

CRT Strategy against Flat Panel Display

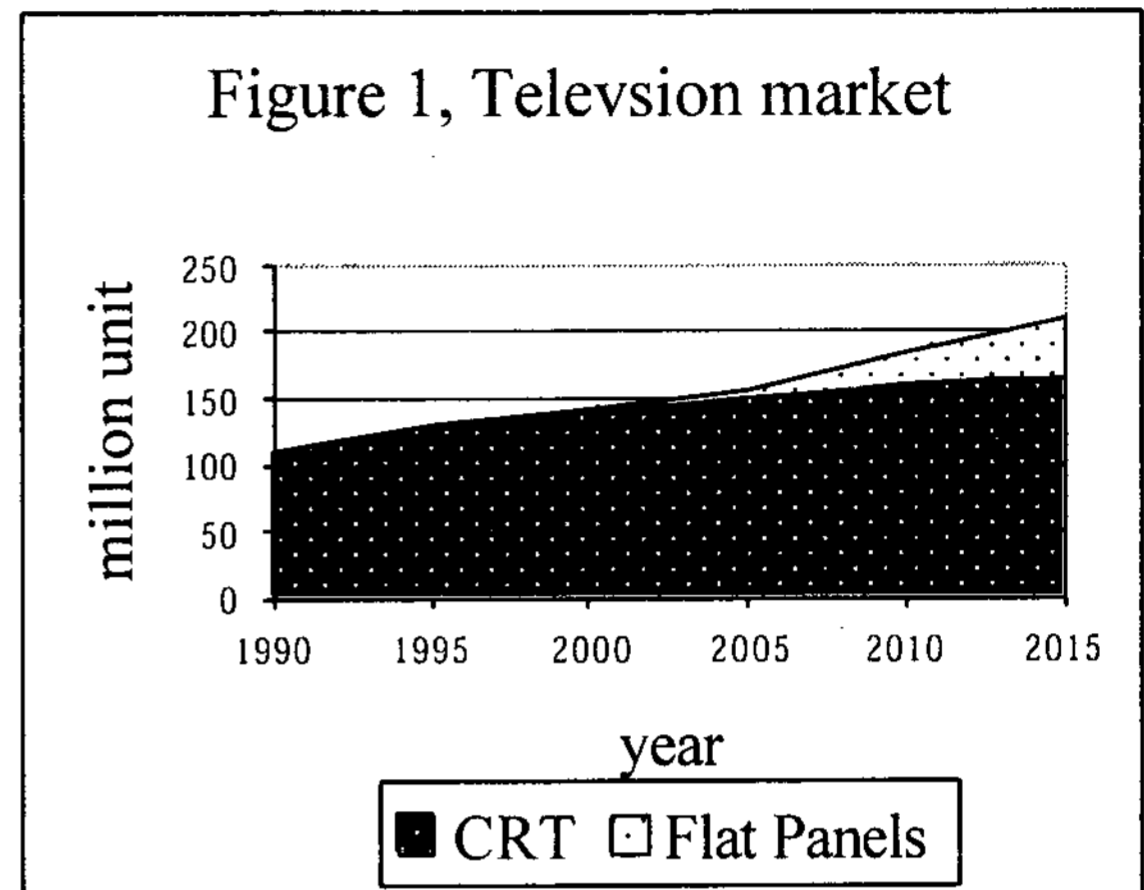
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Abstract

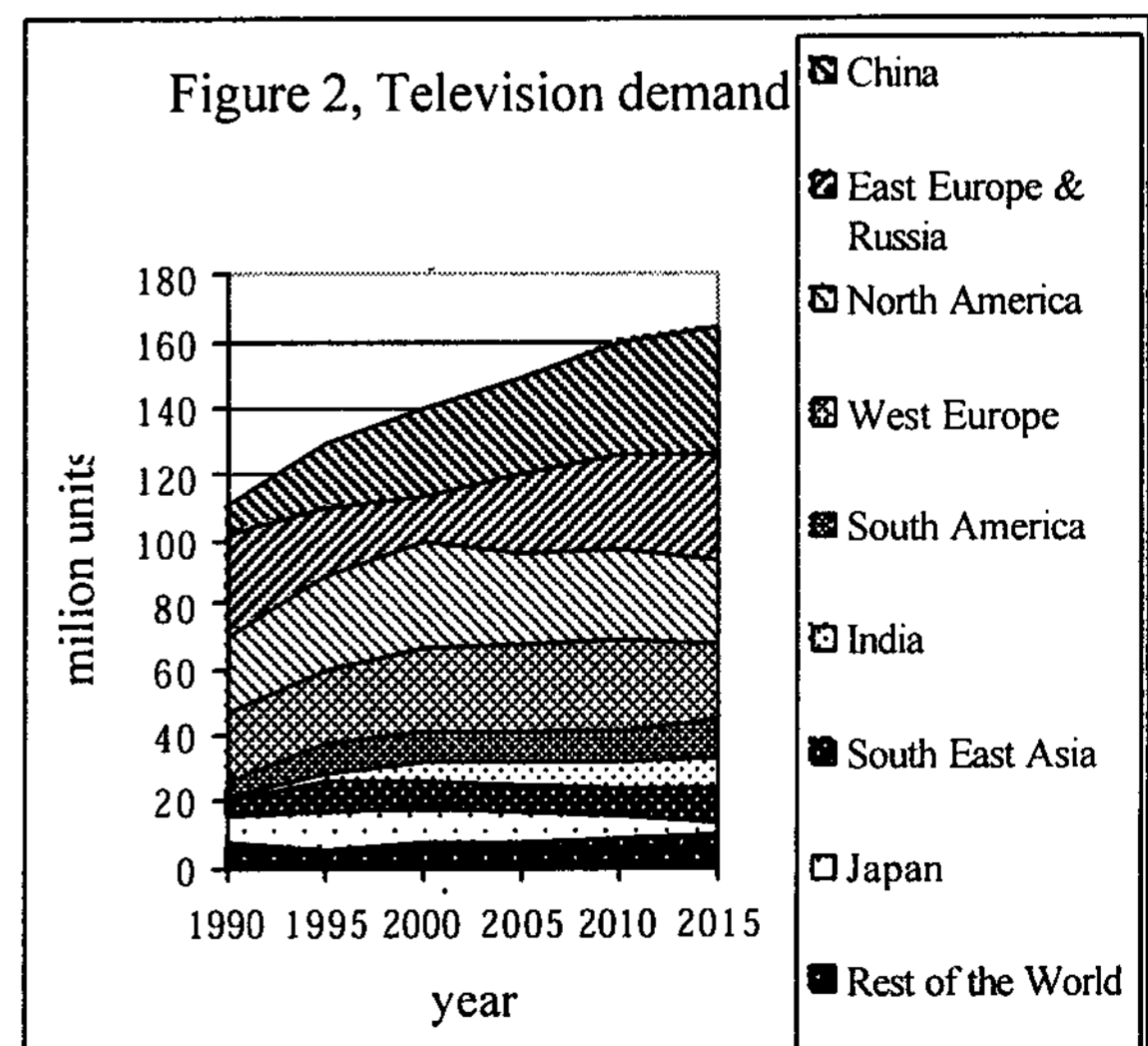
CRTs have been in the mainstream of displays for over 100 years since K. F. Brown invented the first tube in 1897. The position of CRTs, however, has come to be threatened by flat panel displays, whose performances are notably improved these days. The keys to survival of CRTs as leading displays are examined in this report.

1. CRT market

CRTs are mainly used for direct view televisions, projection TVs, or computer monitors. Among these markets liquid crystal displays (LCDs) have increasingly spread in the computer monitor market recently. This phenomenon might be viewed as CRTs would be replaced with LCDs soon. It is natural that one particular type of display is used in a particular application in which it has the superiority over others. In fact present computers require a contrast ratio not exceeding 20:1 and they are mainly used for displaying static images rather than moving images. Furthermore computer displays do not need high peak luminance. With these aspects LCDs are suitable display device for such an application at present moment. Their success of sufficient cost reduction is another reason for the spread of LCDs. On the other hand, in the market of direct view televisions, CRTs are still playing the leading roles, and their position will not change for a while. The present status and a worldwide forecast of the television market are shown in Figure 1.



Demand of displays on TV application will not be covered only by CRTs which were dominant before. Flat panel displays such as LCDs will contribute to the main part of the growth. CRTs are, however, expected to increase with an annual growth of about two percent in a decade ahead.



A CRT demand on television sets mainly consists of that in China, East Europe/Russia, North

America, and West Europe. In North America and West Europe, CRT demand is expected to drop. In Japan, demand on TV sets itself is shrinking. The number of TV sets owned by a household is expected to drop from 2.0 to 1.5 in these areas. CRTs will have eighty percent share of display devices supplied for TV sets in 2015 and the rest will be supplied by flat panel displays.

2. Characteristics of CRTs compared with flat panel displays

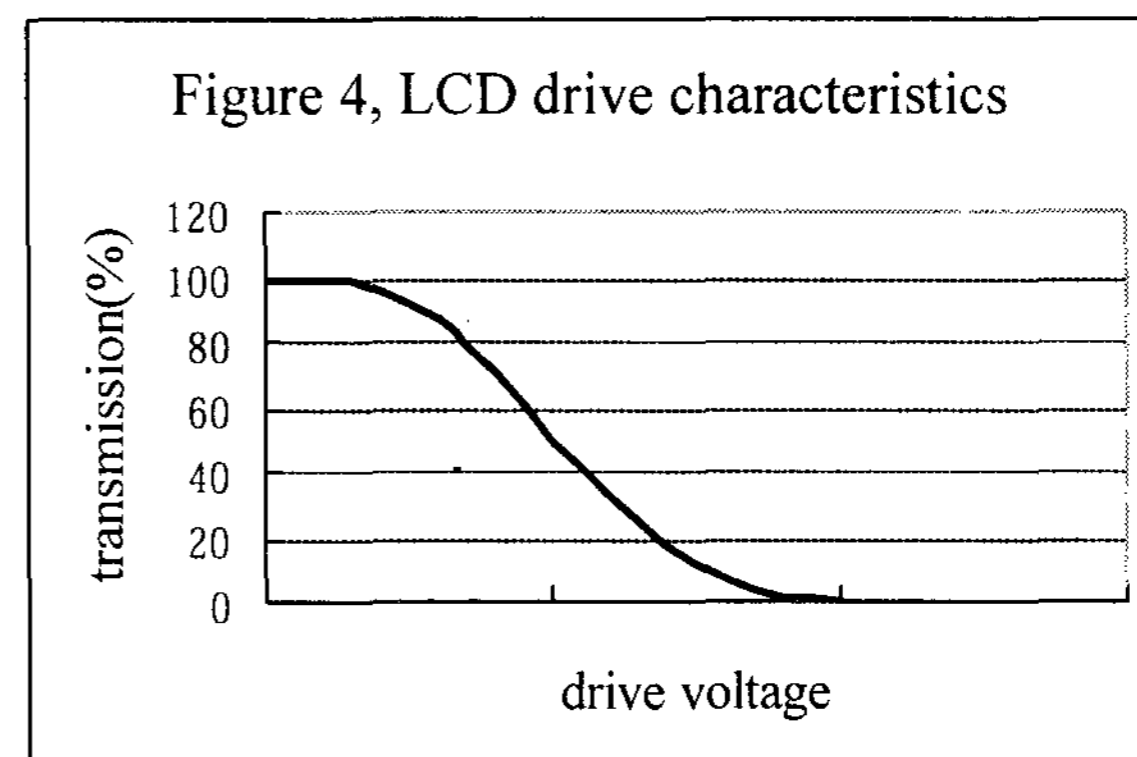
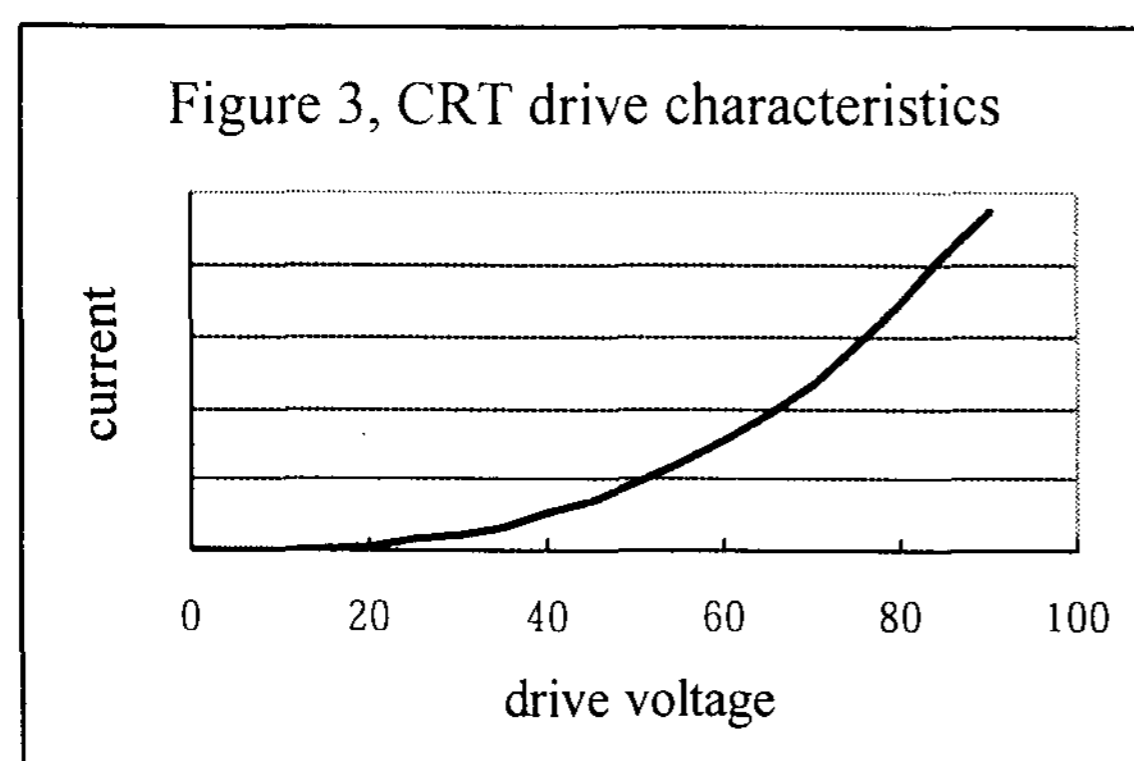
Although CRTs expect to be put in a strict competition with flat panel displays, CRTs have better performances in following categories.

Peak luminance:

An image with high luminance is given by supplying a large amount of electrons. Relationship between current intensity I and drive voltage E which works as a signal for electron gun is non-linear, given by the following equation.

$$I = \alpha E^\gamma$$

In CRTs a value γ lies between 2.5 to 3. Therefore CRTs have a wide dynamic range of brightness which can create precise gradation. The fact that γ value of flat panel displays such as LCDs and plasma display panels (PDPs) is approximately 1 limits the range of gray scales, making gray details in the pictures indistinguishable and less lively.



Typical drive characteristics of CRTs and LCDs are shown in Figure 3 and Figure 4 respectively. Due to this characteristic, the bumps in a snowy field (highlights) and the details of trees at dusk are shown more naturally and lively in CRTs than in other displays

Moving pictures:

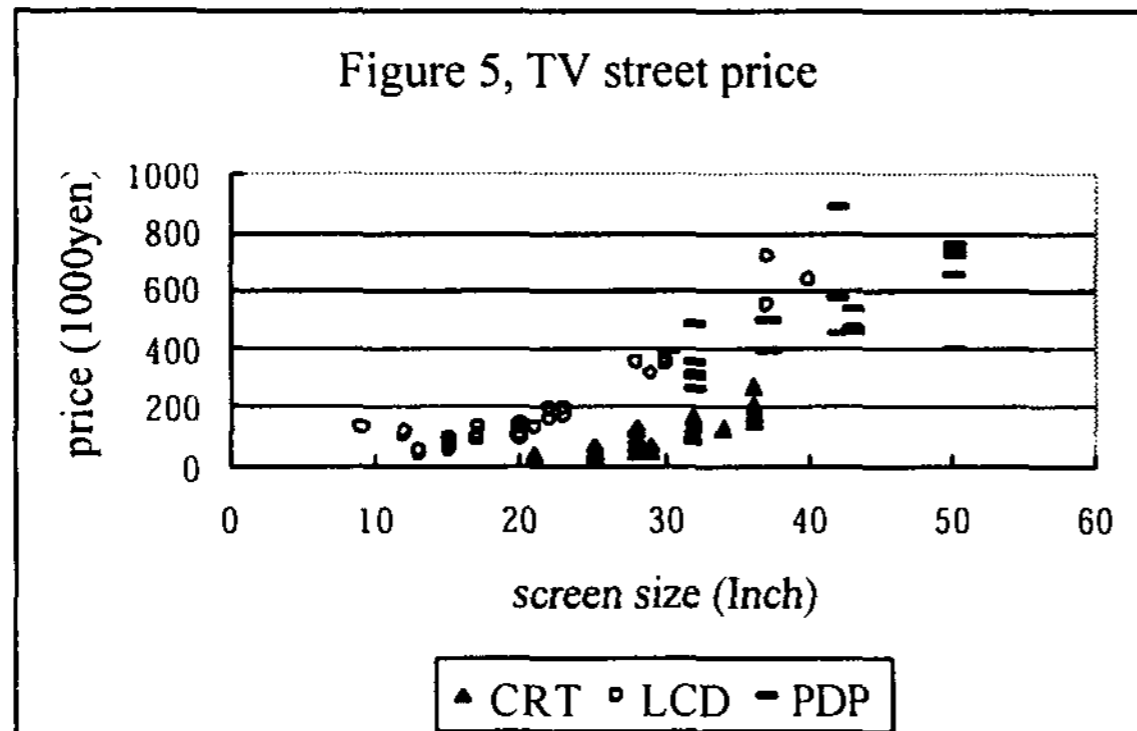
In CRTs, a spot of the screen emits light only at the moment when a beam of electron hits the spot and remains a slight afterglow. On the contrary, each pixel keeps its data (luminance) until next signal is input in flat panel displays such as LCDs, aiming to keep high luminance of the picture. This mechanism makes the moving pictures in flat panel displays blurred. Although the responding time of flat panel displays has been shortened, this cannot be an essential solution. The attempt to shorten the turn-on time of the back light is made to eliminate the fault of the holding mechanism in LCDs [1]. This fault in moving pictures caused by the holding mechanism stands out more in bigger screens.

Production cost:

Since CRTs are made of materials which are easily procured in general, their material cost are relatively low. Their simple and short manufacturing process keeps their cost lower than that of other flat panel displays. The price of the

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equipment for CRT production is also low. Therefore CRT TVs are much cheaper than flat panel TVs. Recent street prices of TVs in Japan are shown in Figure 5.



CRTs have those three advantages over other flat panel displays and will keep them in the future as well. Therefore CRTs will not be replaced with flat panel displays for quite a long time.

3. Technical problems to be solved with CRTs

Weight, depth and power consumption are faults which should be overcome to make the most of CRTs.

Weight:

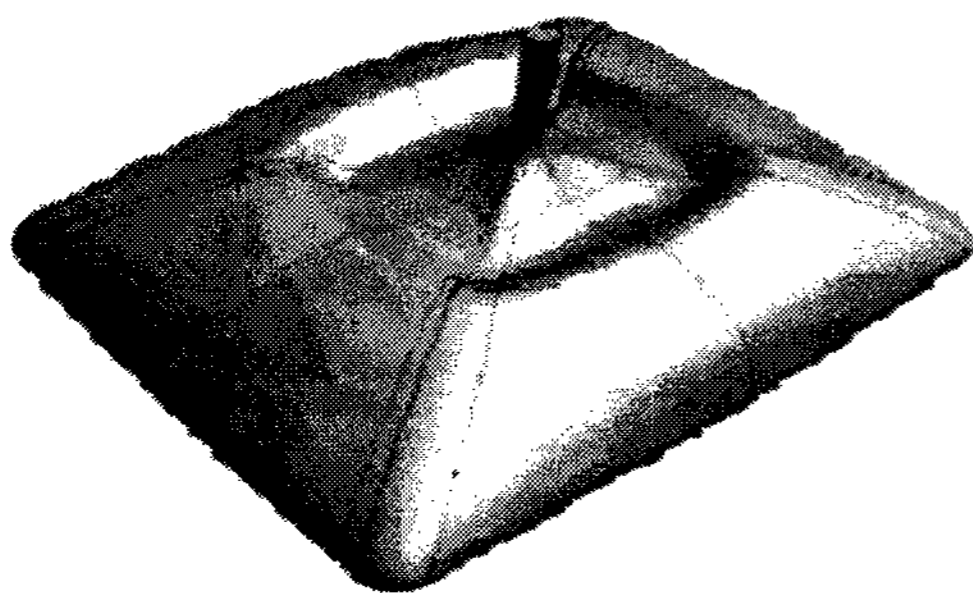


Figure 6, Nobel funnel shape to reduce its weight by T.Sugawara [3]

Most part of CRT weight is glass. Lately thicker

glass is required to endure the atmospheric pressure owing to the design of flat face screen. Glass strengthened by thermal tempering process is used to reduce the weight [2]. Designing glass parts to make stress dispersed and not to concentrate at a local spot is another useful method [3] shown in the figure 6.

Depth:

In the present system of deflecting electron beams, there are two measures to make the depth of CRTs short: to widen the deflection angle; and to make the deflection angle narrow with increasing the number of electron beams.

CRTs with a larger deflection angle consume more power and have more de-focused beam spot than those with a narrow deflection angle. Although it is difficult to realize CRTs with more than 100 degree deflection angle, one example with the deflection angle of 120 degrees was produced [4]. In another system, a pair set of electron beams are deflected with narrow angles and each set of electron beams creates a small image [5]. This is an excellent idea shown in the figure 7 to make the depth small without widening the deflection angle. However it needs to patch two pictures into one, which pushes up the cost.

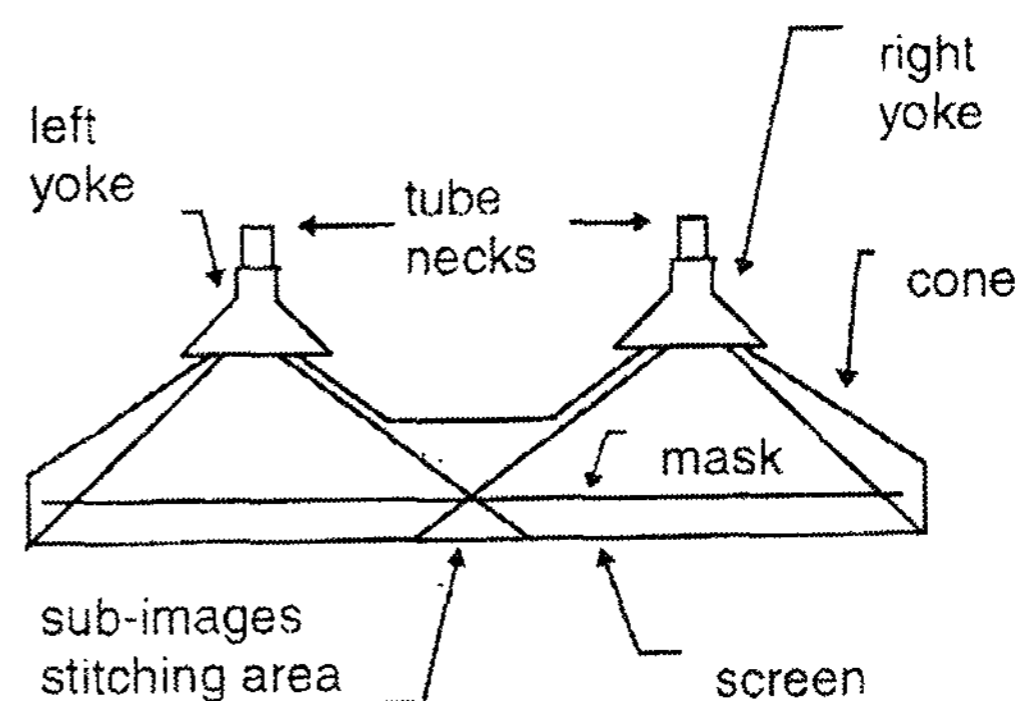


Figure 7, Camel tube to reduce depth by S.Sluyterman [5]

Power consumption:

Power consumption of CRTs is larger than that of LCDs. Biggest part of the power is consumed by the deflection yoke in televisions with CRTs. Although improvements such as a rectangular cone deflection yoke have been taken, it is still difficult to make a sharp cut in power consumption.

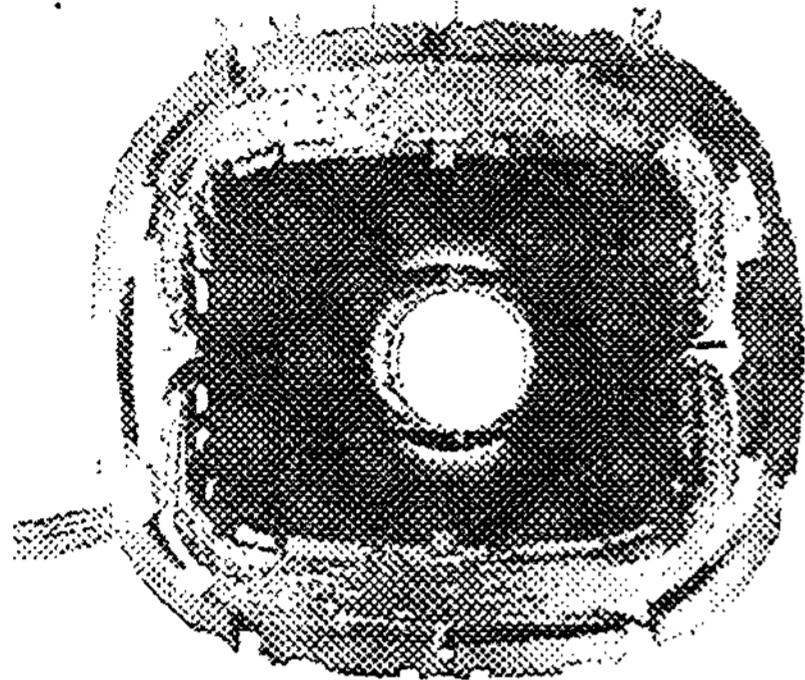


Figure 8, Rectangular Cone Deflection Yoke by Y.Sano et al [6]

These attempts to overcome the faults of CRTs are good for improving the performance of CRTs. But they seem not to be effective to surpass flat panel displays even with the best results.

4. Strategy for survival of CRTs

When CRTs were predominant display device, the business was paid off by improving their performances such as resolution, luminance, life and cost in spite of their limits in the characteristics. Now customers have an additional option of flat panel displays, CRT manufactures have to address the limits of CRTs and plan the strategy to survive in the competition which is completely different from the past.

How can CRTs survive? The answer is to make the best of their characteristics. Basically CRTs can be produced in cheaper cost and create more lively images on the screen than LCDs or PDPs. If the CRT manufactures allocate the production bases appropriately and supply suitable models

responding to the needs of changeable markets, they still can expect the sales growth. An important point in designing is to make the best performance with the lowest cost.

Areas of production and consumption of CRTs have changed from USA, Europe to Japan, and to Korea, Taiwan. Now they are changing to China, East Europe, and India. If manufactures can supply CRTs which exactly meet to the demand in these areas, the CRT business can grow steadily.

5. Conclusion

Since performances of flat panel displays have been improved, now CRTs become display devices which are used rather in particular applications where they have superiorities than in all possible places. CRTs can produce beautiful motion pictures with low cost, which will ensure a continuous demand on usage for televisions for a long term. CRTs will keep their status as a main display device particularly in the area where low prices are necessary. Engineers should focus on designing and production to meet these demands.

6. Reference

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