Review of Color CRT Electron Gun Design Trends and the CRT Industry Surviving Strategy

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Abstract

The evolution of color CRT electron gun design over the past 40 years is addressed. Many milestones of CRT E-gun design are cited. For the future survival of color CRT the multi-beam group color E-gun and the recently announced multi-beam type index gun are suggested as the answer to the challenge of the next generation's requirements of low power and high performance color CRT

Introduction

The color CRT industry has gone through many major electron gun related performance improvements since its commercialization forty years ago. Prior to 1990, color CRT was the only choice for a consumer display device. Its evolution imposed very little threat to the survival of the color CRT, even though such changes meant a bulkier tube that used more power. For example, in order to meet the requirement of brighter and better resolution in a color TV, the conventional approach of electron gun design was to increase the anode voltage and/or to increase the neck size to enable it to house a larger and better gun. The larger neck size caused the yoke to become larger also and to use more deflection power, at the same time causing the tube to become longer. The higher anode voltage caused the tube to use more power and to have more harmful x-ray radiation.

Today, the environment of the industry has changed and the color CRT is no longer the only choice available. The approach previously described has become unacceptable. In fact, continued use of the method might even increase the chance of the CRT being replaced by LCD, PDP, etc. In recent years, many color CRT manufacturers have announced low power tube designs and other power saving, yet cost effective, electron gun designs.

In the past, electron gun design has played a major role in the evolution of the color CRT. The survival of color CRT in the coming years will, undoubtedly, put more burden on the E-gun designs. This paper will review the major steps which the color CRT electron gun design has taken throughout the past forty years and will suggest some direction for future changes in color CRT development.

Past Revolutional Color CRT Electron Gun Designs

In general, color CRT electron gun design during the past forty years can be best described as evolutional change, which is a slow, gradual process. The few events

which might qualify as "revolutional change are listed in the following.

A revolutional design change is a change which will give the CRT industry a major impact in performance improvement, manufacturing cost saving, or both.

1. <u>The Switching of Color Gun Design from Delta to Inline Type</u>
This change greatly simplified the 3-beam convergence problem. Besides better convergence performance, this design gavc the TV set maker a big cost saving. (late 1960's)

2. <u>Unitized Inline Electron Gun Part Design (1)</u>
This gun design is substantially simpler and cheaper than the individual grid type gun design previously used. At the same time, it gives much better alignment control between the individual color guns as shown in Fig. (1A) and Fig. (1B). (early 1970's)

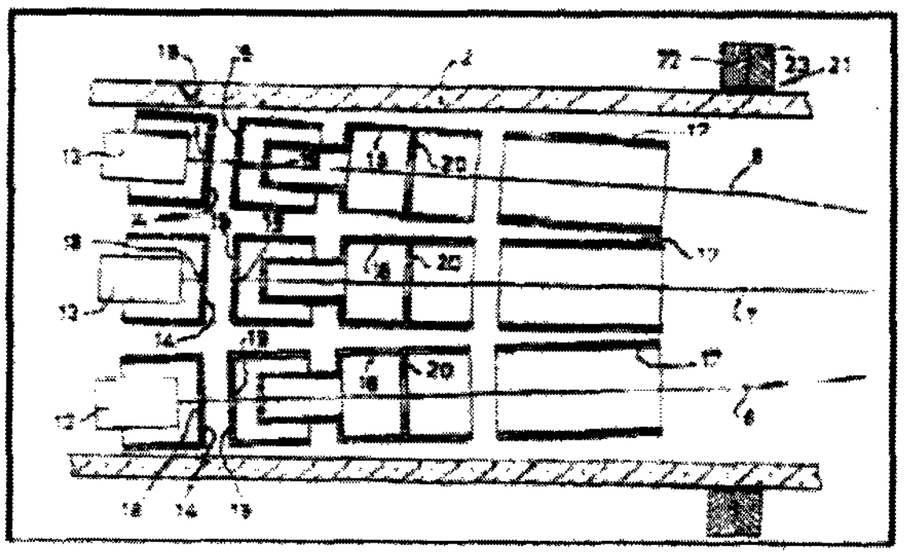

Fig. 1-A
The Individual Inline Gun

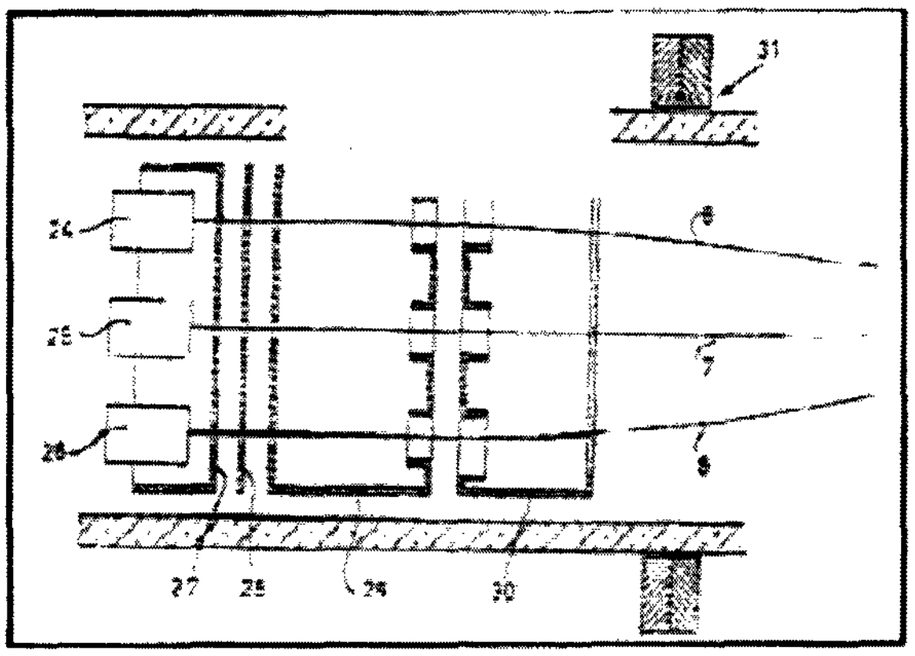

Fig. 1-B
The Unitized Inline Gun

3. <u>The Basic Electron Optics Optimization Study</u>
The realization of the relationship of beam angle to the optimization of spherical aberration, magnification and space charge effect in electron optics design has a major impact in future CRT color gun design (2), as shown in Fig (2).

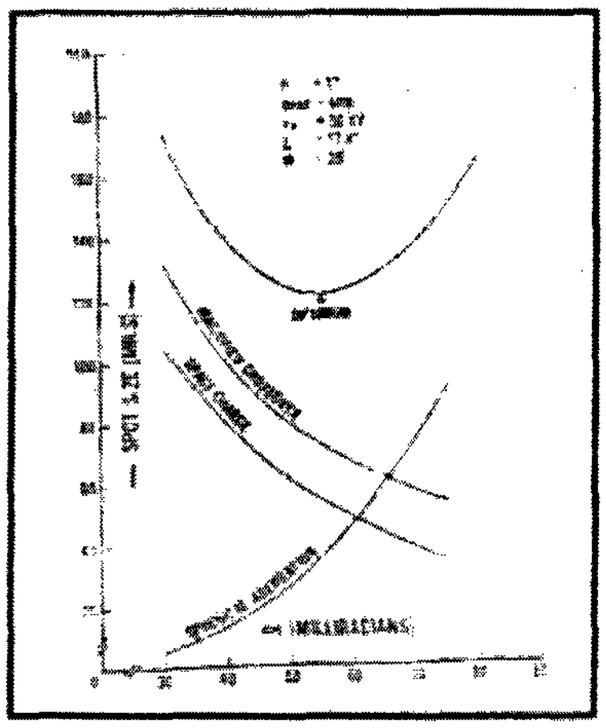

Fig. 2
Optimization Curve

Aided by the discovery of using G2 aperture thickness to control the beam angle (3) and adopting the use of computer modeling techniques made the above mentioned

optimization design practical. (1970's)

4. Common Lens Inline Gun Design

The common lens inline gun design has reduced the aberration of the main lens and enabled most of the color TV tubes of today to reach the limits of system performance (4,5) as shown in Fig. (3) and (4).

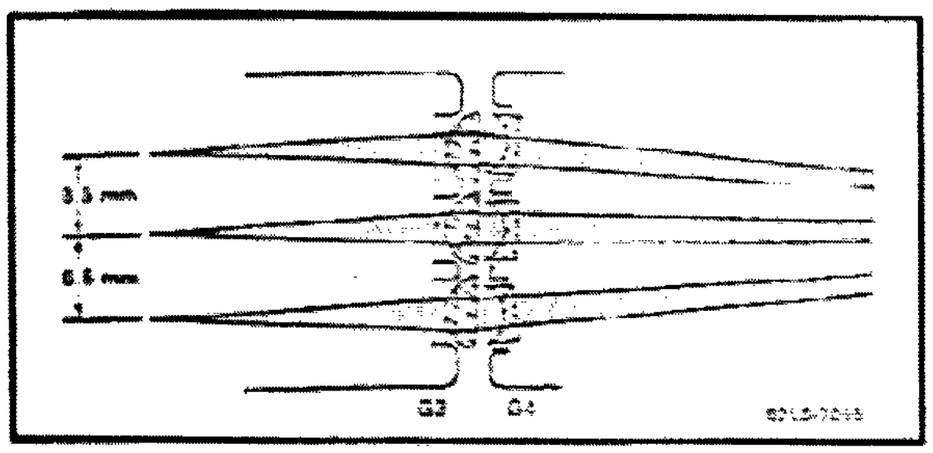

Fig. 3
Conventional Inline Gun

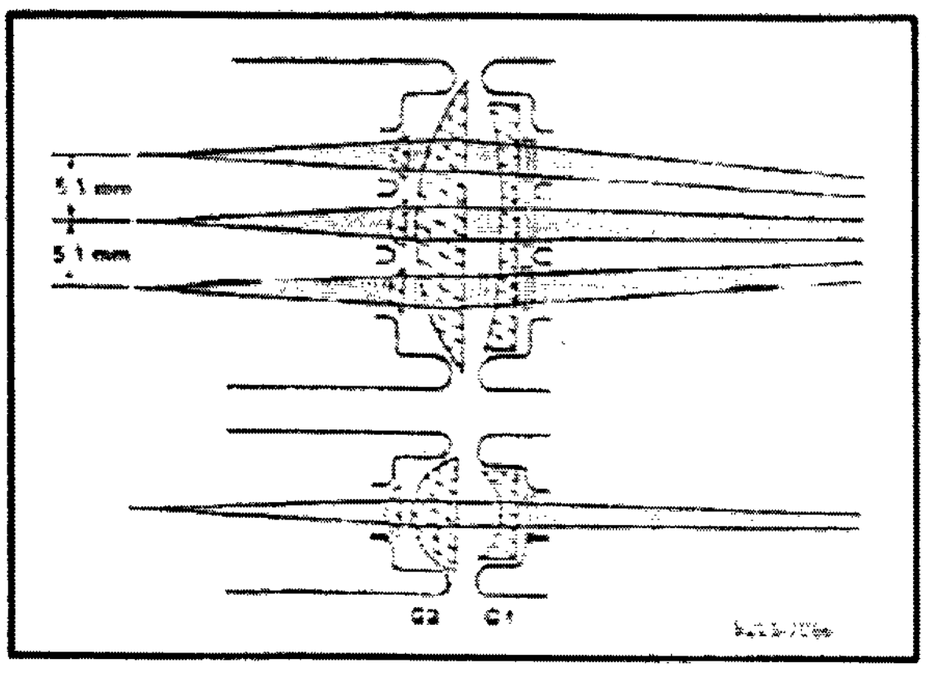

Fig. 4
Common Lens

The development of the EA shaped auxiliary aperture to compensate for the asymmetric effect caused by the common lens (6), plus the adoption of 3-D computer modeling techniques (7,8, 9) made the common lens color gun design practical. (early 1980's)

The Survival Strategy of the Color CRT Industry

It is quite clear from the above mentioned electron gun's revolutional design change list that in the 1960's, 1970's and early 1980's there were many major changes. However, for over twenty years there has been no revolutional change in the color CRT industry. As CRT electron gun design engineers, we are aware of the fact that a revolutional design change is needed and is needed right now.

In the February '02 issue of Information Display Magazine, Dr. Aris Silzars, President of SID, points out in his article "The Great Race..." that at present, TFT-LCD, and PDP in the large panel display are as good as anyone would want for television viewing in terms of their performance in brightness, resolution, color gamut and contrast.

The survival strategy of the CRT industry seems to be as follows:

1. Maximize the Most Relevant Advantage of CRT - Low Cost

The low price of CRT is still a formidable barrier for other display devices to cross. For example, the PDP industry is still trying to achieve a $100US per inch price goal. At the same time, in today's market the sales price of a nearly flat 29 inch color CRT set already has achieved a price of even lower than $7US per inch. If we study the market penetration curve as shown in Fig. (5), we will find that if the price ratio of other display devices to CRT is greater than 3, then the potential market penetration will be

less than 10%.

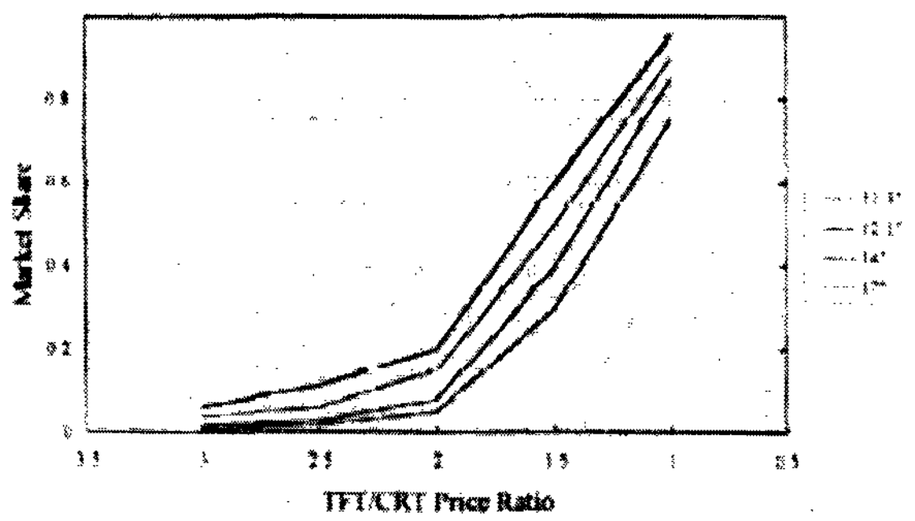

Fig. 5
Optimistic Penetration Curve

Furthermore, most CRT components such as deflection yoke, shadow mask, glass pancl, etc. still have room for lower prices.

II. <u>Minimize CRT's Disadvantages</u>

A) Shorter Tubes

There are a few shorter tube designs which have been published at recent SID conferences, such as:

- Very large deflection angle CRT (128 or above) (10, 11)
- Camel tube (12) as shown in Fig. 6.
  (a) Transposed scanning tubes (13)

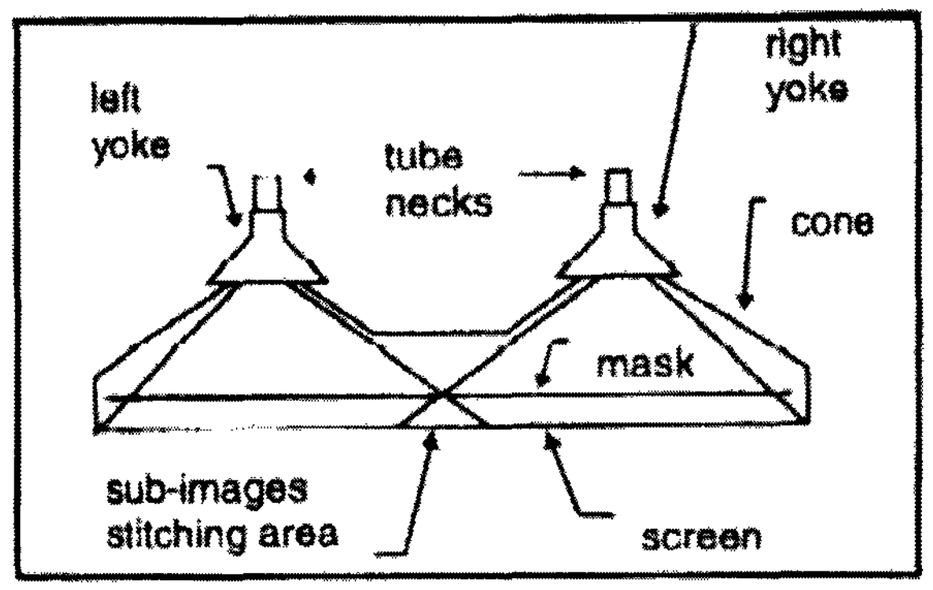

Fig. 6.
The top view of a Camel CRT

B) Lower Power Usage

There are a few designs which can greatly lower the power consumption of color CRT such as:

- New Index (FIT) tube - no beam energy loss due to no shadow mask (13).
- Multi-Beam group color E-gun - lower power consumption due to smaller neck and lower deflection frequency (15) as shown in Fig. 7.

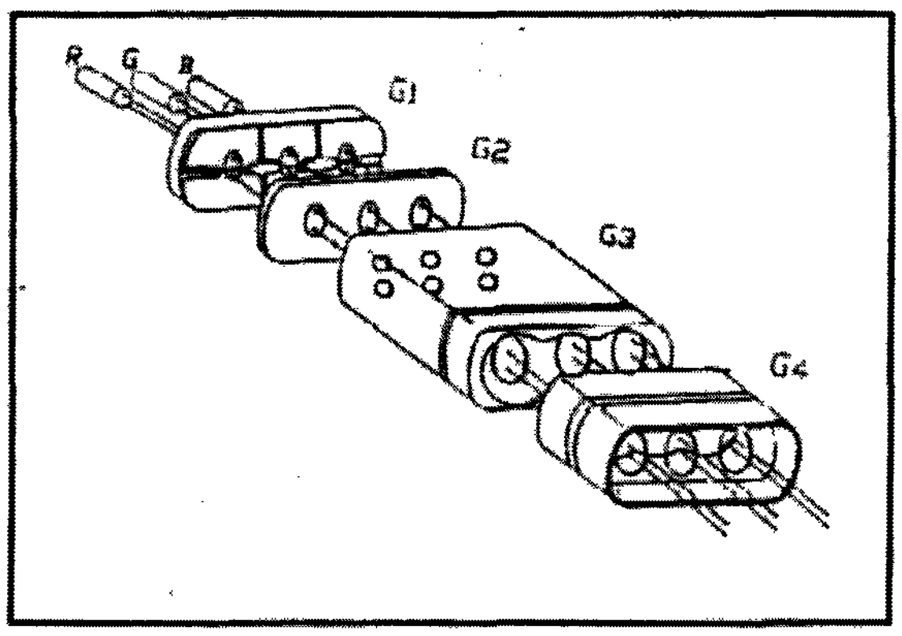

Fig. 7
2-Beam Group BPF Gun

Conclusion

The CRT industry is under the threat of being replaced by other display devices. Its survival will rely on revolutional design changes which will maximize its advantage of low cost and minimize its disadvantages of bulk and high power consumption.

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