AVALANCHE TRANSISTOR DISCRIMINATOR FOR LOW ENERGY RADIATIONS*

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ABSTRACT

A fast discriminator circuit is used as the basic element in fast timing circuits using fast photomultipliers. The fast discriminator is based on avalanche transistor and delivers a constant voltage pulses at the ouput. The triggering level goes down to 0·1 Volt and the output pulse has a rise time of the order of 2ns and FWHM 8ns. The circuit has been successfully used in resolving the closely spaced low energy conversion lines of ^{144}Ce[1,2].

INTRODUCTION

STANDARDISATION of the fast pulses of different energies is always desirable when the coincidence techniques are applied in the investigation of nuclear decay schemes. Valve and transistor limiters were commonly used by authors[3–5] as pulse equalisers. The advent of the avalanche transistor and the tunnel diode has immensely enhanced the progress of the coincidence techniques where timing selections are inevitable[5].

The present paper describes a fast discriminator circuit which employs Fairchild silicon 2N914 avalanche transistor. Such transistors have superior rise time, large signal ouput and better reliability. The fast discriminator was used in the coincidence studies of low energy beta and gamma transitions of ^{144}Ce[1,2]. With this arrangement, the closely spaced low energy beta and gamma ray lines of ^{144}Ce, which hitherto remained controversial, have been successfully well resolved[1,2].

DESCRIPTION

The avalanche discriminator circuit is shown in Fig. 1. The base of the transistor is grounded to earth by 100 Ω resistor. Bias is applied on to the emitter through resistors Re and Ré and the decoupling capactors Cd, Cd′ and Cd″. Output is taken from the collector *via* a variable capacitor C. The amplitude and time constant were adjusted to the desired values by varying the value of C and keepihg load resistor R_L constant. The value of load resistor R_L was kept 100 Ω in order to match the impedance of transmission line. The use of induction of 5 mH in the power supply line and the bias line is to protect the power supply and other units against the reflected avalanche pulses. The PNP avalanche transistor is triggered by positive pulse. Such pulses are available from the anode of 56AVP which are inverted by a transformer consisting of a few turns of copper wire on ferrite core. Ringing in the output pulse is reduced to minimum by making the connection leads as short as possible. The whole circuit is kept in a copper box grounded to earth. This was essential in order to protect the circuit against the possible interference of the external radiations. The bias on the emitter is adjusted to cut off the noise level. The circuit was found to trigger the input down to 0·1 Volt. The fast output pulse available from the discriminator is shown in Fig. 2. The rise time of the output pulse was found to be of the order of 2 ns, whereas the FWHM was about 8 ns.

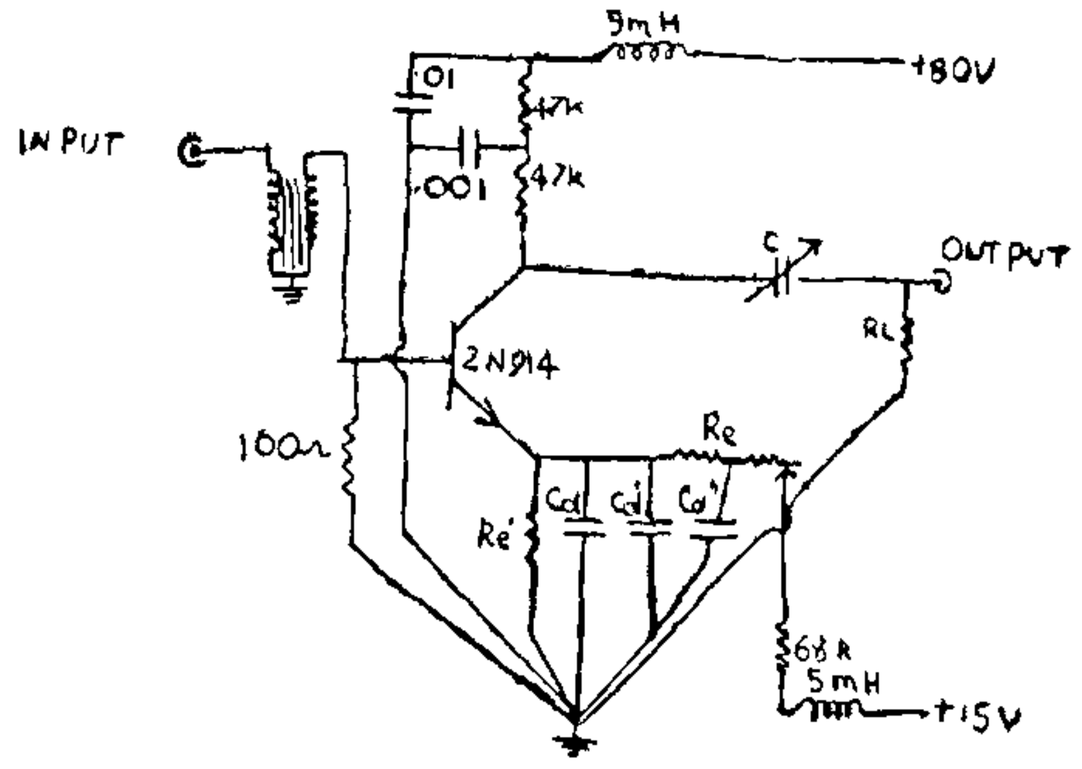

FIG. 1. The avalanche discriminator circuit. R_L—100 Ω, Re—26 k, Re′—1 k, Cd—0·001 mF, Cd′—1·0 mF, Cd″—0·01 mF, C—10 pF.

FIG. 2. Output pulse of the discriminator. Pulse rise time 10 ns cm^{-1}; pulse height 1 V cm^{-1}.

EXPERIMENT

Figure 3 shows the schematic diagram of *e-e* coincidence system in which the avalanche transistor

* The work was done at Bedford College, London University.

discriminators were used as pulse equalisers. In order to test the performance of the discriminator circuit, the delay curves were plotted by focussing the magnetic beta spectrometers on the conversion lines of ^{144}Ce[1]. A typical delay curve is shown in Fig. 4. The sharp rise and the flat top of the curve are attributed to the fast rise time of the discriminator output pulse. A compatible resolution of the fast coincidence system is estimated to be $2\tau = 14$ ns. With this resolution, the random coincidences were reduced to minimum (of the order of 10^{-3} counts per second) and the closely spaced low energy conversion lines were found well resolved[2].

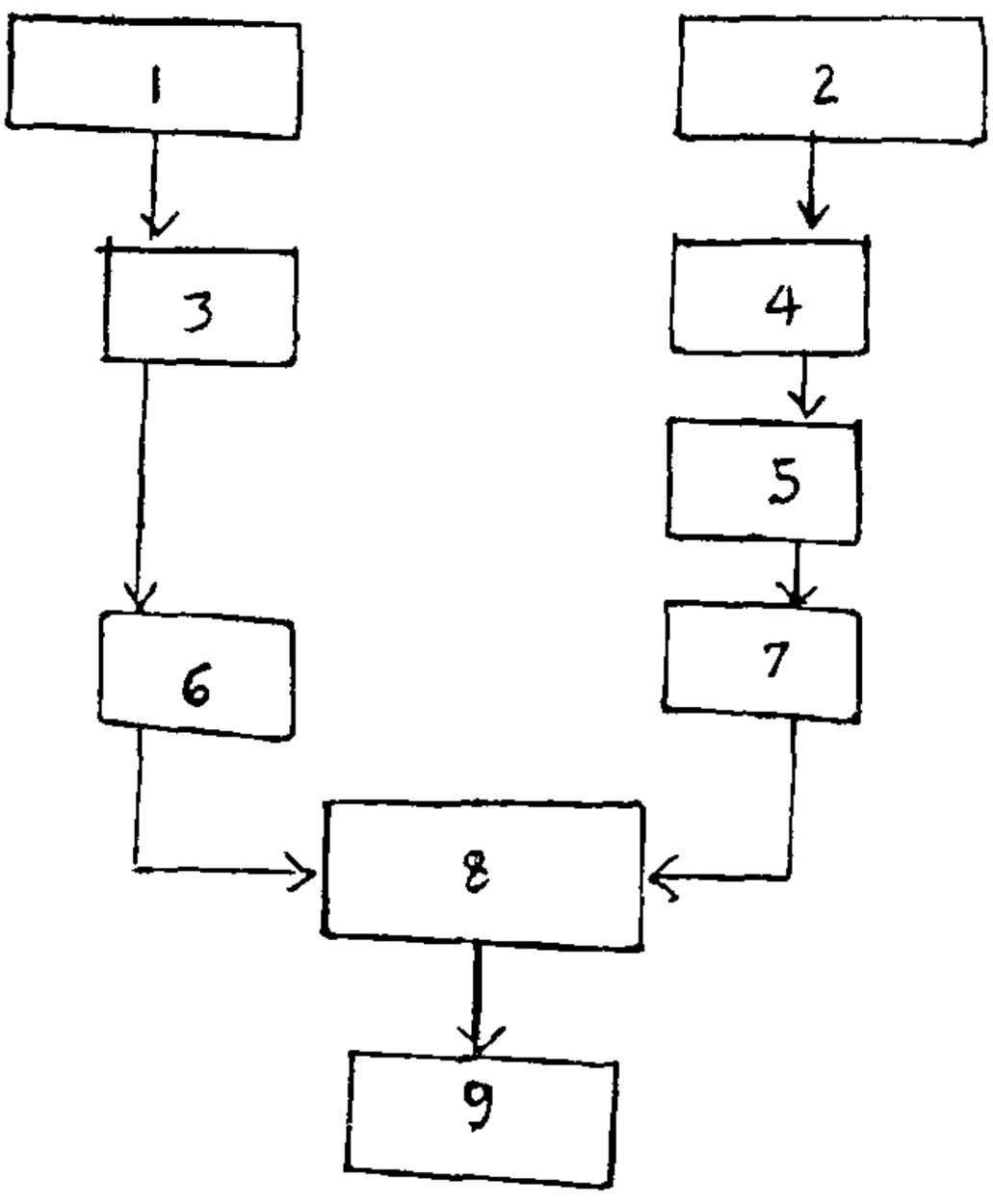

FIG. 3. Schematic diagram of the *e-e* coincidence systems. 1-2, Beta spectrometers, 3, 4-anode of the 56 AVP photomultiplier, 5—delay (ns.), 6, 7—avalanche discriminators, 8—fast coincidence unit, 9—scalar.

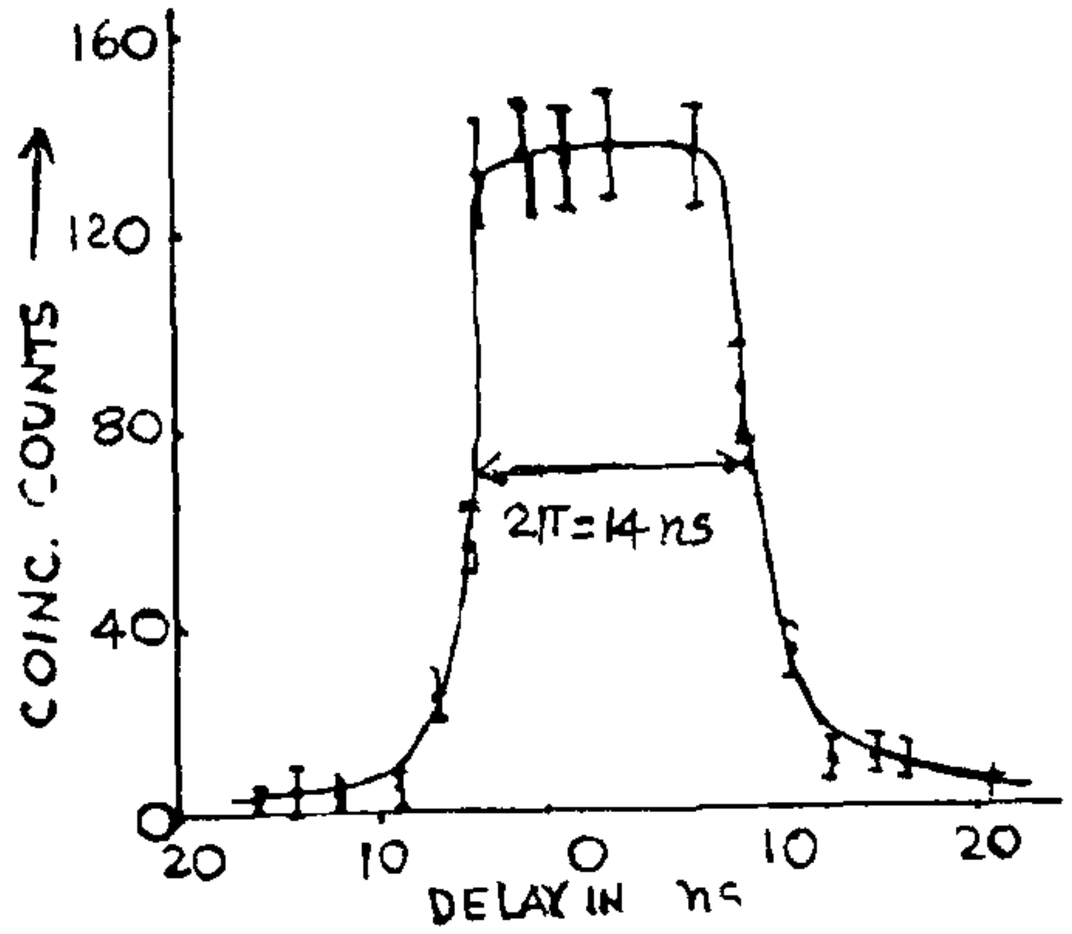

FIG. 4. The delay curve.

The narrow pulse width and the fast rise time of the output pulse are the unique features of the fast avalanche discriminator circuit. Moreover, the circuit is inexpensive and simple in design.

ACKNOWLEDGEMENT

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