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Nakamura et al.

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[54] **COLOR CATHODE RAY TUBE HAVING GAS FOR CONDUCTION OF HEAT FROM SHADOW MASK**

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[73] Assignee: **Mitsubishi Kenki Kabushiki Kaisha,** Tokyo, Japan

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[21] Appl. No.: **355,100**

[30] **Foreign Application Priority Data**

May 8, 1972 Japan 47-45129

[52] **U.S. Cl.** **313/481;** 313/408

[51] **Int. Cl.** **H01j 29/00;** H01j 31/20

[58] **Field of Search** 313/224, 481

[56] **References Cited**

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Attorney, Agent, or Firm—Oblon, Fisher, Spivak, McClelland & Maier

[57] **ABSTRACT**

A shadow mask color cathode-ray tube and a process for the preparation thereof. In a color cathode-ray tube having a shadow mask, an electron beam having an energy of about 26 KV. and 1.0 mA. is directly received by the shadow mask. A part of the energy is converted to thermal energy, resulting in the thermal expansion of said shadow mask to cause undesirable phenomenon. According to the present invention, an inert gas is filled in said cathode-ray tube whereby the thermal radiation of said shadow mask is improved to reduce the deviation of said beam that causes color breakup.

3 Claims, 7 Drawing Figures

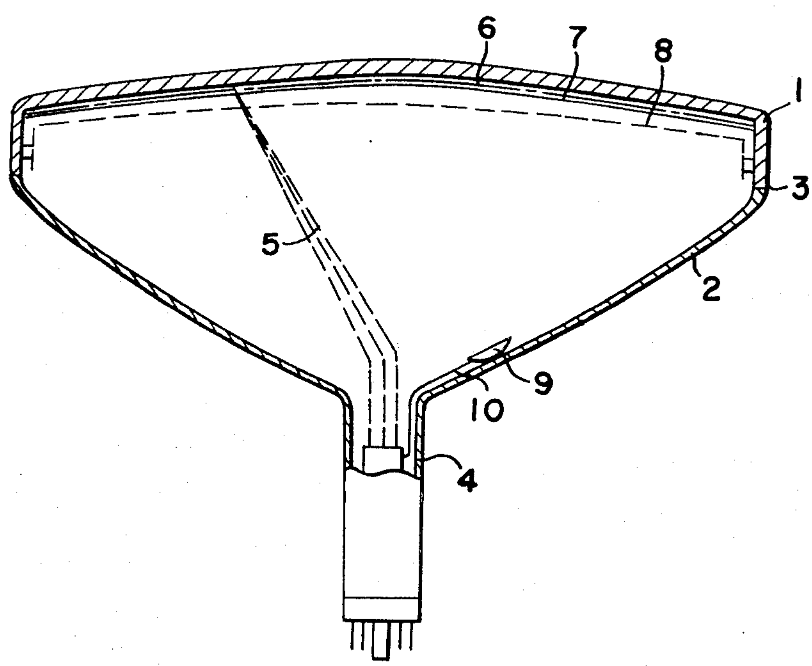


FIG. 1

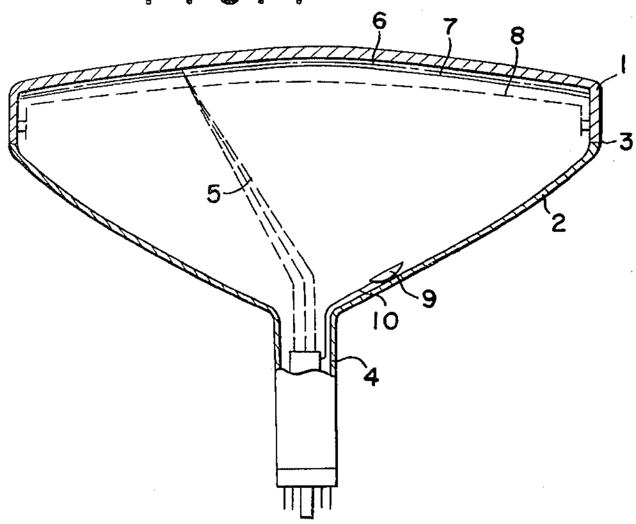
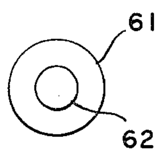


FIG. 2a



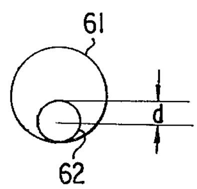


FIG. 2b

FIG. 3

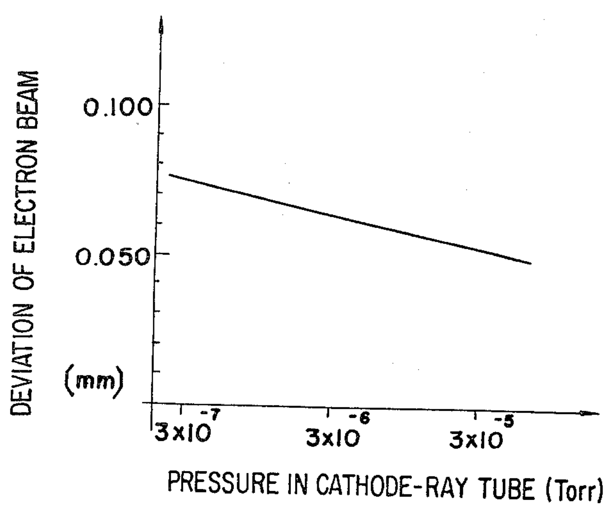


FIG. 4

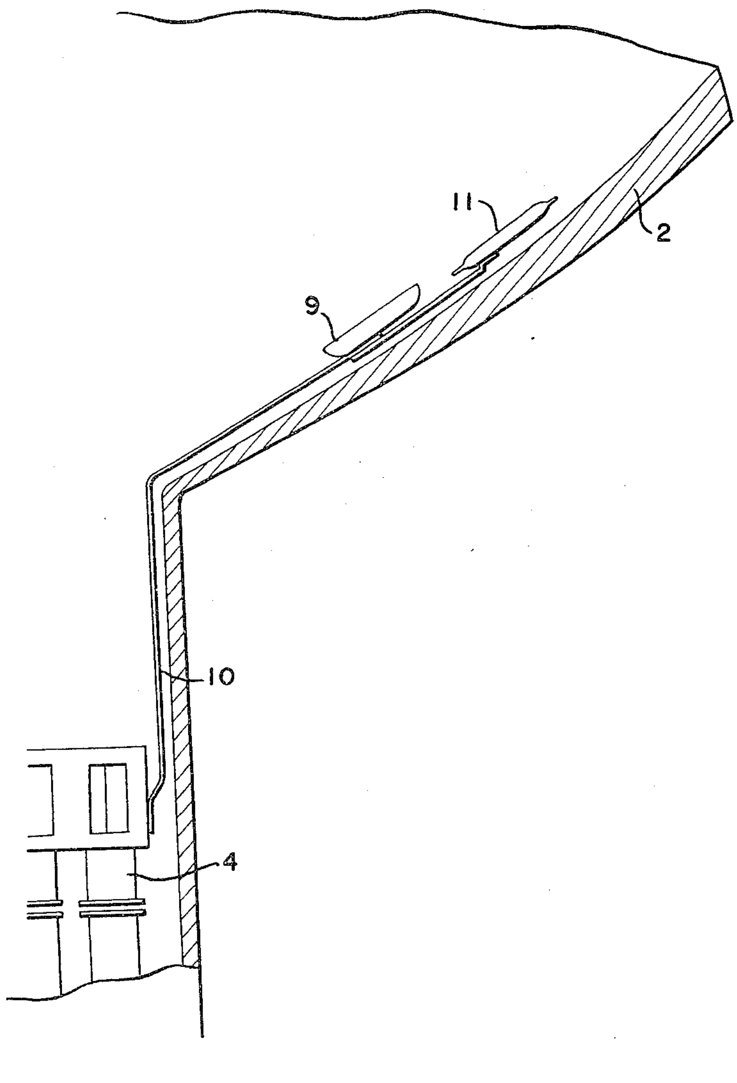


FIG.5

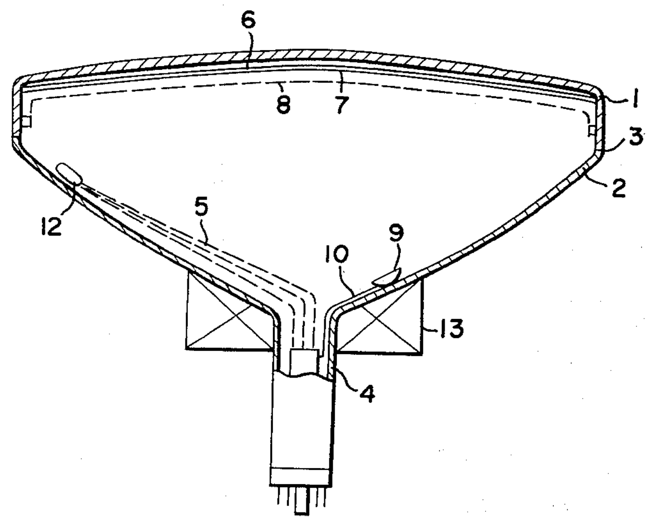
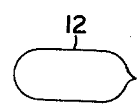


FIG.6



COLOR CATHODE RAY TUBE HAVING GAS FOR CONDUCTION OF HEAT FROM SHADOW MASK

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a shadow mask color cathode-ray tube, and more particularly to a solution to the problem of color breakup caused by the thermal expansion of the shadow mask.

2. Description of the Prior Art

In general, a shadow mask color Braun or cathode-ray tube comprises a group of three electron guns which emit electron beams, a flourescent screen having a group of three color flourescent dots illuminated by the irradiation from the electron beams, and a shadow mask placed between the electron guns and the floures-cent screen. The shadow mask is made of a thin metal plate having a predetermined curvature which is placed adjacent the flourescent screen. The metal plate has small holes corresponding to each of the three color fluorescent dots. For example, a commercial 20 inch color cathode-ray tube has about 400,000 of such holes. The three electron beams generated from the group of electron guns are crossed at the shadow mask to pass through the small holes to irradiate the fluorescent dots. Generally, the total area of the small holes is about 15% of the total area of the shadow mask. Thus, when the electron beams are scanned through the whole surface of the shadow mask, the electron beams finally irradiated on the fluorescent dots through the small holes comprise about 15% of the total beams. The remaining 85% of the electron beams collide with the shadow mask which converts them to thermal energy. Accordingly, the temperature of the shadow mask rises, which causes a deformation of the curved surface by thermal expansion. This leads to a disordering of the relative positions of the small holes and the flourescent dots, whereby a specific electron beam does not irradiate the desired fluorescent dot which causes an undesirable phenomenon known as color breakup.

In order to overcome the above-mentioned difficulty, the following methods or combinations thereof have been employed:

1. A method for preventing the deviation of an electron beam from the fluorescent material dot by reducing the electron beam radius to less than fluorescent dot radius, even when the electron beam is deviated by the displacement of the small hole of the shadow mask.
2. A method for compensating the thermal deformation by employing a bimetal supporter to hold the shadow mask on the cathode-ray tube body.
3. A method for reducing the thermal deformation of the shadow mask by employing a special connecting structure between the supporter and the shadow mask. However, when the deviation in time or the thermal deformation is high, the compensation range is inadequate by said methods.

In case (1) above, there is a substantial disadvantage in that the luminous area of the fluorescent dots is reduced to cause a dark picture. Accordingly, in practice, the color breakup phenomena is difficult to overcome.

This is especially true in a structure having a dark background and light local parts, wherein the electron beams are concentrated upon the light local parts which locally heats the shadow mask to cause the thermal expansion; this is referred to as the "local doming

phenomenon". As the local doming phenomenon occurs in different places and for different durations, it is difficult to compensate for thermal expansion by such methods. It appears that in order to compensate for the thermal expansion due to the local doming phenomenon, it would be most advantageous to improve the thermal radiation characteristics of the shadow mask.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide a shadow mask color cathode-ray tube for preventing color breakup due to thermal expansion by improving the thermal radiation characteristics of the shadow mask.

It is another object of this invention to provide a shadow mask color cathode-ray tube wherein an inert gas, especially the gases belonging to group O of the Mendelejeff periodic table, is filled in the cathode-ray tube to improve the thermal radiation characteristics of said shadow mask.

The conventional gas charge process, which is well-known in the electronic tube industry, comprises connecting the tube to an exhauster to discharge air in the tube by a vacuum pump, then charging a gas from a by-pass passage of the vacuum circuit connecting the tube with the vacuum pump, and then sealing the tube. This conventional process has disadvantages in that the degree of vacuum in the tube is sometimes decreased by operating or apparatus trouble which results in electronic tubes having a low degree of vacuum. It is additionally difficult to accurately control the amount of the sealed gas and generally a complicated gas sealing apparatus is necessary for this purpose. It should be noted that the amount and partial pressure of the inert gas sealed in the tube, especially a gas from Group O of the Mendelejeff periodic table, should be accurately controlled.

Accordingly, it is an additional object of this invention to provide a new process for simply and accurately controlling the amount and partial pressure of a gas sealed in a cathode-ray tube.

BRIEF DESCRIPTION OF THE DRAWINGS

Various objects, features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description of the present invention when considered in connection with the accompanying drawings, in which:

FIG. 1 is a sectional view of a shadow mask color cathode-ray tube;

FIG. 2 is a schematic view for showing the deviation of the beam;

FIG. 3 is a graph showing the relation between the deviation of the beam to the pressure in the cathode-ray tube;

FIG. 4 is an enlarged partial sectional view of the funnel part of the cathode-ray tube;

FIG. 5 is a sectional view of a shadow mask color cathode-ray tube containing a capsule; and

FIG. 6 is a front view of the capsule shown in FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, wherein like reference numerals represent identical or corresponding parts throughout the several views, and more particularly to FIG. **1** thereof, one preferred embodiment of a shadow mask color cathode-ray tube according to this invention is illustrated. The reference numeral **1** designates a panel and **2** designates a funnel having a neck part and a funnel part wherein the open end of the funnel part is sealed with the panel **1.** The reference numeral **3** designates the sealing part between panel **1** and funnel **2; 4** designates a group of three electron guns held in the neck part of funnel **2,** and electron beams **5** are irradiated from the electron guns. The reference numeral **6** designates a fluorescent screen having fluorescent dots which are illuminated by the irradiation of the electron beams. An aluminum back layer **7** is placed on the fluorescent screen **6** at the electron gun side, and a shadow mask **8** is adjacent fluorescent screen **6** placed on the inner surface of the panel **1.** A getter **9** is positioned at the funnel part of funnel **2** and the getter is held by the electron guns **4** through a spring plate **10.** The getter **9** comprises a vessel containing a getter metal, e.g. barium, to form a getter deposition membrane (not shown in the drawing) by vaporizing the getter metal through heating.

In the above-described shadow mask color cathode-ray tube, in order to improve the thermal radiation characteristics of the shadow mask **8,** a conventional vacuum process is applied to provide a high vacuum condition within the cathode-ray tube. Then a gas of Group O of the Mendelejeff periodic table is sealed in the tube at the partial pressure of $10^{-2} - 10^{-7}$ Torr. By way of example, the gas may comprise argon, neon, helium, xenon, radon or krypton. The sealed gas of Group O is inert so that the gas does not affect the normal functions of the cathode-ray tube.

However, since the specific heat of the gas so inserted is relatively low, the thermal energy transmitted when atoms or molecules of the gas collide with shadow mask **8** is applied to the tube body, i.e., the panel **1** and the funnel **2,** so as to improve the thermal radiation of shadow mask **8.** Accordingly, the advantage lies in reducing the color breakup by irradiating the particular electron beam **5** to different fluorescent dots without irradiating the object fluorescent dots by any thermal expansion of the shadow mask **8.**

An experiment was conducted to measure the amount of the sealed gas and the deviation of the beam on the fluorescent dot, and the results thereof appear in FIGS. **2** and **3.** In FIG. **2,** the reference numeral **61** designates green fluorescent dots, and **62** designates luminance points resulting from the electron beam **5.** A distance d of the deviation was measured on the fluorescent screen of the panel by using a microscope. The dots **61** were offset from the center of the tube by 100 mm.

FIG. **2**(a) shows the relation of the green fluorescent dot **61** at a beam current of 50 μA to the luminance point **62** resulting from the electron beam **5,** wherein the center of the fluorescent material dot **61** coincides with the center of the luminance point **62.** FIG. **2**(b) shows the deviation d from the center of the fluorescent dot **61** to the center of the luminance point **61** 4.5 minutes after increasing the beam current from 50 μA to 1200 μA. The anode voltage during the operation of the color cathode-ray tube at a beam current of 1200 μA was 23.8 KV.

FIG. **3** shows the relation between the pressure of an amount of sealed gas of the Group O (here, argon gas) to the deviation d. The horizontal axis represents the inner pressure of the color cathode-ray tube and the vertical axis represents the divergence or deviation d. When the argon gas was not charged, the pressure was 3×10^{-7} Torr and the deviation d was 0.074 mm. When the argon gas was charged to the pressure of 3×10^{-5} Torr, the deviation d was 0.053 mm. In this experiment, the total remaining gas pressure in the tube was measured by a B-A ion gauge, and the partial pressure of the argon gas in the tube was confirmed by employing the Omeger Torron.

In the preparation of a cathode-ray tube, the step of the getter vapor deposition, wherein the getter **9** is vaporized by heating from the outer side of the tube by high-frequency heating or the like, the getter is deposited on the inner surface of the tube for forming the getter deposited membrane. This step is performed for increasing the degree of vacuum in the tube and for preventing the collision between atoms and molecules of the remaining gas with the cathode so as to break the cathode. The remaining gas in the tube is absorbed in the getter deposited membrane.

However, according to the present invention, the gas of Group O sealed in the tube is an inert gas. Accordingly, the inert gas does not chemically react to be absorbed. Only the physical absorption of the inert gas is found, but the absorption velocity is negligible and the absorption force is weak, so that the inert gas of Group O is substantially not absorbed, and the partial pressure of the inert gas is not changed, while the remaining gas is absorbed to decrease the partial pressure thereof.

When the partial pressure of the inert gas of Group O is lower than 10^{-2} Torr, the cathode deterioration caused by the collision of ions is negligible. However, when the partial pressure of the inert gas is too low, the object of this invention cannot be attained. Accordingly, the inert gas is sealed in the range of partial pressure of 10^{-2} Torr to 10^{-7} Torr. However, as stated above, in order to seal the inert gas of Group O in the tube with high accuracy, it is not suitable to employ the above-mentioned gas seal method. Thus, the cathode-ray tube of the present invention must be prepared differently, as will become more clear hereinafter.

Referring now to FIG. **4,** an example of the novel preparation of the cathode-ray tube according to the present invention will now be explained. FIG. **4** is an enlarged partial sectional view of the funnel part of the funnel **2** of the cathode-ray tube, wherein a capsule **11** sealably contains a predetermined amount of inert gas of Group O and is supported in the tube by getter **9** and associated structure. After exhausting the tube by a conventional exhauster to achieve a high degree of vacuum, the capsule **11** is heated from the outside by high frequency heating whereby the capsule becomes deformed by the thermal expansion of the gas therein to thereby discharge the gas in the tube.

The capsule **11** can be prepared by cutting a metal pipe to a predetermined length so as to contain a constant amount of the sealed gas, sealing the inert gas of Group O under a constant pressure, nipping both ends of the pipe and sealing the ends. The temperature of the capsule **11** when discharging the sealed gas by the thermal expansion, can be selected depending upon the hardness of the capsule and the shape of the sealed part. However, it is necessary for the temperature to be higher than the baking temperature of the tube during the exhausting step, and it is preferably higher than 300°C. When the capsule **11** is heated from outside the tube, the sealed gas is easily discharged from the sealed part of the capsule **11** by the thermal expansion of the sealed gas. The partial pressure of the gas discharged in the tube can be accurately controlled by adjusting the inner sectional area and length. As an example, when a gas having a pressure of 1 Torr is sealed in a pipe having an inner sectional area of 0.1 cm^2 and a length of 1 cm. and is discharged in 10l of a cathode-ray tube, the resulting pressure is 7.6×10^{-3} Torr.

Referring now to FIG. **5**, another example of the preparation of a cathode-ray tube is illustrated. FIG. **5** is a sectional view of the shadow mask color cathode-ray tube. The inert gas of Group O is sealed in a capsule **12**, shown more clearly in FIG. **6**, which is preferably made of a heat meltable material such as glass having a thickness of about 0.1 – 0.2 mm. The capsule is fixed on the funnel part of the funnel **2** with a thermosetting glass cement such as frit glass. After exhausting the tube to a high vacuum, an electron beam **5** generated from an electron gun **4** is deviated by a deflection coil **13** to collide with the capsule **12** to form a hole therein, whereby the sealed gas in the capsule **12** is then discharged into the tube.

As stated above, when an inert gas of Group O of the Mendelejeff periodic table is sealed at a partial pressure of 10^{-2} Torr to 10^{-7} Torr, the thermal radiation of the shadow mask can be improved without any deterioration of the characteristics of the cathode-ray tube, since the gas of Group O is inert. Accordingly, the present invention makes it possible to prepare the cathode-ray tube having a low color breakup. Moreover, the gas of the Group O can be supplied with high accuracy in the cathode-ray tube, since the gas of Group O can be sealed in a capsule placed in the tube and then discharged by a relatively simple method after exhausting and sealing the tube to a high vacuum.

Incidentally, in the above embodiment, gases of Group O are employed; however, a similar result can be attained by employing any gas inert to the cathode plate such as hydrogen, nitrogen, a hydrocarbon gas or the like. Accordingly, and quite obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described herein.

What is claimed as new:

1. An improved shadow mask color cathode-ray tube comprising:

an air-tight tube comprising a panel and a funnel having a neck part and a funnel part wherein the funnel part is sealed to said panel to form an air-tight enclosure,

a fluorescent screen having numerous three color fluorescent dots arranged in a pattern and disposed within said tube adjacent to said panel,

three electron guns disposed within said tube for emitting three electron beams having an energy of about 26 KV and 1.0 mA which strike said fluorescent dots causing them to fluoresce where struck,

a shadow mask containing numerous openings corresponding to the pattern of the three color fluorescent dots disposed within said tube adjacent said fluorescent screen between said fluorescent screen and said electron guns,

a gas having a low specific heat disposed in said tube at a partial pressure in the range of 10^{-2} to 10^{-7} Torr., for distributing to the walls of said tube the heat caused by said electron beams striking said shadow mask thereby preventing thermal deformation of said shadow mask.

2. The shadow mask color cathode-ray tube according to claim **1**, wherein said sealed gas is selected from the group consisting of the gases of Group O which comprise helium, neon, argon, krypton, xenon, and radon.

3. The shadow mask color cathode-ray tube according to claim **1**, wherein said sealed gas is selected from the group consisting of hydrogen, nitrogen and hydrocarbon gas.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,906,281
DATED : September 16, 1975
INVENTOR(S) : Koji Nakamura et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Change Assignee from "Mitsubishi Kenki Kabushiki Kaisha" to --Mitsubishi Denki Kabushiki Kaisha--.

Signed and Sealed this

ninth **Day of** *March 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks