Electron Gun Assembly; Alternative Grid Alignment Systems

Con Brantjes, Maarten Zonneveld
Mechanical Gun Development, PPD
LG.Philips-Displays, Eindhoven, Holland
E-mail : con.brantjes@lgphilips-displays.com
maarten.zonneveld@lgphilips-displays.com

Abstract

Within LG.Philips Displays electron gun assembly different grid alignment methods are used. Besides the commonly used mandrel alignment of grids (Inner Reference System, IRS), also a unique Outer Reference System (ORS) is used as grid alignment method in high-end gun assembly. This alignment method combines alignment accuracy with maximum electron optical design freedom and maximum flexibility in electron gun production.

1. Introduction

The alignment of the apertures in electron guns is very important for the focus performance. In the manufacturing it is most logic to use the apertures as direct reference for the grid alignment.

Commonly used tube designs use a convergence architecture which requires a step of the pitch of the apertures in the prefocus lens of the electron gun.

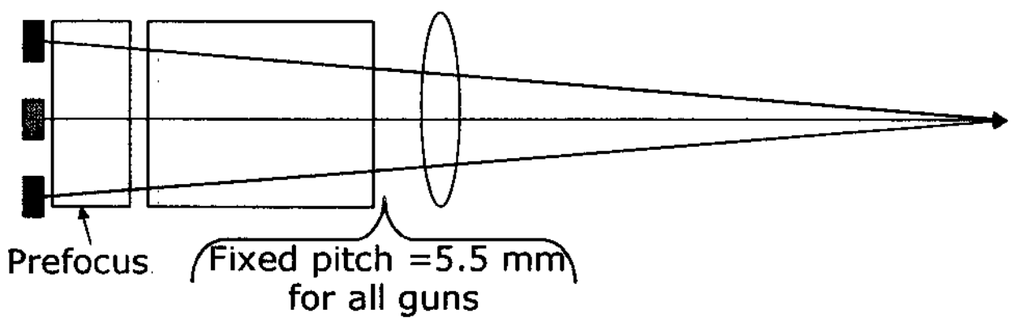

Figure 1 Schematic drawing of electron beam through the gun

This results in a tapered mandrel, which puts restriction on the apertures in the gun.

By developing an alignment system which is independent of the apertures a wide variety in electron optical design comes within reach.

In this article the basic principles and the capabilities of the centering systems are described.

2. Inner Reference System (IRS)

This alignment method is commonly used in electron gun manufacturing worldwide. In this system the grids are aligned using mandrels through the grid apertures.

General disadvantage of this system is that during stacking of the grids the small G1/G2 apertures can be damaged or scratched, resulting in unwanted flashovers or stray emission. Also the mandrel tops can easily be distorted, resulting in eccentricity of the apertures.

Each gun type requires its own specific tooling; change over in production needs exchange of the jigs which is costly and time consuming.

Restriction to the electron optical design is that all apertures must have a continuous increasing dimension in X and Y.

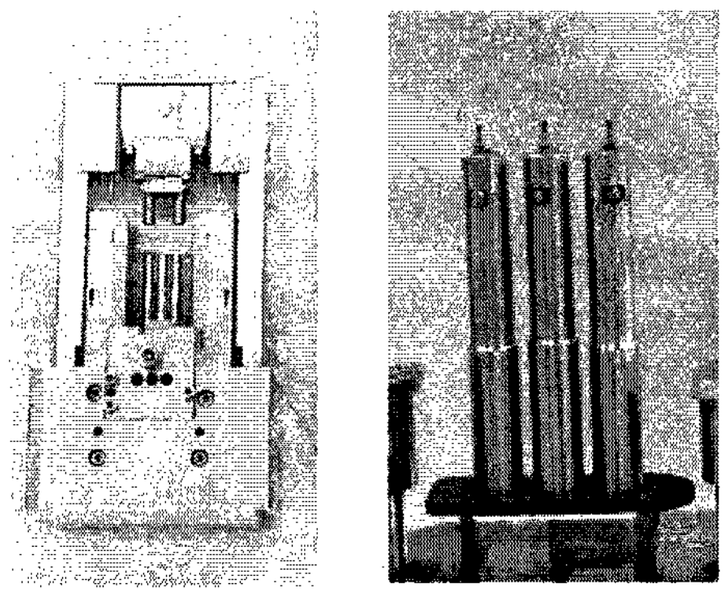

Figure 2 Photograph of an IRS beading jig and mandrels

3. Outer Reference System (ORS)

The ORS alignment system was introduced in the Philips gun manufacturing. Presently all high-end CPT and CDT electron guns are manufactured with this system.

In this system all grids are aligned making use of special reference planes on the outer contour of the

grids, except for the mainlens which is still aligned on mandrels.

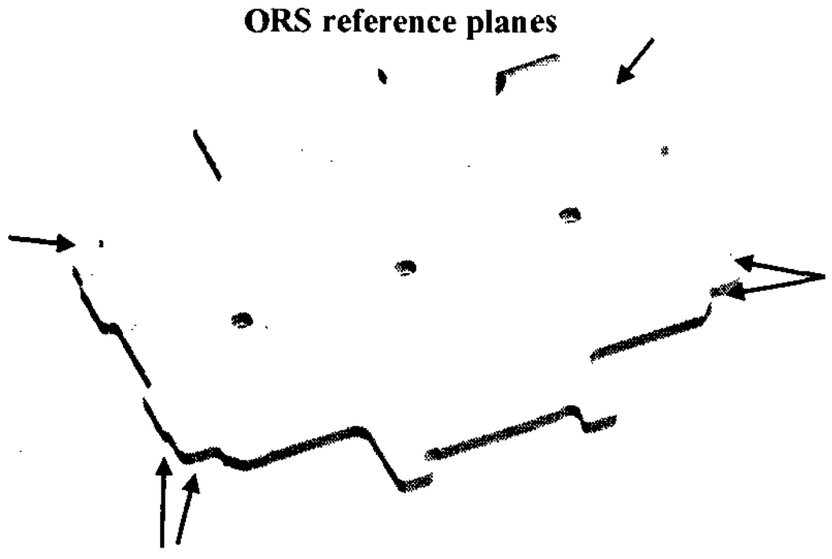

Figure 3 ORS alignment planes in grids

The basic philosophy is that a grid is supported on 3 points and all degrees of freedom in X- and Y-direction are suppressed. After stacking of the grids in the jig the alignment of the grids is not perfect due to the clearance between grids and jig. However the dimensions of the reference planes of the grids are defined in such a way that due to the temperature rise and expansion of the grid during the beading, the dimensions will just fit or clamp in the jig and a perfect aligned grid will result.

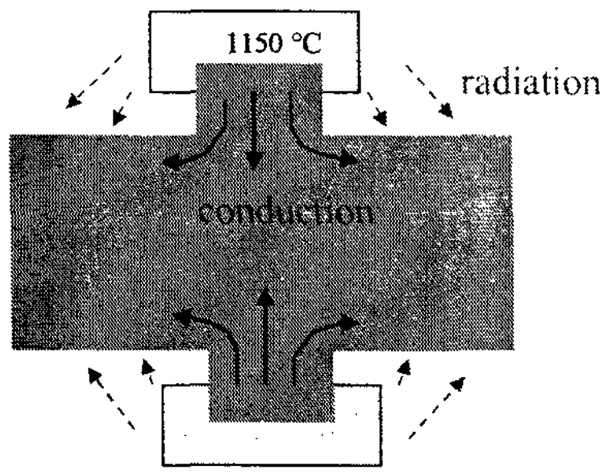

Figure 4 Heating of grid during beading

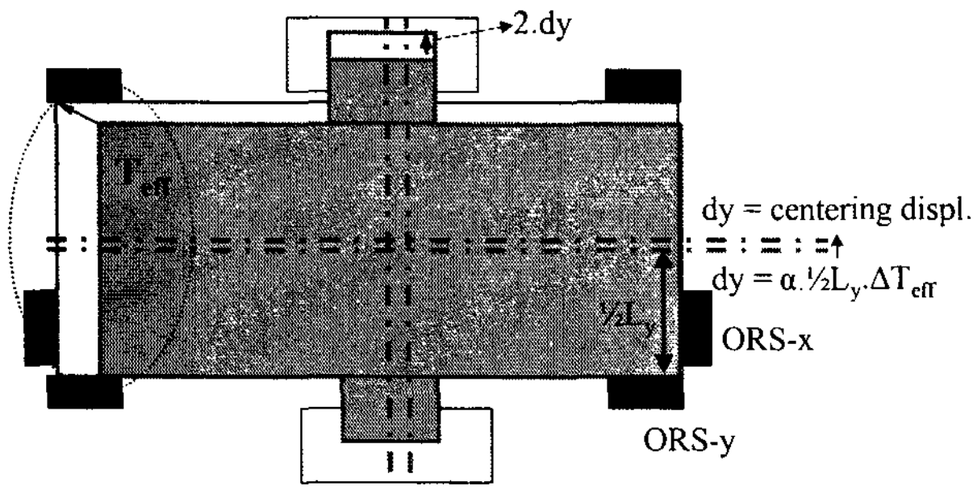

Figure 5 Alignment of grid by expansion

This centering mechanism has been optimized for all grids by extensive simulations and experiments.

The eccentricity of the apertures depends on the position accuracy of these apertures with respect to the outside reference planes during manufacturing of the grids. The practical results of the ORS system are shown below

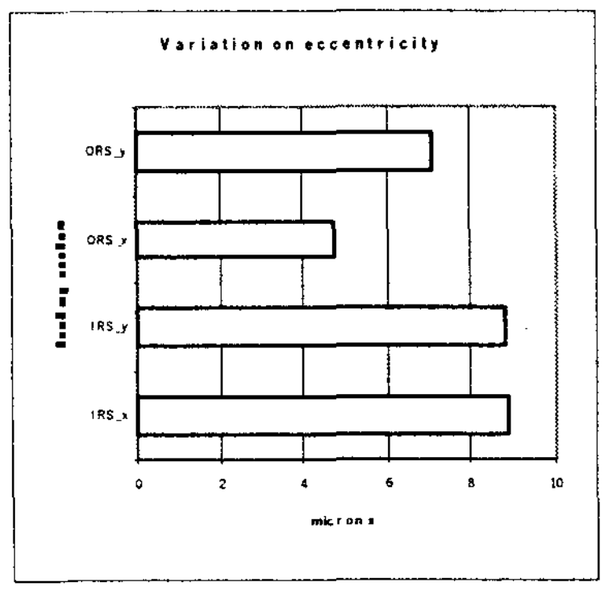

Figure 6 : capability of IRS ad ORS

The advantages of using ORS system are:

- maximum electron optical design freedom of design in aperture shape/ size and pitch
- industrial flexibility, changing over from type to type only requires new spacers
- no contact with apertures, no scratches or deformation of apertures

A practical complication is that the historical design of main lenses does not fit in the circumference of the ORS dimensions. Therefore the main lens is still centered by using mandrels.

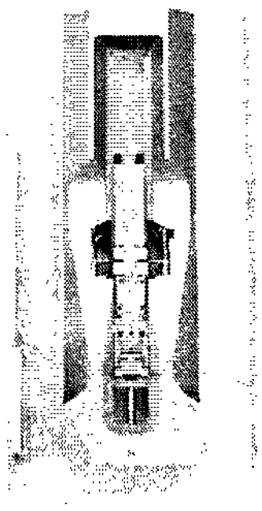

Figure 7 Photograph of the ORS beading jig.

4. Full Outer Reference System (FORS)

During development of the new generation high-end guns with new main lens concepts, we had the opportunity to design the main lens circumference in such a way that it fits within the ORS dimensions.

In the FORS system also the main lens alignment is realized by making use of reference planes on the outer contour of the grids.

The advantages of using FORS system are:

- ultimate electron optical design freedom of design in aperture shape/ size and pitch, including the main lens.
- no contact with main lens apertures which are fragile and critical for electron optical and high-voltage performance

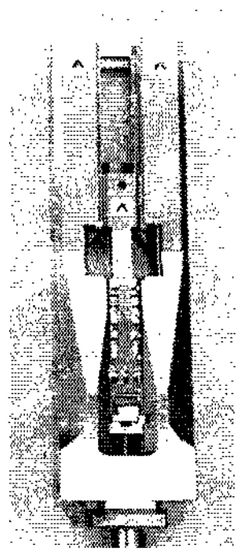

Figure 8 Photograph of a FORS beading jig.

5. Conclusions

The development in alignment system from IRS to ORS to FORS has enabled us to increase Electron Optical design freedom resulting in the development and production of electron gun designs with a higher complexity and better tube performance.

With the (F)ORS systems we can produce a large variety of gun types with minor adaptations of equipment, resulting in low investments for new types and short changeover times in production.

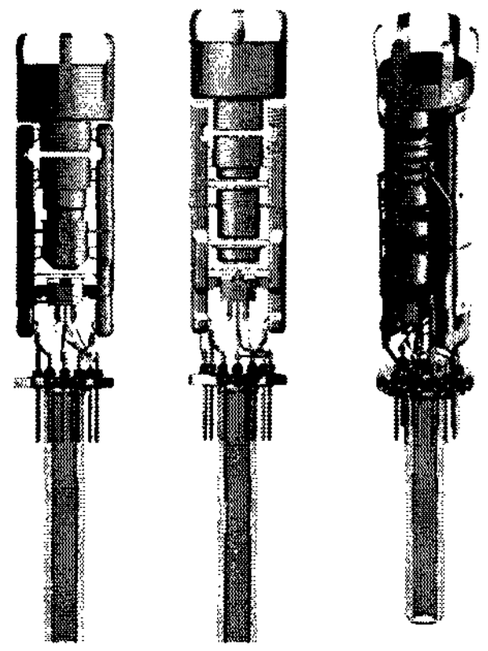

Figure 9 Evolution of gun designs through time.