CHAPTER 2
BASIC PRINCIPLES OF PHOTOMULTIPLIER TUBES [1)-5)]

A photomultiplier tube is a vacuum tube consisting of an input window, a photocathode, focusing electrodes, an electron multiplier and an anode usually sealed into an evacuated glass tube. Figure 2-1 shows the schematic construction of a photomultiplier tube.

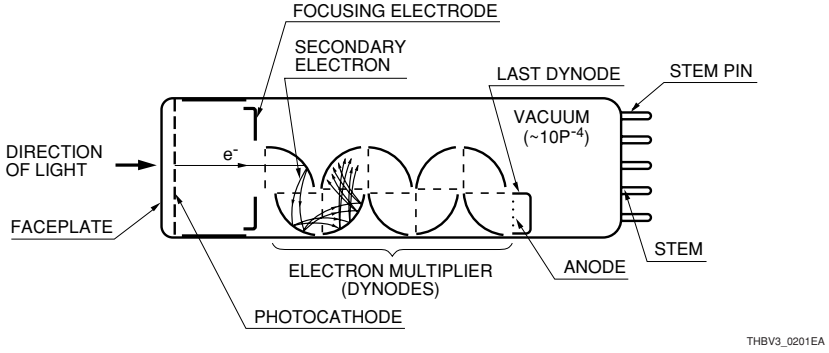

Figure 2-1: Construction of a photomultiplier tube

Light which enters a photomultiplier tube is detected and produces an output signal through the following processes.

(1) Light passes through the input window.

(2) Light excites the electrons in the photocathode so that photoelectrons are emitted into the vacuum (external photoelectric effect).

(3) Photoelectrons are accelerated and focused by the focusing electrode onto the first dynode where they are multiplied by means of secondary electron emission. This secondary emission is repeated at each of the successive dynodes.

(4) The multiplied secondary electrons emitted from the last dynode are finally collected by the anode.

This chapter describes the principles of photoelectron emission, electron trajectory, and the design and function of electron multipliers. The electron multipliers used for photomultiplier tubes are classified into two types: normal discrete dynodes consisting of multiple stages and continuous dynodes such as microchannel plates. Since both types of dynodes differ considerably in operating principle, photomultiplier tubes using microchannel plates (MCP-PMTs) are separately described in Chapter 10. Furthermore, electron multipliers for various particle beams and ion detectors are discussed in Chapter 12.