I. Pulse Height Discrimination in Nuclear Pulse Spectrometry.

In the field of nuclear technology, electronic counters are widely used to analyze the radiation process. Fig. 1.1 represents the principal parts of an electronic counter employed in nuclear counting system.

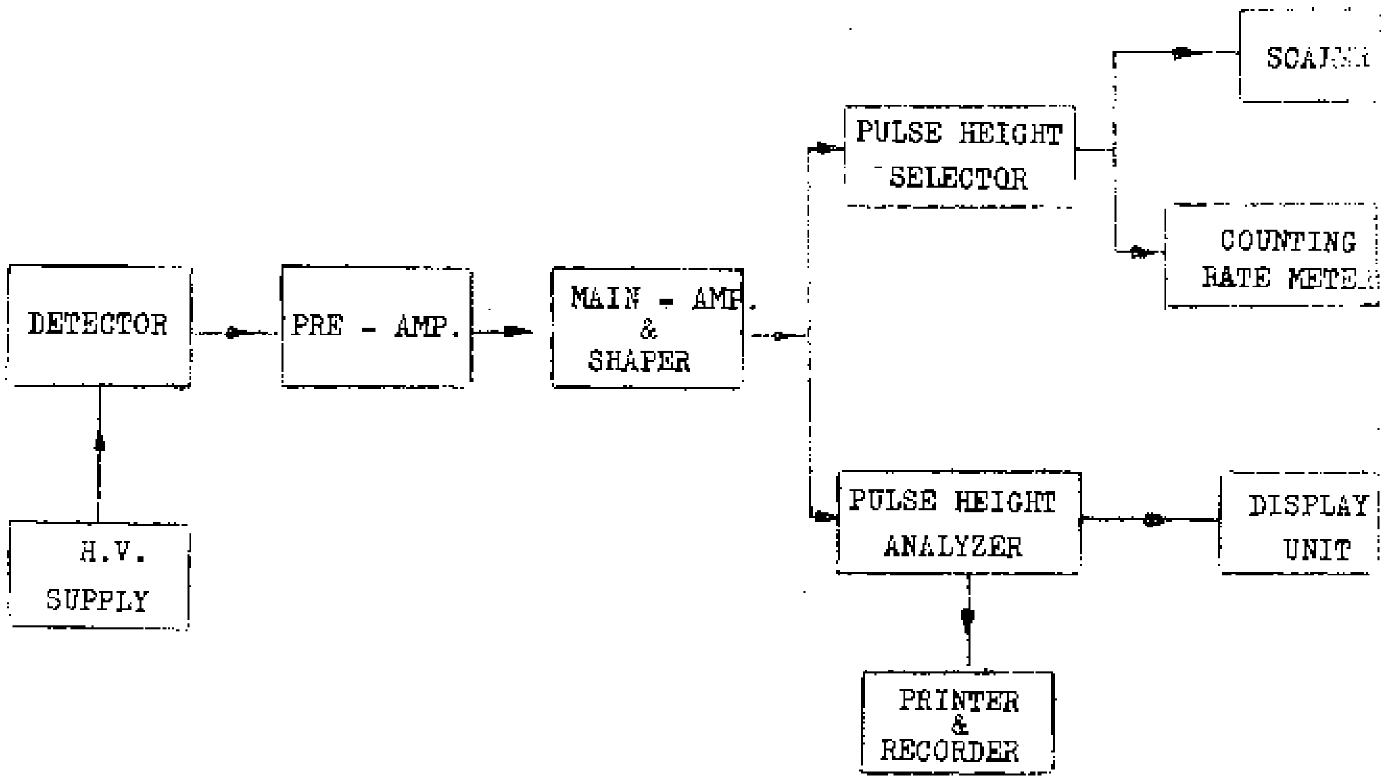

Fig. 1.1 Principal parts of electronic counter in nuclear counting system.

The first part is the detector which may be a G.M. (Geiger-Muller) counter, a scin-tillator with photo-multiplier tube or a BF_3 counter. It gets the appropriate high voltage from a high voltage supply section. Upon receiving radiation of the proper kind the detector delivers a signal pulse which will be amplified by a pre-amplifier. However, the significant amplification occurs in the main amplifier and afterwards the amplified signal is shaped to a proper appearance suitable to be further operated by the pulse height selector or pulse height analyzer.

In pulse height analyzer the signal pulse will be analyzed according to their amplitude stored (in the multi-channel analyzer) and displayed or recorded. This is achieved sequentially according to the programmed set in the multichannel analyzer. The recorded out-put or the result displayed will be on the other hand the spectrum of the radiation under investigation.

Pulse height selector sometimes called discriminator is generally used to discriminate signal pulse from unwanted signal or noise, which in some case becomes a serious problem in nuclear measurement. In general the discriminator is a basic circuit in pulse height analysis and is the main topic of this thesis.

Consequently stress will be given on the analysis and the performance of several discriminator circuits.

1.1 Type of discriminator

The discriminators are the heart of the analyzer, the stability is the major factor controlling instrumental accuracy. Whilst in theory countless methods exist which will indicate the equality between a ranging voltage (the input signal pulse) and a fixed reference voltage (the discriminator or channel level). So far only two discriminator forms have remained of practical importance for high speed operation. They are "integral discriminator and differential discriminator."

1.1.1 Integral discriminator

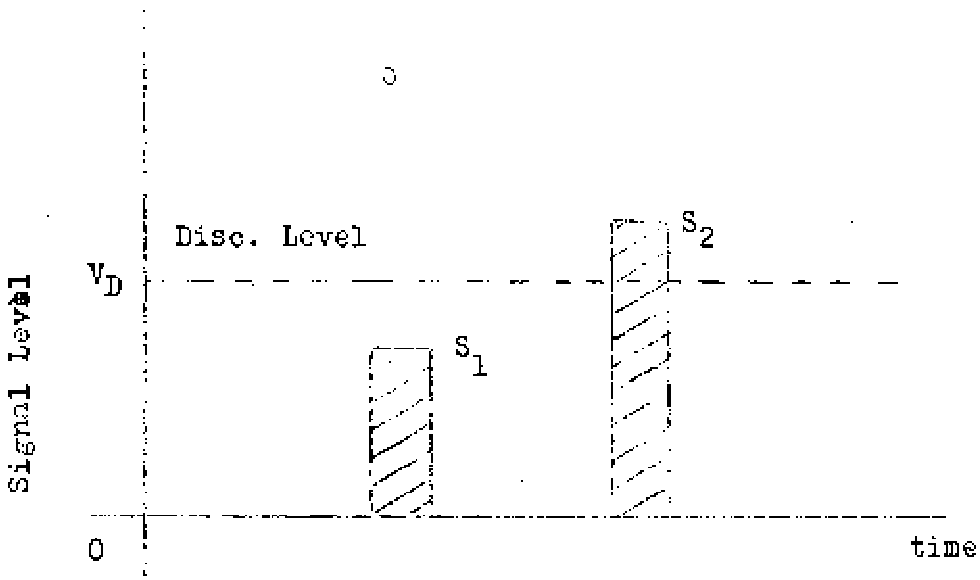

Fig. 1.2 Signal pulses and The discriminator level in integral discrimination

This is a circuit that rejects all signals S1 in Fig.1.2 with an amplitude less than the bias setting and passes to the following state all signals S2 in Fig. 1.2 with an amplitude greater than the bias. A pulse height distribution can be measured with an integral discriminator by recording the output observed at a number of bias setting. The number of observations and the voltage intervals between them are chosen to yeild the desired resolution. If the counting rate is plotted against the bias voltage, we obtain the "integral bias curve" as in Fig. 1.3 a and if we differentiate point by point the integral bias curve i.e. measuring the slope at several point in the integral bias curve, the differential bias curve is obtained(Fig. 1.3 b).

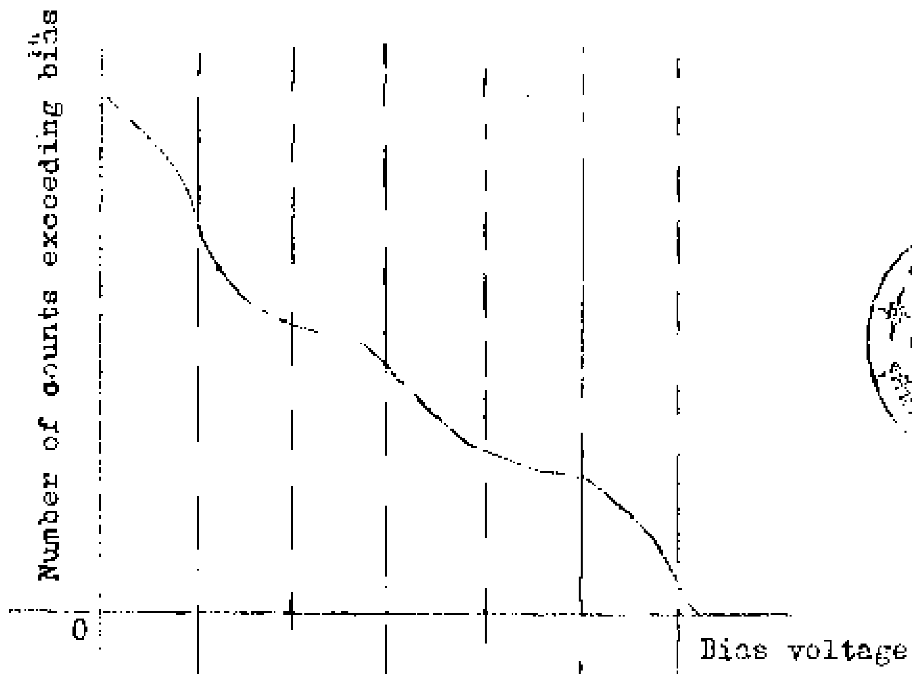

Fig. 1.3 a Integral bias Curve

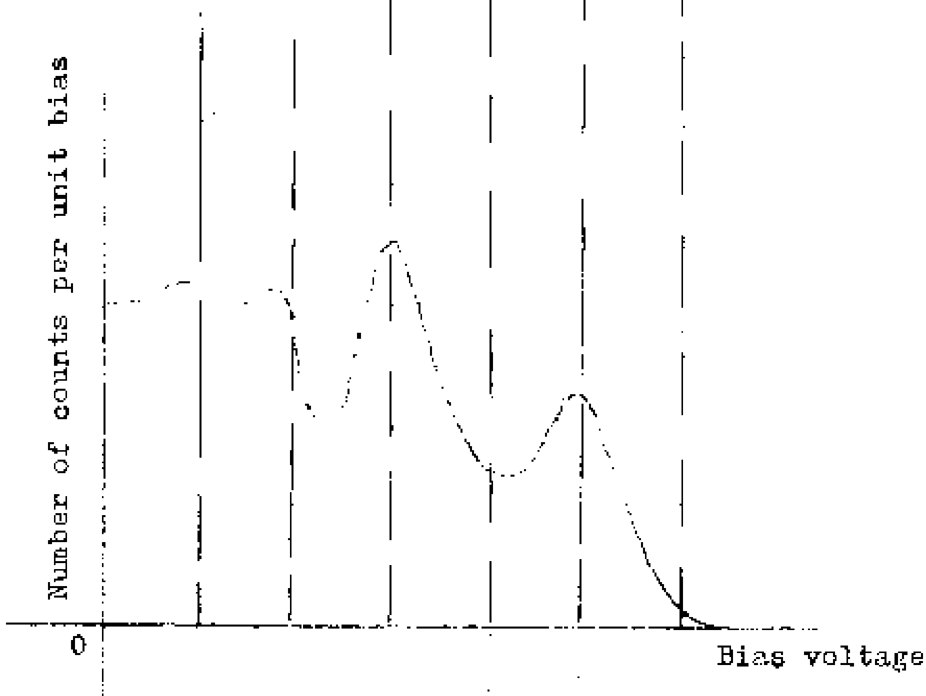

Fig. 1.3 b Differential bias curve

Pulse amplitude discriminator circuits may be classified into two groups.

1.1.1.1 <u>High level discriminator</u> This circuit is generally made up of a simple components such as diode or transistor circuit whose level of triggering is high. For example, back biased diode discriminator, Schmitt trigger etc.

1.1.1.2 <u>Low level discriminator</u> This circuit is built up of special components whose triggering level is rather low. One of these components is the tunnel diode which plays a great role in the developement of discriminator circuits described in following sections. Generally the low level discriminators are used to discriminate the signal coming directly from the detector as shown in Fig. 1.4

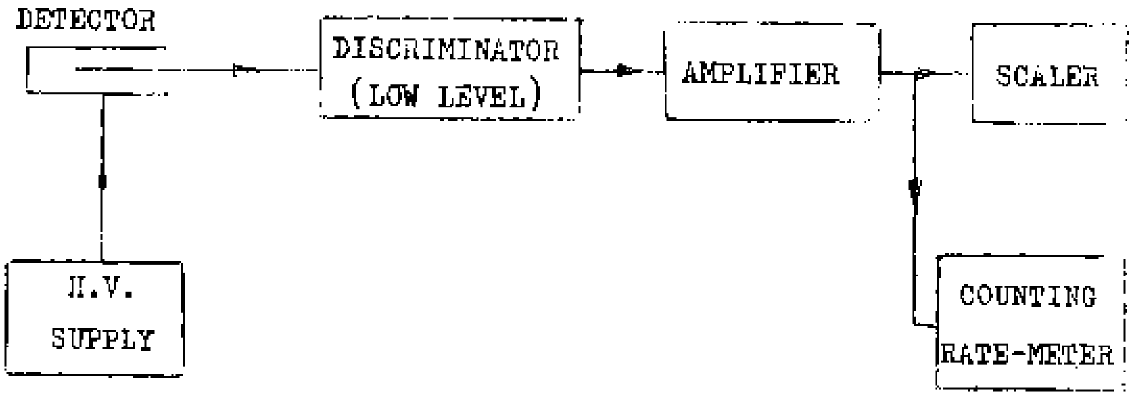

Fig. 1.4 Block diagram of counting system showing the position of low level discriminator

1.1.2 Differential discriminator

The statistical difficulty with integral discriminators can be eliminated by the use of differential discriminators (Single channel pulse height analyzer). A differential discriminator consists of two discriminator circuits with a small, usually adjustable, difference in their triggering thresholds so that signals in a small voltage range Δ V exceeding one threshold but not the other can be counted (S2 in Fig. 1.5). Signals exceeding the threshold may be counted simultaneously with two scaling circuits for the same time interval.

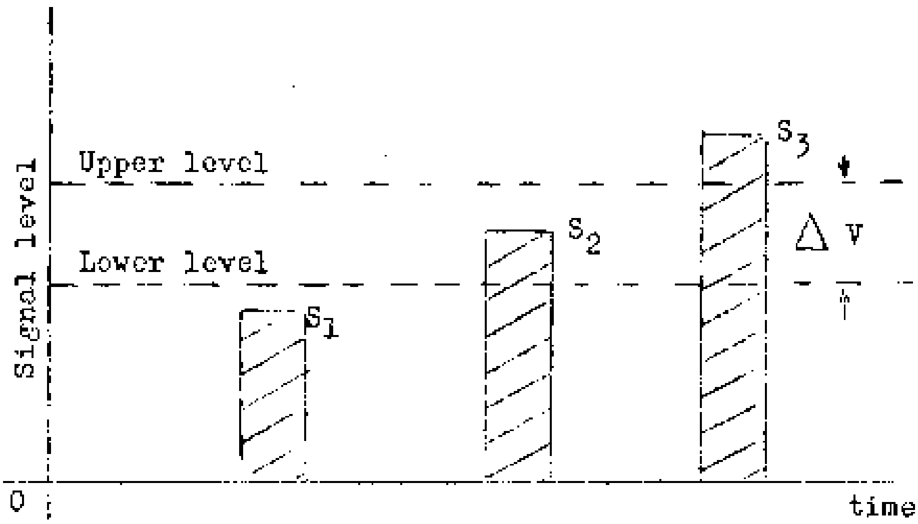

Fig. 1.5 Signal pulses and the discriminator levels in differential discriminators

Signals exceeding the lower threshold can be divided in to two parts: One in the interval Δ V and the other above the upper threshold. The number of events in the voltage interval Δ V is determined by subtracting the upper and lower measurements. But all commercial analyzers include an anti-coin-cident circuit, which cancels all signals above the upper threshold, so that only signals that fall in the voltage interval Δ V are passed. In this way only one scaling unit is necessary. See Fig. 1.6

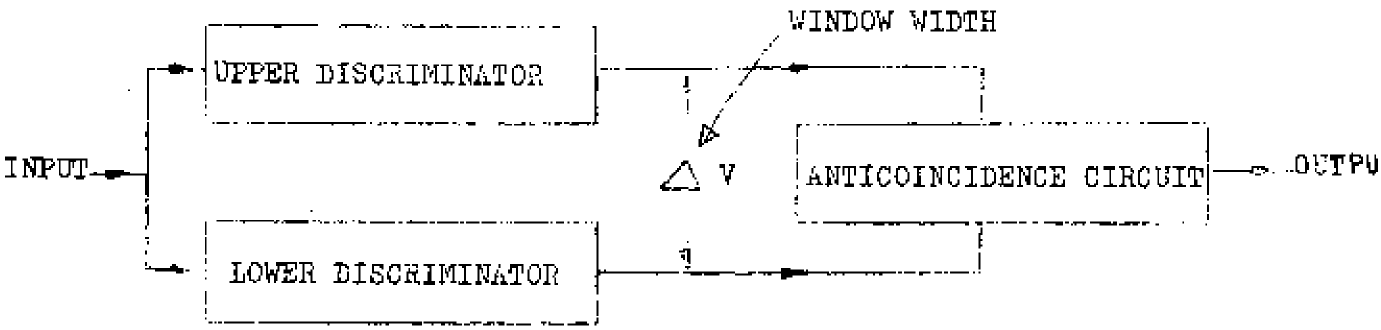

Fig. 1.6 Principle of differential discriminator using anti-coin-cidence circuit.