

PATENT SPECIFICATION

(11) 1 497 906

- (21) Application No. 18551/75 (22) Filed 2 May 1975
 (31) Convention Application No. 476441
 (32) Filed 5 June 1974 in
 (33) United States of America (US)
 (44) Complete Specification published 12 Jan. 1978
 (51) INT CL² H01J 9/38 29/28
 (52) Index at acceptance

H1D 12B47Y 12B6 12B9 12C 34 4A4 4A7 4F2E 4F2Y 4K4
 4K7D 4K7Y 4K8 9L 9Y



(54) METHOD OF 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 novel method of making a cathode-ray tube, including conditioning a partially-completed tube-bulb assembly for long-term storage and/or long-distance transit.

Typically, a cathode-ray tube such as a shadow-mask color-television picture tube is made by (i) producing a luminescent-screen structure upon the inner surface of a face-plate panel, (ii) heat-sealing the panel to the large opening of a funnel, (iii) heat-sealing a mount assembly to the small opening of said funnel, and then (iv) exhausting and sealing the tube. In some situations, it is desired to store for a relatively long term, e.g., three to thirty days, the partially-completed assembly as it exists after step (ii). In other situations, it is desired to ship such a partially-completed assembly to a manufacturing plant as many as a hundred to three thousand miles away, which may require a relatively long transit time. In both situations, the assembly may be, and usually is, subjected to fluctuations in temperature and humidity.

Some picture tubes have screen structures comprising a layer of aluminum metal, in contact with a layer of carbon particles which may be either crystalline (such as graphite) or amorphous (such as lamp black). The carbon layer may be employed on the viewing side of the screen structure as a light absorbing matrix as described in, for example, U.S. Patent No. 3,558,310; and/or on the gun side of the screen structure as a heat-absorbing layer as described in, for example, U.S. Patent No. 3,703,401. In either or both type structures, the aluminum metal layer becomes progressively degraded in con-

ductivity and reflectance, by converting to aluminum compounds, when the layer is exposed for any extended term to normal ambient water-vapor concentrations in excess of about 2500 ppm (herein meaning parts water vapor per million parts gas by volume), corresponding to a dew point of about +12°F. The degradation starts at random points on the aluminum layer and spreads outwardly therefrom. Even when only small areas of the aluminum layer are degraded in this manner, the tube is rendered unsalable.

In solving a different problem, U.S. Patent No. 3,650,401 suggests flushing the bulb assembly with a dry (dew point -22°F) noncontaminating gas soon after heat sealing the panel to the funnel, and then capping the bulb assembly with a temporary closure. This process has been found to retard the degradation of the aluminum metal layer where there is no carbon layer present. But, where a carbon layer contacts the aluminum metal layer, this conditioning is effective for only a short period of time.

The method of the invention herein follows the procedural steps outlined above except that, just after heat-sealing the panel to the funnel, the following steps are performed: (a) while the tube is still hot (e.g., 150 to 300°F) from the heat sealing the panel to the funnel, the interior of the assembly is flushed with a dry noncontaminating gas, (b) the flushed bulb assembly is cooled to room temperature, (c) then the cooled bulb assembly is reflushed with a dry noncontaminating gas and (d) the reflushed assembly is capped with a temporary closure. A dry gas is hereby defined as containing less than about 1000 parts water vapor per million parts gas. This corresponds to a dew point of about -4°F and lower.

By following these steps (a) through (d), degradation of aluminum metal layers in contact with layers of carbon particles has been substantially entirely prevented for relatively long periods of time, for example, up to thirty-nine days. Experience has shown that a capped, reflushed assembly can be

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exposed over a long term to ambients wherein the temperature fluctuates to as low as 0°F and the humidity fluctuates to a dew point of as high as 70°F (about 100,000 ppm water vapor), without degrading the aluminum layer.

In accordance with an embodiment of the invention, the following steps are employed in making, for example, a shadow-mask cathode-ray tube. A glass faceplate panel is heat sealed to a glass funnel with a devitrifiable glass frit, using a method such as that described in U.S. reissue Patent No. 25,791, to form a bulb assembly. Prior to heat sealing the panel to the funnel, a mask assembly has been mounted in the panel; a luminescent-screen structure comprising a carbon particle layer and an aluminum metal layer has been produced on the inner surface of the panel; and the funnel has been provided with an internal conducting coating, typically of graphite. The funnel is comprised of a cone portion, sealed at its larger end to the faceplate panel, and a cylindrical neck portion, joined to a smaller end of the cone and having its other end open to receive the stem of the mount assembly.

Shortly after the bulb assembly leaves the heat-sealing oven, and while it is still hot (150–300°F) therefrom, the interior of the assembly is flushed with a dry noncontaminating gas. This may be done as shown in Figures 2 to 4 of U.S. Patent No. 3,658,401, by inserting an elongated tube and a surrounding resilient stopper into the open end of the neck portion of the bulb assembly and admitting the dry gas from a gas source through a valve and associated tubing. The upper end of the tubing may be formed with apertures for directing the gas in a desired manner, e.g., outwardly. The outer periphery of the stopper is either noncircular or is formed with longitudinal grooves to permit the residual gases within the bulb assembly to be flushed out by the gas that is introduced. Instead of centering the tubing axially with respect to the stopper, the tubing may be eccentric to the stopper to improve the flushing action. The size of the tubing, the size of the apertures and grooves, and the gas pressure used to introduce the gas are chosen to provide the desired flushing action within the desired flushing time. In one apparatus that has been used successfully in making twenty-five-inch rectangular color picture tubes, the envelope is flushed for about 1 minute and the volume within the bulb assembly is exchanged at least three times.

The dry noncontaminating gas used for flushing is preferably dry warm air containing about 350 ppm water vapor (which has a dew point of about –22°F). The flushing gas should be nonreactive to the tube structure. Air, oxygen, nitrogen, argon, helium,

neon, and mixtures thereof may be used. The water-vapor content of the gas should be less than 1,000 ppm or have a dew point less than about –4°F. Hydrocarbon gases, carbon dioxide, and other contaminants, if any, should be removed from the flushing gas. The temperature of the flushing gas is not critical and may be at, above, or below room temperature.

After the flushing is completed, the flushing apparatus is removed. The flushed bulb assembly is permitted to cool to room temperature, i.e., about 60 to 75°F. Then, the interior of the assembly is again flushed, in the same manner described above, with a dry noncontaminating gas which is preferably warm air having a dew point of about –22°F. Then, a resilient cap, as is shown in Figure 5 of U.S. Patent No. 3,658,401, is applied to cover the neck opening and maintain the bulb assembly filled with the noncontaminating gas at atmospheric pressure for a relatively long term prior to the next manufacturing operation, which is usually the combined gun-insertion and mount-sealing step. It has been found that envelopes so flushed and capped can be held or stored up to six weeks, if necessary or desired, without degradation of the aluminum metal layer of the screen structure.

After storage and/or transit, the cap is removed; the mount assembly is inserted in the neck of the bulb assembly; and the glass stem of the mount assembly is sealed in the neck as shown, for example, in Figure 5 of U.S. Patent No. 3,063,777. The bulb assembly with the mount assembly sealed therein may now be exhausted and baked, to remove gases therein and to degass various of the structures and internal surfaces, by any known method such as that described in U.S. Patent No. 2,532,315. After exhausting and baking the bulb assembly, the tube is completed by performing the conventional steps of activating the cathode, tipping off the exhaust tubulation, flashing the getter, aging the gun electrodes, and testing the tube.

In one test series, six 19-inch faceplate panels were provided with a screen structure comprising a luminescent layer, a light-absorbing matrix, and an aluminum-metal reflecting layer. The panels were baked to remove volatile material, cooled to room temperature and then stored in a plastic bag with desiccant until they were ready for heat sealing. The faceplate panels were sealed to the tube funnel as described above, and afterwards, the gases in the sealed bulb assemblies were examined for moisture content before subsequent processing. As a group, the sealed bulb assemblies had an average moisture content of about 6050 ppm water vapor. The frit-sealed bulbs were divided as follows:

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Bulb I	double-flushed and	not capped
Bulb II	double-flushed and	capped
Bulb III	not flushed and	not capped
Bulb IV	not flushed and	capped
Bulb V	single-flushed and	capped
Bulb VI	single-flushed and	not capped

temperature and humidity. The ambient contained about 3900 ppm water vapor (dew point of about +22°F). The bulbs were examined for defects to the aluminum-metal layer and to the screen. Only Bulb II, double-flushed and capped, did not have moisture defects. The following Table contains a summary of the moisture levels in ppm of water vapour by volume during the test using a du Pont 510 moisture analyzer.

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After the above processing, all six bulbs were placed in an environmental chamber and cooled from room temperature to 0°F, held for two hours, and quickly returned to room

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TABLE

		Before Flush	Dew Point	After 1st Flush	Dew Point	After 2nd Flush	After Cycle	Dew Point
25	Bulb I	6000	+32°F	500	-16°F	300	3000	+15°F
	Bulb II	5500	+30°F	300	-25°F	100	800	-7°F
	Bulb III	6000	+32°F	—	—	—	4000	+23°F
	Bulb IV	6000	+32°F	—	—	—	4000	+23°F
	Bulb V	6200	+32.5°F	350	-23°F	—	2800	+14°F
30	Bulb VI	6000	+32.5°F	400	-20°F	—	2500	+12°F

WHAT WE CLAIM IS:—

1. In a method of making a cathode-ray tube including the steps of (i) producing a luminescent viewing-screen structure having an aluminum metal layer in contact with a layer of carbon particles, said structure being supported on the inner surface of a faceplate panel, (ii) heat sealing said panel to the large opening of a funnel part of the tube, and (iii) thereafter heat sealing a mount assembly to the small opening of said funnel, the inclusion just after step (ii) but before step (iii), of the further steps of (a) flushing the interior of the panel and funnel assembly with a dry (as hereinbefore defined) non-contaminating gas, while it is still hot from heat sealing, (b) cooling the flushed assembly to

room temperature, (c) reflushing the cooled assembly with a dry noncontaminating gas, and (d) then capping the small opening of said funnel with a temporary closure.

2. The method according to claim 1, wherein said noncontaminating gas is air.

3. A double flushing method of making a cathode ray tube at least to the stage of having its face-plate panel provided with its viewing screen and sealed to its funnel, substantially as hereinbefore described.

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10 Bulb I double-flushed and not capped
Bulb II double-flushed and capped
Bulb III not flushed and not capped
Bulb IV not flushed and capped
Bulb V single-flushed and capped
Bulb VI single-flushed and not capped

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	Bulb IV	6000	+32°F	—	—	—	4000	+23°F
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room temperature, (c) reflushing the cooled assembly with a dry noncontaminating gas, and (d) then capping the small opening of said funnel with a temporary closure.

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