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Datasheet for the decision
of 20 October 2009

Case Number:	T 1645/06 - 3.4.03
Application Number:	99890066.6
Publication Number:	0987734
IPC:	H01J 29/86
Language of the proceedings:	EN

Title of invention:
Cathode ray tube

Applicant:
Samsung Display Devices Co., Ltd.

Opponent:
-

Headword:
-

Relevant legal provisions:
-

Relevant legal provisions (EPC 1973):
EPC Art. 54(1),(2), 56

Keyword:
"Novelty (yes) - after amendment"
"Inventive step (no) - after amendment"

Decisions cited:
-

Catchword:
-

Case Number: T 1645/06 - 3.4.03

D E C I S I O N
of the Technical Board of Appeal 3.4.03
of 20 October 2009

Appellant:	Samsung Display Devices Co., Ltd. 575, Sin-Dong Paldal-Ku Suwon-Si Kyunggi-Do (KR)
Representative:	Schwarz, Albin Kopecky & Schwarz Patentanwälte Wipplingerstraße 30 AT-1010 Wien (AT)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted 26 May 2006 refusing European patent application No. 99890066.6 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman:	G. Eliasson
Members:	R. Q. Bekkering J. Van Moer

Summary of Facts and Submissions

I. This is an appeal against the refusal of application 99 890 066 for lack of clarity, Article 84 EPC 1973, and lack of novelty, Article 54(1) and (2) EPC 1973, over

D1: EP 0 833 364.

II. At oral proceedings before the board, the appellant applicant requested that the decision under appeal be set aside and that a patent be granted on the basis of the request submitted during the oral proceedings.

III. Claim 1 reads as follows:

"*A cathode ray tube comprising:*
a rectangular panel (3) on which a phosphor screen is formed;
a cylindrical neck (11) in which an electron gun is disposed; and
a funnel (5) formed contiguous to the panel, wherein the funnel (5) includes a cone part (5a) at the area where a deflection yoke (7) is mounted whose interior surface has a circular cross-section at the position contiguous to the neck (11), and the circular cross-section is deformed from the neck side to the panel side to have a non-circular cross-section having a maximum diameter along a direction other than the horizontal and vertical axis, and perpendicular distances from the longitudinal funnel axis to the interior surface of the cone part are non-linearly increasing or decreasing, characterized in that the vertical interior surface of the cone part (5a) is

convexed to the funnel axis and has the maximum value at the position of the cone part (5a) which is closest to the panel with fulfilling the following condition,
$\Delta H/rd=0.16$
where rd represents a distance from the funnel axis to the interior surface of the funnel at the diagonal direction, and ΔH represents a distance from a vertical line (L_v) which connects the neighbouring two corner points formed at the convexed vertical interior surface of the cone part (5a) to the top of the convexed vertical interior surface, and the horizontal interior surface of the cone part (5a) at the non-circular cross-section is convexed to the funnel axis and has the maximum value at the position of the cone part (5a) which is closest to the panel with fulfilling the following condition,
$\Delta V/rd=0.34$
where rd represents a distance from the funnel axis to the interior surface of the funnel at the diagonal direction, and ΔV represents a distance from a horizontal line (L_h) which connects the neighbouring two corner points formed at the convexed horizontal interior surface to the top of the convexed horizontal interior surface and in that the ΔH/rd increases as the rd increases and the ΔV/rd increases as the rd increases".

IV. The appellant in substance provided the following arguments:

The objective problem solved by the application was the selection of the optimal convexity of the cone part for low power consumption of the deflection yoke and high vacuum stress resistance. Document D1 only provided for values of ΔH/rd and ΔV/rd of about 0.1 and thus for a much smaller convexity. As the application provided for the first time the relevant boundary conditions, the presence of an inventive step had to be recognised.

Reasons for the Decision

1. The appeal is admissible.

1.1 *Novelty*

1.1.1 *Document D1*

Document D1, corresponding to the Japanese document cited in the application as originally filed (description page 3, second paragraph), is concerned with a cathode ray tube comprising a rectangular panel (3) on which a phosphor screen is formed, a cylindrical neck (7) in which an electron gun is disposed and a funnel (4) formed contiguous to the panel (page 4, lines 15 to 32; figures 1 and 2). The funnel (4) includes a yoke attachment portion (12) to which a deflection yoke (11) is attached.

The yoke attachment portion (12) is substantially pyramidal. In detail, the cross section of the outer surface of the yoke attachment portion (12), which is perpendicular to the tube axis and located near the joint between the neck (7) and the funnel, is circular like the neck, as shown in figure 4. However, the cross sections of the outer surface of the yoke attachment portion at an intermediate position between the two axial ends of the yoke attachment portion and at the axial end thereof on the phosphor screen side are substantially rectangular in correspondence with the shape of the effective portion (1) of the face panel (3), as shown in figures 5 and 6 (page 4, lines 33 to 38; figures 4 to 6).

In contrast, as shown in figures 5 and 6, in a cross section perpendicular to the tube axis of the yoke attachment portion, the inner contour of the yoke attachment portion is not completely rectangular, but pincushion-shaped, i.e. all the sides are projected toward the tube axis. Each of shorter sides of the inner contour of the yoke attachment portion has a convexity having a peak on the horizontal axis and each of longer sides has a convexity having a peak on the vertical axis. Moreover, each corner has arced surfaces both inside and outside (page 4, lines 46 to 53).

The shape of the inner contour of a cross section of the yoke attachment portion is defined as follows. In a cross section perpendicular to the tube axis Z of the yoke attachment portion (12) as shown in figure 7, the intersection of the inner contour of the yoke attachment portion and a line passing through the tube axis Z and defining an angle θ with the horizontal axis X is represented by $Pi(\theta)$, the shortest distance between $Pi(\theta)$ and the horizontal axis X is represented by $Piv(\theta)$, and the shortest distance between $Pi(\theta)$ and the vertical axis Y is represented by $Pih(\theta)$. The inner contour of the yoke attachment portion has a shape such that $Piv(\theta)$ is expressed by a non-monotone increasing or decreasing function which has a maximum value at an angle θ_0 ($0 < \theta_0 < 90$), and $Pih(\theta)$ is expressed by a non-monotone increasing or decreasing function which has a maximum value at an angle θ_0 ($0 < \theta_0 < 90$) (page 5, lines 7 to 16).

Accordingly, document D1 discloses, using the terminology of claim 1, a cathode ray tube comprising:
a rectangular panel (3) on which a phosphor screen is formed;
a cylindrical neck (7) in which an electron gun is disposed; and
a funnel (4) formed contiguous to the panel, wherein the funnel includes a cone part (12) at the area where a deflection yoke (11) is mounted whose interior surface has a circular cross-section at the position contiguous to the neck (7), and the circular cross-section is deformed from the neck side to the panel side to have a non-circular cross-section having a maximum diameter along a direction other than the horizontal and vertical axis (ie is pincushion-shaped), and perpendicular distances from the longitudinal funnel axis to the interior surface of the cone part are non-linearly increasing or decreasing (ie as a function of an angle θ as defined above).

Document D1, thus, discloses a cathode ray tube according to the preamble of claim 1. This is, in fact, uncontested by the appellant.

1.1.2 In a concrete example of D1 (see page 5, lines 17 to 34, table 1 and figures 5 and 6) the outer surface is substantially rectangular and the distances from the tube axis to the outer surface of the yoke attachment portion along the diagonal axis, horizontal axis and vertical axis are 30.4 mm, 27.2 mm and 22.6 mm, respectively. The thickness of the yoke attachment portion in example "Type C" is 3.3 mm along the diagonal axis, 6.0 mm along the horizontal axis and 6.0 mm along the vertical axis.

According to claim 1, the vertical interior surface of the cone part (5a) is convexed to the funnel axis and has the maximum value at the position of the cone part (5a) which is closest to the panel fulfilling the following condition,

$$\Delta H/rd=O.16$$

where rd represents a distance from the funnel axis to the interior surface of the funnel at the diagonal direction, and ΔH represents a distance from a vertical line (Lv) which connects the neighbouring two corner points formed at the convexed vertical interior surface of the cone part (5a) to the top of the convexed vertical interior surface, and the horizontal interior surface of the cone part (5a) at the non-circular cross-section is convexed to the funnel axis and has the maximum value at the position of the cone part (5a) which is closest to the panel fulfilling the following condition,

$$V/rd=O.34$$

where rd represents a distance from the funnel axis to the interior surface of the funnel at the diagonal direction, and ΔV represents a distance from a horizontal line (Lh) which connects the neighbouring two corner points formed at the convexed horizontal interior surface to the top of the convexed horizontal interior surface.

The fact that in the application the corners are arced introduces some ambiguity as to where exactly the "corner points", used in the above claimed definition of the vertical and horizontal lines and thus of ΔH and ΔV, are. Still, it can be roughly held that in the above example of D1 both ΔH and ΔV are about 3 mm, rd=27.1 mm and, thus, ΔV/rd and ΔH/rd are about 0.1.

In document D1 the yoke attachment portion (12) has a circular inner surface cross section at the neck side and becomes convex in both the horizontal and the vertical direction toward the panel. Since the yoke attachment portion provides a gradual transition from the circular, concave inner surface at the neck side to a pincushion-shaped, convex inner surface towards the panel, it is bound to have a position where ΔH=0 and ΔV=0 and, accordingly, where ΔH/rd=0 and ΔV/rd=0. From this position, the value of ΔH/rd and ΔV/rd will increase towards the panel side and reach a maximum value at some point. The value of ΔH/rd and ΔV/rd, thus, increases as rd increases, as required by claim 1. Furthermore, since in the application the extension of the cone part toward the panel is not defined, inevitably in D1 the claimed condition that the maximum value of the convexity is at the position of the cone part which is closest to the panel holds true.

Accordingly, all features of claim 1 are known from document D1 with the exception that the maximum values of ΔH/rd and ΔV/rd are 0.16 and 0.34, respectively, and thus larger than those of D1 which are both about 0.1.

1.1.3 The subject-matter of claim 1 is thus new over document D1 (Article 54(1), (2) EPC 1973). It is also new over the remaining available, more remote prior art.

1.2 *Inventive step*

1.2.1 According to document D1, which provides the closest prior art, the shape of the inner contour of the yoke attachment portion (12) is determined in accordance with the shape of an electron beam passage region (28) in the yoke attachment portion. As a result of detailed analysis of orbits of electron beams in cathode ray tubes of the in-line self-convergence type, the following fact was quantitatively confirmed: when a substantially rectangular raster is drawn on the phosphor screen, the electron beam passage region (28) is not completely rectangular but distorted like a pincushion, i.e., the sides of the outer contour of the electron beam passage region (28) are curved inwardly toward the tube axis Z. Based on this analysis, the inner contour of the cross section of the yoke attachment portion (12) is formed of curved sides as described above to form a pincushion shape similar to the shape of the cross section of the electron beam passage region (28), so that the inner surface of the yoke attachment portion (12) can be as close as possible to the electron beam passage region (28). For example, the distance between the inner surface of the yoke attachment portion (12) and the electron beam passage region (28) is set to about 1 mm (page 4, line 54 to page 5, line 6).

Thus, in the cross section of the yoke attachment portion (12) of the funnel (4), the outer contour is substantially rectangular and the inner contour has four convex sides curved inwardly toward the tube axis. With this structure, the inner surface of the yoke attachment portion can be close to the electron beam passage region (28) to the possible limit. In addition, the yoke attachment portion (12) can be thick in portions near the horizontal and vertical axes, thereby increasing the strength of the yoke attachment portion. Therefore, the strength against the atmospheric pressure of the vacuum envelope (10) can be increased, and the deflection efficiency of the deflection yoke (11) can be improved to reduce the deflection power (page 5, lines 17 to 23).

Specifically, as is clear from the examples in the table on page 5 of D1, the vacuum stress is considerably reduced, as the thickness of the yoke attachment portion along the horizontal and vertical axes is increased. In the "Type C" example discussed above, as shown in figures 5 and 6, the distance between the inner surface of the yoke attachment portion and the electron beam passage region along the horizontal and vertical axes is reduced to the possible limit, about 1 mm. The shape of the pyramidal yoke attachment portion on a plane perpendicular to the tube axis substantially coincides with the orbit of the electron beams not only in the diagonal direction but also in the horizontal and vertical directions, at any position of the yoke attachment portion along the tube axis direction. As a result, the vacuum stress at maximum can be as low as 1100 pis and the deflection power can be 22% reduced as compared to the conventional cathode ray tube.

Thus, a cathode ray tube is provided, in which the yoke attachment of the funnel has a sufficient glass thickness, even if the yoke attachment portion is pyramidal, and which satisfies the demand for high luminance and high-frequency deflection, by effectively reducing the deflection power, while maintaining sufficient strength against the atmospheric pressure of the vacuum envelope (page 5, line 48 to page 6, line 2).

These are in fact the same consideration provided in the application, according to which the object of the invention is to provide a cathode ray tube capable of effectively deflecting electron beams, and thereby reducing the deflection power consumption and having increased strength against external stress (page 4, lines 5 to 8).

The technical effect of the above distinguishing feature of claim 1 with respect to D1, ie the larger maximum values of $\Delta H/rd$ and $\Delta V/rd$ of 0.16 and 0.34, respectively, and thus the larger convexity of the inner surface of the cone part, is an adaptation to a differently shaped (ie more convex pincushion-shaped) electron beam passage region in the cone part. Obviously, it is only possible to increase the convexity of the inner surface of the cone part if the convexity of the electron beam passage region is increased, as otherwise the electron beam would hit the inner surface and fail to reach the panel.

The electron beam passage region is generally defined by the geometry of the tube, in particular the aspect ratio of the panel, the length of the neck with respect to the panel size etc., and by the deflection yoke, and may as a consequence vary.

The objective problem to be solved relative to D1, thus, is to adapt the pincushion-shaped cone part of D1 to a particular tube with a given pincushion-shaped electron beam passage region.

1.2.2 The problem *per se* is obvious to a person skilled in the art of cathode ray tube technology, as the teaching of D1 is applicable to different tube types.

A skilled person faced with the task of constructing the cone part of a cathode ray tube with a given geometry and a given deflection yoke would, following the teaching of document D1, first determine the electron beam passage region in the cone part and then adjust the inner surface of the cone part to be as close as possible to the electron beam passage region. The claimed maximum values for ΔH/rd and ΔV/rd of 0.16 and 0.34, respectively, have been obtained in this manner (see application, page 10, lines 7 to 10). Hence, these values correspond to the values the skilled person, depending on the circumstances, would arrive at without exercising inventive skills.

1.2.3 The appellant argued that the objective problem solved by the application was the selection of the optimal convexity of the cone part for low power consumption of the deflection yoke and high vacuum stress resistance. Document D1 only provided for values of ΔH/rd and ΔV/rd of about 0.1 and thus for a much smaller convexity. In fact, as the type B example of D1 provided virtually the same vacuum stress resistance as example type C, however with a thickness of the yoke attachment portion of only 4 mm in both the horizontal and the vertical direction, rather than the 6 mm of the type C example, the skilled person would prefer the even less convex type B example. The application provided for the first time the relevant boundary conditions.

However, as discussed above, the provision of a convex cone part inner surface as well as the underlying consideration that the cone part should be optimised so as to on the one hand be as close as possible to the electron beam passage region, so as to allow the yoke to be as close as possible to the electron beam and hence reduce the deflection power, and on the other hand to provide the cone part with sufficient thickness, so that it is resistant against the vacuum stress, is already known from document D1. Furthermore, in D1 the type C example is presented as the preferred embodiment, as the distance between the inner surface yoke attachment portion and the electron beam passage region is reduced to the possible limit and at the same time the vacuum stress is at its lowest value.

1.2.4 Accordingly, the subject-matter of claim 1 is obvious to a person skilled in the art and thus lacks an inventive step in the sense of Article 56 EPC 1973.

Order

For these reasons it is decided that:

The appeal is dismissed.

Registrar	Chair
S. Sánchez Chiquero	G. Eliasson