE

(71) We, RCA CORPORATION, a corporation organized under the laws of the State of Delaware, United States of America, of 30 Rockefeller Plaza, City and State of New York, 10020, United States of America, 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:—

This invention relates to a method for making a cathode-ray tube, particularly degassing the mount-assembly structures thereof by simultaneous exhausting and baking steps prior to sealing the tube.

In making a cathode-ray tube, a luminescent screen and various conductive coatings are applied to various internal surfaces of the envelope. A mount assembly, supported on a glass stem and including the electron gun or guns, is sealed into the neck portion of the tube envelope. The assembled tube, which is open to the atmosphere through a glass tubulation connected to the stem, is baked at about 300° to 450°C and simultaneously exhausted to a relatively low pressure. Then, the tube is tipped off; that is, the tubulation is sealed. Apparatus for carrying out this process is described in the prior art; see, for example, United States Patent Nos. 2,532,315 and 3,115,732.

Near the end of the baking and exhausting cycle, and prior to tipping off, radio-frequency energy at about 1.0 to 1.5 megahertz is applied to the mount assembly to heat and degass the mount structures. Then, electric current is passed through each cathode heater to heat the cathode, decompose the cathode coating material, and degas the cathode structure. It has been suggested to perform these latter two steps either sequentially or simultaneously. However, each of the sequential and simultaneous orders of processing has given disadvantages. Sequential application of radio-frequency energy and heater current does not produce tubes having the highest cathode-emission characteristics, and simultaneous application frequently results in an increase

in the proportion of tubes rejected for unsatisfactory performance.

In accordance with the method of the invention radio-frequency energy and heater current are applied to the mount assembly and cathode heater, respectively, first sequentially and then simultaneously during simultaneous baking and exhausting steps prior to sealing. The initial sequential processing performs the previous functions of degassing the structures and decomposing the cathode coatings. The subsequent simultaneous processing may raise the temperatures of all the structures, e.g. above 450°C to outgas them again. This tends to prevent redeposition of materials released from other structures. As a result, the finished tubes exhibit higher emission currents from their cathode and there is a higher yield of satisfactory finished tubes.

In the drawing, the sole Figure is a schematic plan view of an apparatus for practicing the invention showing the relative locations of the heating zones and the processing positions.

The apparatus shown in the sole Figure comprises a train of carts A moving counter-clockwise along a closed, elongated loop. A generally U-shaped tunnel oven B is located over a portion of the train of carts so as to enclose the tubes being processed. The tunnel is divided into 28 zones numbered 1 through 28. Except for zones 13 and 14, the zones are straight and of equal length of about 10 feet. Bus bars delivering electrical energy for processing the tubes are located along zones 15 through 24 and divided into processing positions C numbered 1 through 42. The processing positions are each about 28 inches in length. This apparatus is similar to the apparatus described in United States Patent No. 2,532,315; however, it employs the improved cart disclosed in United States Patent Nos. 3,115,732.

A sequence of 25V-size color television picture tubes (assembled but not yet exhausted and sealed) is loaded successively, one tube to a cart, onto the train of carts A, which pass continuously into and through the tunnel oven B of this apparatus at the

rate of about 54 to 80 carts per hour. Each tube includes an envelope having a face-plate, a funnel portion, and a glass-neck portion. The neck portion is closed at one end by a glass stem having metal stem leads and a glass tubulation extending outwardly therefrom. The metal stem leads also extend inwardly and support the mount assembly of the tube. The mount assembly includes the electron guns of the tube. Each gun includes an indirectly-heated thermionic cathode having a heated side and an emitting side, a cathode heater spaced from the heated side of the cathode, and a grid (G1) spaced from the emitting side of the cathode. The tubulation is connected to equipment for exhausting gas from the tube and the stem leads are connected so that a current may be passed through the cathode heater. A coil is disposed about the neck so that radio-frequency energy may be applied to the mount assembly of the tube.

Each cart passes through the tunnel oven B in about two to three hours. The temperatures of the zones increase from about room temperature (at zone 1) to about 440°C (at zone 11) and then decrease to about 100°C (at zone 28). During most of the transit through the oven B (zones 1 to 25), pumps are removing gas from the interior of each tube through the exhaust tubulation extending from the stem that is sealed into the tube neck. Starting at zone 17 (processing positions 10 through 18), radio-frequency energy at about 1.0 to 1.5 megahertz is applied to the mount assembly according to the schedule in the Table. No radio-frequency energy is applied at processing positions 19 through 23. However, a cathode-heater current of about 1.1 amps is passed through the cathode heaters with an applied voltage of about 12.0 volts dc at position 23. The applied voltage is higher than the normal operating voltage of about 6.3 volts, and causes the cathode temperature to rise about 150° to 250°C above the normal operating temperature of about 800°C. At processing positions 24 through 28, both radio-frequency energy and cathode-heater current are applied simultaneously to the mount assembly and cathode heaters, res-

pectively, according to the schedule in the Table. The heating effects on the cathode and grids No. 1 (G1) and No. 3 (G3) of the tube, at the various positions, are also shown in the Table. At positions 29 to 34, heat is applied to melt a portion of the tubulation and seal (tip-off) the tube interior from the atmosphere.

The prior factory process follows the schedule shown in the Table, except that the radio-frequency energy (rf) and the cathode heater current (If) are both zero at positions 24 through 28. This permits the temperatures of the cathode, G1, and G3 to drop continuously to about 200°C at position 28 (in zone 21). In the method, on the other hand, the simultaneous application of radio-frequency energy and cathode-heater current at positions 24 through 28 raises the temperatures of the cathode and grid No. 1 above 450°C, preferably above 600°C. This additional high-temperature heating is believed to clean and degas the surfaces of the various structures without causing "lifting" of the coating on the cathode i.e. raising the emission coating from its cathode base structure. Results have shown an increase of about 8 percent in cathode-emission current in the finished tubes and a reduction of the number of tubes rejected due to "lifted" cathode coatings and other causes, as compared with the prior process which employs only the sequential application of radio-frequency energy and cathode-heater current.

While the above example employs a particular schedule on a particular cathode-ray-tube and on a particular machine, the invention is not limited to any of these. The method may be practiced with different schedules and various tubes and on a variety of machines. For example, the invention may be practiced on a stationary machine with periodic tube processing. However, the method does require the sequential application of radio-frequency energy and cathode-heater current, followed by their simultaneous application, to the mount assembly and cathode heater, respectively, preferably for at least two minutes.

TABLE

	Position	rf Amps	If Amps	T°C Cathode	T°C G1	T°C G3
	10	7.0	0	200	300	250
	11	7.0	0	260	400	325
5	12	7.0	0	320	450	375
	13	7.0	0	380	475	425
	14	7.0	0	420	500	475
	15	9.0	0	420	575	505
	16	9.0	0	480	575	575
10	17	12.5	0	560	750	625
	18	12.5	0	640	770	675
	19	0	0	560	550	600
	20	0	0	480	500	525
	21	0	0	400	450	450
15	22	0	0	320	400	375
	23	0	1.1	950	350	300
	24	9.0	0.8	850	525	440
	25	9.0	0.8	860	570	480
	26	9.0	0.8	870	600	520
20	27	9.0	0.8	880	620	560
	28	9.0	0.8	890	640	560
	29	0	0	400	480	420
	30	0	0	320	380	350

WHAT WE CLAIM IS:—

25 1. A method for making a cathode-ray tube comprising an envelope and a mount assembly including at least one cathode and a heater therefor sealed in said envelope, said method including the steps of baking
30 said envelope and mount assembly at about 300° to 450°C and simultaneously exhausting gases from said envelope prior to sealing said envelope wherein during said braking and exhausting steps, radio-frequency
35 energy is applied to said mount assembly and electrical current is applied through said heater, first sequentially and then simultaneously.

40 2. The method in accordance with claim 1, wherein the subsequent simultaneous

application of energies heats said mount assembly including said cathode above 450°C.

3. The method in accordance with claim 2, wherein said subsequent simultaneous
45 application of energies heats said cathode above 600°C.

4. A method of making a cathode-ray tube substantially as described hereinbefore.

5. A cathode-ray tube made by the
50 method of any one of Claims 1—4.

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