Introduction to Image Intensifier Tubes

General

The basic principle of image intensification is identical for all different intensifier versions.

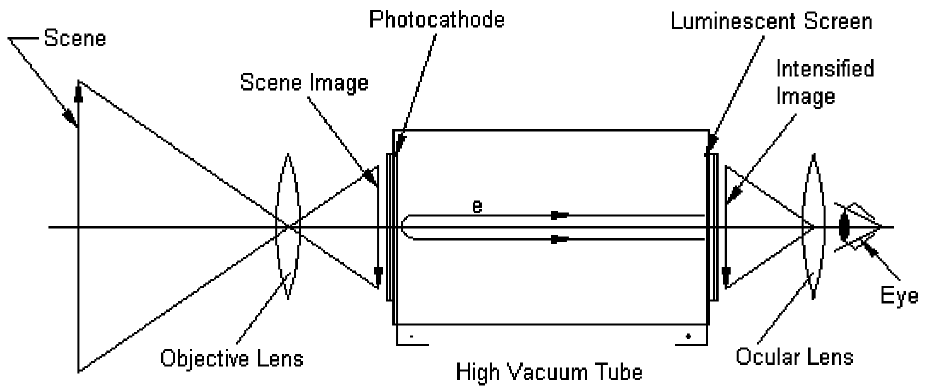

Fig. 1: Basic principle

An image - ultraviolet, visible light, or near infrared - is projected onto the transparent window of the vacuum tube as shown in Fig. 1. The vacuum side of this window carries a sensitive layer called the photocathode. Light radiation causes the emission of electrons from the photocathode into the vacuum which are then accelerated by an applied DC voltage towards a luminescent screen (phosphor screen) situated opposite the photocathode. The screen's phosphor in turn converts high energy electrons back to light (photons), which corresponds to the distribution of the input image radiation but with a flux amplified many times.

The terminology "image intensifier" and "image converter" are frequently confused. In particular, image conversion refers to the transfer from an invisible to a visible spectral range, such as image converters used in night vision. On the other hand, image intensifiers which perform as the name suggests often also function as image converters.

Image intensifiers are classified in three categories: first, second, and third generation. Each generation has specific advantages and disadvantages.

First Generation Image Intensifiers (Intensifier Diodes)

Intensifier tubes in this category feature especially high image resolution, a wide dynamic range (the ability to reproduce the ratio between the bright and dark parts of an image), and low noise. They possess moderate gain in the range of some hundreds of Lumens per Lumen (lm/lm). First generation tubes utilize only a single potential difference to accelerate electrons from the cathode to the anode (screen). Focusing is achieved by two methods:

- by placing the screen in close proximity to the photocathode (proximity diode), see Fig. 2, or,
- by using an electron lens to focus electrons originating from the photocathode onto the screen (inverter diode), Fig. 3.

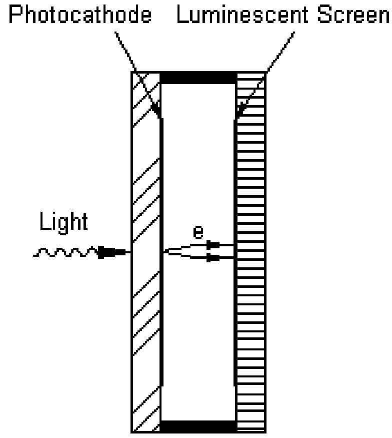

Fig. 2: Proximity focus image intensifier diode

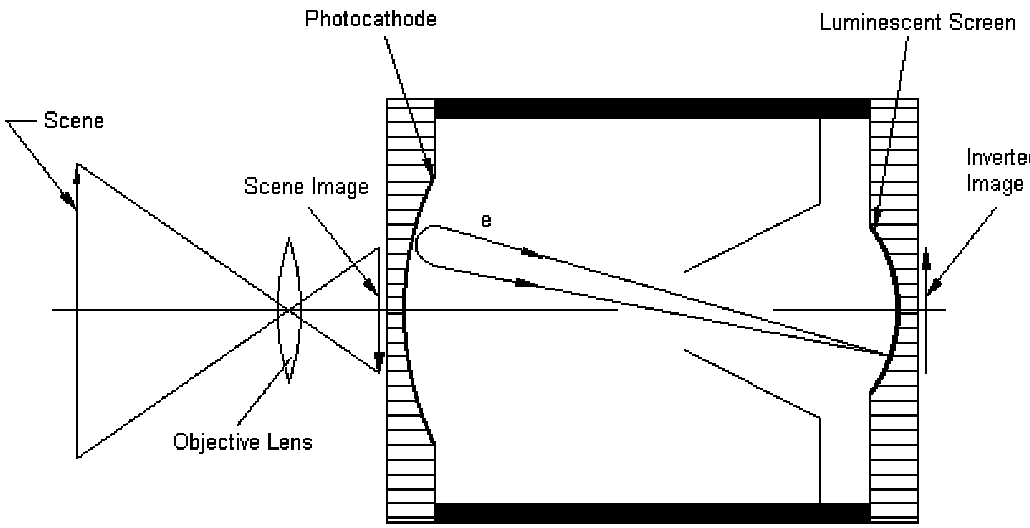

Fig. 3: Inverter image intensifier diode

Second Generation Image Intensifiers

The major difference between first and second generation tubes is the use of electron multipliers, i.e., not only the energy but also the number of electrons between input and output is significantly increased. Multiplication is achieved by use of a device called microchannel plate (MCP). These are very thin plates of conductive glass containing many small holes, typically 10 µm diameter. It is in these holes where successive, secondary electron emission occurs which leads to multiplication factors of up to four orders of magnitude.

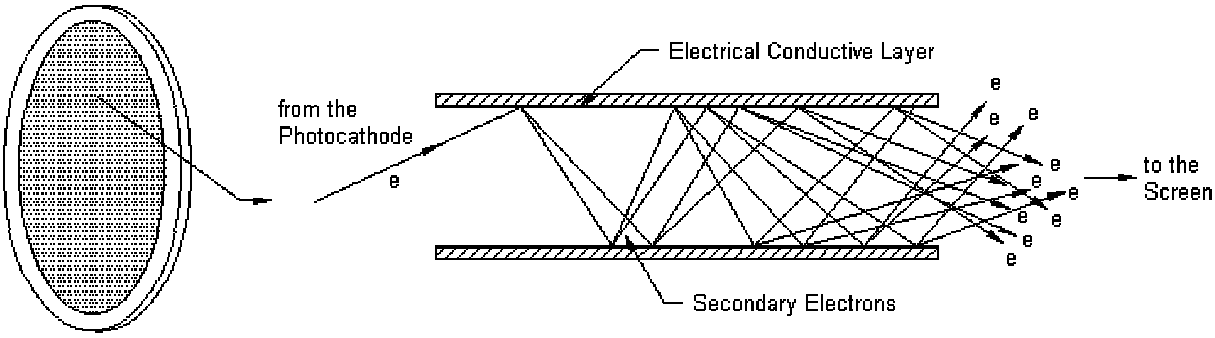

Fig. 4: Microchannel plate (MCP)

The achievable image resolution and dynamic range are less than those of first generation intensifiers, whereas luminous gain is significantly higher. Luminous gain ranges from 10.000 lm/lm for a single stage MCP up to 10^7 lm/lm for intensifiers having two microchannel plates.

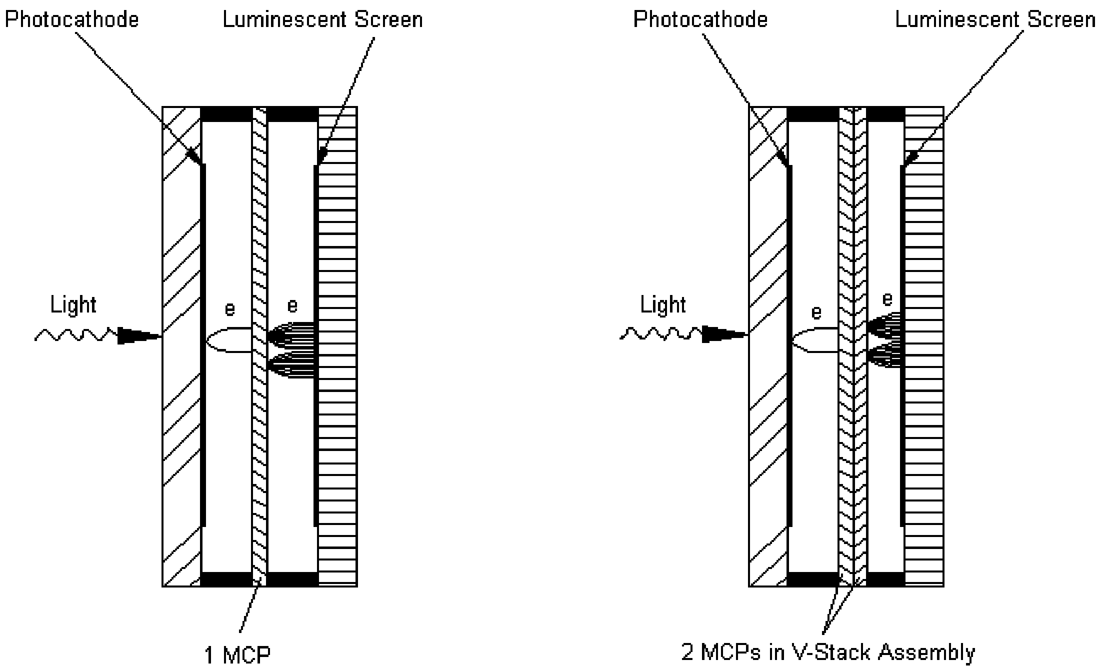

Fig.5: Proximity focus MCP image intensifiers

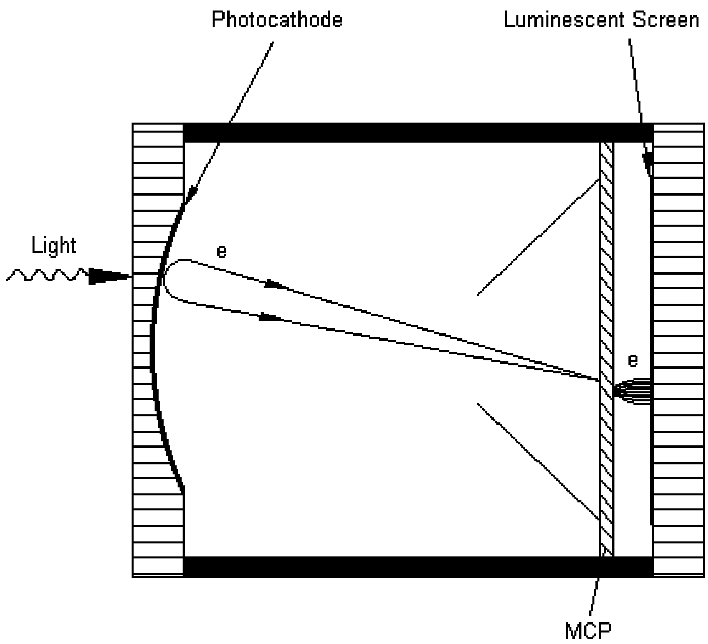

Fig. 6: Inverter MCP image intensifier

Third Generation Image Intensifiers

Third generation image intensifier tubes employ proximity focus MCP intensifiers with Gallium-Arsenide photocathodes. These have a luminous sensitivity of approximately 1.200 µA/lm instead of 300 µA/lm found in the multialkali photocathodes normally used in first and second generation intensifiers.

The main advantage is in the red and near infrared; they are not appropriate for ultraviolet. The high infrared sensitivity also makes these tubes more susceptible to high thermal noise.

Proximity Focus Image Intensifier Advantages

Proximity focus intensifiers of first, second and third generation are of compact mechanical construction with their length being smaller than their diameter. Furthermore, they are completely free of geometric distortion and feature high resolution over the photocathode's entire useful area. Image magnification is exactly 1:1. Additional advantages include their immunity against electrical and electromagnetical strayfields, and ability to function as extremely fast optoelectronic shutters in the nanosecond range.

All of these features may be restricted or not available in inverter intensifiers, however.

PROXITRONIC Image Converter and Image Intensifier Tubes PROXIFIER® and MCP-PROXIFIER®

Our name, **PROXITRONIC** = **PROXI**mity focus optoelec**TRONIC**, represents the field of our expertise and products. In 1978, when the company's founder Hans W. Funk together with 15 former colleagues took over the special tubes business from Robert Bosch Television Systems in Darmstadt (BOSCH FERNSEH), proximity focus intensifier diodes were the most challenging product. The goal, to exceed the gain and resolution of these devices was achieved after a couple of years. Instead of the usual operating voltage of 6 kV in use at that time, we succeeded in introducing three models with voltages up to 15 kV and 80 lp/mm. This technical breakthrough brought PROXITRONIC to the forefront worldwide of proximity diode manufacturers.

With increasing demand, the production capacity as well as the number of employees increased. The basis for this growth is the result of a method we developed whereby the two main parts of the intensifier - photocathode and screen - are processed separately in their own special high vacuum containers. This so called "Two-Container-Method" provides very high flexibility in the production of intensifiers and allows us to be able to produce and store in advance all types of photocathodes, luminous screens, and window materials. Thus, these components may be combined into a single custom-built image intensifier in a high vacuum chamber quickly and easily according to a customer's request.

The addition of microchannel plate intensifiers to PROXITRONIC's production program in 1990 was aided by the advantage that the time consuming degassing process requires only one high vacuum pump system for up to ten containers. Microchannel plates degassing is a very sensitive process which determines the final quality of MCP intensifiers; long term stability, noise, and gain can only be optimized by cautious degassing. At PROXITRONIC up to 80 hours per intensifier are expended to achieve optimum degassing.

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