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* Since the submission of the manuscript for the accompanying letter to the editor, the positron and negatron spectra of Cu^{64} have been studied using identical techniques. The resulting F−K plots show no deviation from a straight line as low as 50 kev. This suggests the possibility of the existence of a forbidden spectrum or complex disintegration in the case of Cu^{61}. However, the possibility of a forbidden transition does not seem reasonable in view of the fact that the *ft*-value for this isotope predicts an allowed transition.

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A. Germanium Counter

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WHEN insulating crystals, such as diamonds, are used as crystal counters of nuclear particles, a complicating factor is the trapping of mobile charge carriers in the crystal. This results in a broad pulse height distribution and the development of internal space charge fields. These effects can be greatly minimized for bombarding particles of high specific ionization by using a very thin crystal together with a high electric field. A method of obtaining the equivalent of this is to use a barrier layer in a semiconductor. The properties of the barrier layer in germanium under a point contact are such that one can calculate under what circumstances it could be used as a counter.[1]

Figure 1 shows the equivalent circuit to be considered where R_b, C_b represent the constituents of the barrier impedance, R_i, C_i those of the amplifier input, and R_s the series resistance of the body of the germanium. By applying a reverse bias to the barrier, we can insure that $R_b \gg R_s$ and thus neglects R_s completely. The equivalent circuit then reduces to a simple parallel RC circuit where $R=R_bR_i(R_b+R_i)^{-1}$ and $C=C_i+C_b$. Bombardment of the barrier by an alpha-particle produces free electrons and positive holes in the barrier region which are then swept out by the barrier field aided by the applied field. The time taken to sweep the carriers out of the barrier region is assumed to be short compared with the RC relaxation time, so that this action is equivalent to the production of an impulse current across the barrier layer, resulting in a peak voltage across the barrier of $v=Q/C$ where Q is the effective charge transported across the barrier. We require that C be small enough to give an adequate signal-to-noise ratio thus limiting the maximum area of the barrier that can be employed. The noise power per unit cycle from a barrier varies inversely with the frequency and increases with increasing bias.[2] Consequently, it is important to eliminate the low frequency noise components and to operate at as low a bias as possible. We also require that the relaxation time RC be long compared with the amplifier rise time. The relaxation time of a barrier in N-type high back-voltage germanium is of the order of 0.1μ sec. or less,

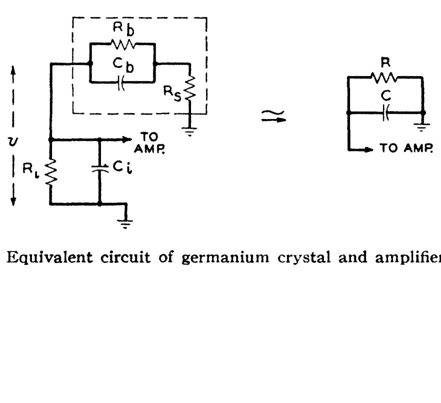

FIG. 1. Equivalent circuit of germanium crystal and amplifier input.

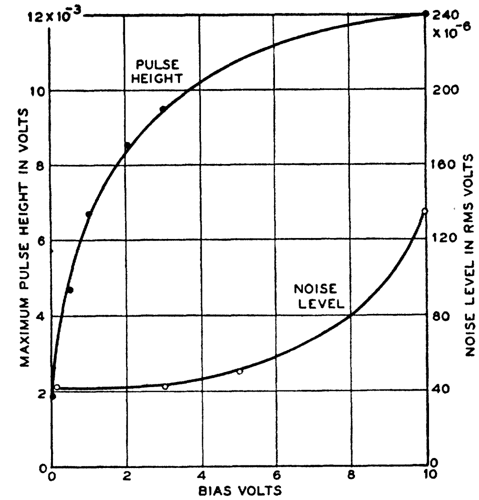

FIG. 2. Observed maximum pulse height and noise level as a function of applied bias.

thus requiring rather wide band amplification. This relaxation time can be increased by reducing the barrier capacity to less than the amplifier input capacity which condition also results in the maximum pulse voltage.

Experimentally this condition was realized by setting a phosphor bronze point contact down on the face of a piece of N-type high back-voltage germanium. A large area ohmic contact was made to the opposite face of the germanium. The point was biased negatively with respect to the germanium and was connected to the input of an amplifier covering the frequency range of 100 kc to 15 mc. The barrier capacity was less than 1 $\mu\mu$f and the total input capacity was 17 $\mu\mu$f. The point exhibited a typical rectifier current-voltage characteristic, and the contact area was photo-sensitive. An uncollimated polonium alpha-source was placed near the contact area. The resultant pulses, as displayed on an oscilloscope, showed a broad distribution in pulse height owing presumably to the passage of some alpha-particles near the edges of the sensitive region. However, the maximum pulse height was well defined and is shown in Fig. 2 as a function of bias. The pulse shape agreed with that calculated from the circuit constants; the pulse rise time was apparently limited by the amplifier from which we can only conclude that it was less than 0.05 μsec. It should be noted that pulses are observed at zero bias as a result of the action of the barrier field alone. The maximum observed pulse height corresponds to the passage of 10^6 electronic charges across the barrier per alpha-particle. The current multiplication factor at the collector point has not been determined.[1] The sensitive region has a diameter of between 10^{-3} and 10^{-2} cm.

In another test a commercial Western Electric Type 400 B germanium rectifier was cut open and the wax impregnation removed. It was inserted in the circuit and the results obtained were essentially the same as those described above.

The fast rise and recovery times should commend this counter for high speed or coincidence counting. It will respond effectively only to particles with a high specific ionization, thus discriminating against betas etc. The small sensitive volume renders it spatially selective. Trapping apparently does not play an observable role. The sensitive area could be increased by using a different geometry or by using a $P-N$ junction, the maximum area being subject to the restrictions discussed above.[3] After bombardment by about 10^{13} alphas/cm², the counting efficiency should change but the original condition can be restored by a suitable heat treatment.

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