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A RECOIL PROPORTIONAL COUNTER

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ABSTRACT

Design and characteristics of a cylindrical proportional counter with a thin tristearin radiator are described. The counter has been used for detection of 80-Kev to 3-Mev neutrons.

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A RECOIL PROPORTIONAL COUNTER

Counter Design

Essential features of the design are shown in Fig. 1. The radiators were prepared by B. Diven by evaporation of tristearin in vacuum. They were mounted flat in the counter so as to occupy the position of a chord on the inside cylindrical surface. The platinum or gold lining was of .010" sheet; pieces for the ends of the counter were spun to fit. The lining was cleaned by boiling in concentrated nitric acid and flame-heating to red heat. Positive high voltage was applied to the center wire, and the pulse was taken off the center wire by capacity coupling.

Counter Characteristics

The following table shows the four conditions under which the counters were used:

Counter #	Lining	Radiator Thickness Kev	Gas Filling	Gas Pressure cm	Operating Voltage	Primary-Neutron Energy Mev	Back-ground %
1	Gold	275	Argon	100	1800	1.5	5.0
3	Platinum	120	Argon	26	960	0.600	1.3
4	Platinum	37	Argon	12	760	0.200	2.5
5	Platinum	330	Krypton	170	2380	3.1	1.0

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The background as listed in the table is the ratio of the count taken with the radiator on the far side of the counter to the count with the radiator on the near side, the counter being rotated about its axis to obtain the two positions. The bias for this background test is taken at about half the primary-neutron energy. For the 3.1-Mev neutrons the backgrounds with no lining (brass tube), with gold, and with platinum were in the approximate ratio 20:4:1.

The operating voltage was chosen such that individual pulses due to presence of γ-rays were several times bigger than the amplifier noise. The gas multiplication was of the order of 5 to 50, depending on the gas filling.

The counters were filled with spectroscopically pure gas and allowed to age a day or preferably more, before use. Observed variations in gas multiplication over a period of one week were not more than 10%.

The three lower-energy counters were tested with Li(p,n) neutrons monitored by a 25 fission detector. The high-energy counter was tested with 3.1-Mev D-D neutrons. Typical curves indicating the response of the counters to nearly monokinetic neutrons are given in Figs. 2, 3, and 4. In all cases the data were taken with bias set on the counting circuit in such a way as to count all pulses of size greater than the bias energy.

The theoretical bias curve shown in Fig. 2 accounts for radiator thickness, neglects carbon recoils. It is calculated from

$$e = \left[N\sigma_j(H)x_1/t\right] \left[1-(E_b/E_n) - (1/E_n x_1)\int_0^{x_1} P\, dx\right]$$

$$x_1 = r(E_n) - r(E_b)\ ;\ x_1 \leq t$$

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where N is the number of hydrogen atoms in the radiator, t the radiator thickness, E_n the neutron energy, and E_b the bias energy of the counting circuit. P(x) is given by the relation:

$$x = \sqrt{(P(x) + E_b)/E_n} \left[r\,(P + E_b) - r(E_b) \right]$$

where r(E) is the range-energy relation[1] for protons in tristearin. The absolute efficiency scale used in Fig. 2 is calculated, and the experimental points are normalized to fit at high bias. The discrepancy between theory and experiment at low bias is largely due to the counting of γ-ray pileup and carbon recoils.

The theoretical energy - efficiency curves of Fig. 3 were also calculated from the above relation. The experimental data were taken with a 25 fission detector as monitor, and the curves were plotted using the known energy dependence of $\sigma_f(25)$. The theoretical curves are calculated for arbitrarily chosen biases which in no case quite equals the bias for the experimental curve. Therefore, the degree to which the curves are parallel is the criterion for agreement between theory and experiment. One and the same normalizing factor was used to fit the experimental curves to the calculated ones. Up to about 600 Kev the agreement is within experimental error. As neutron energy increases above 600 Kev a wall effect, no accounted for in the calculations, begins to set in. The large discrepancy at the highest bias is therefore expected.

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1) Hirschfelder and Magee, LA-129

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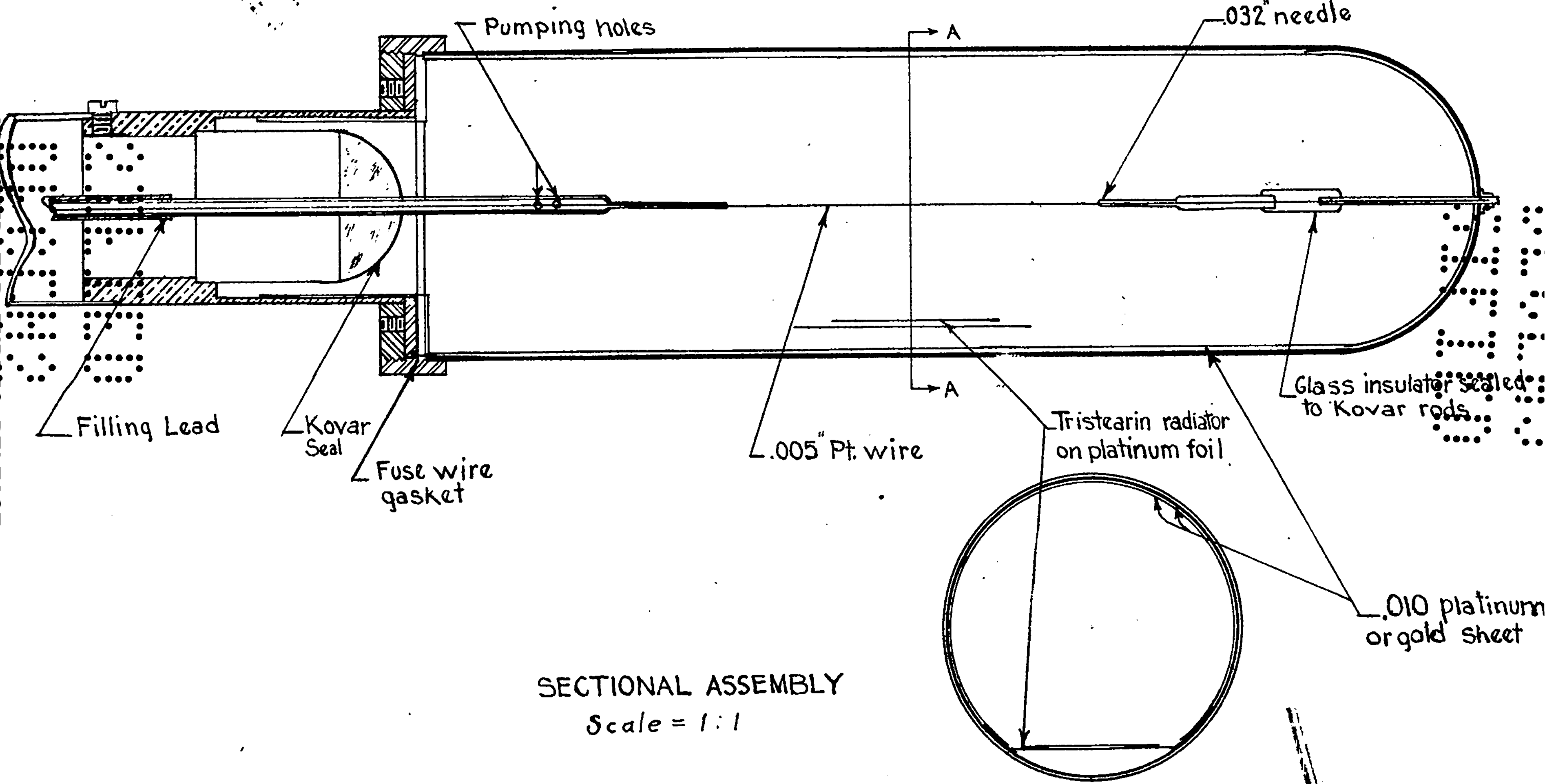
FIG. 1



SECTIONAL ASSEMBLY

Scale = 1 : 1

Section A-A

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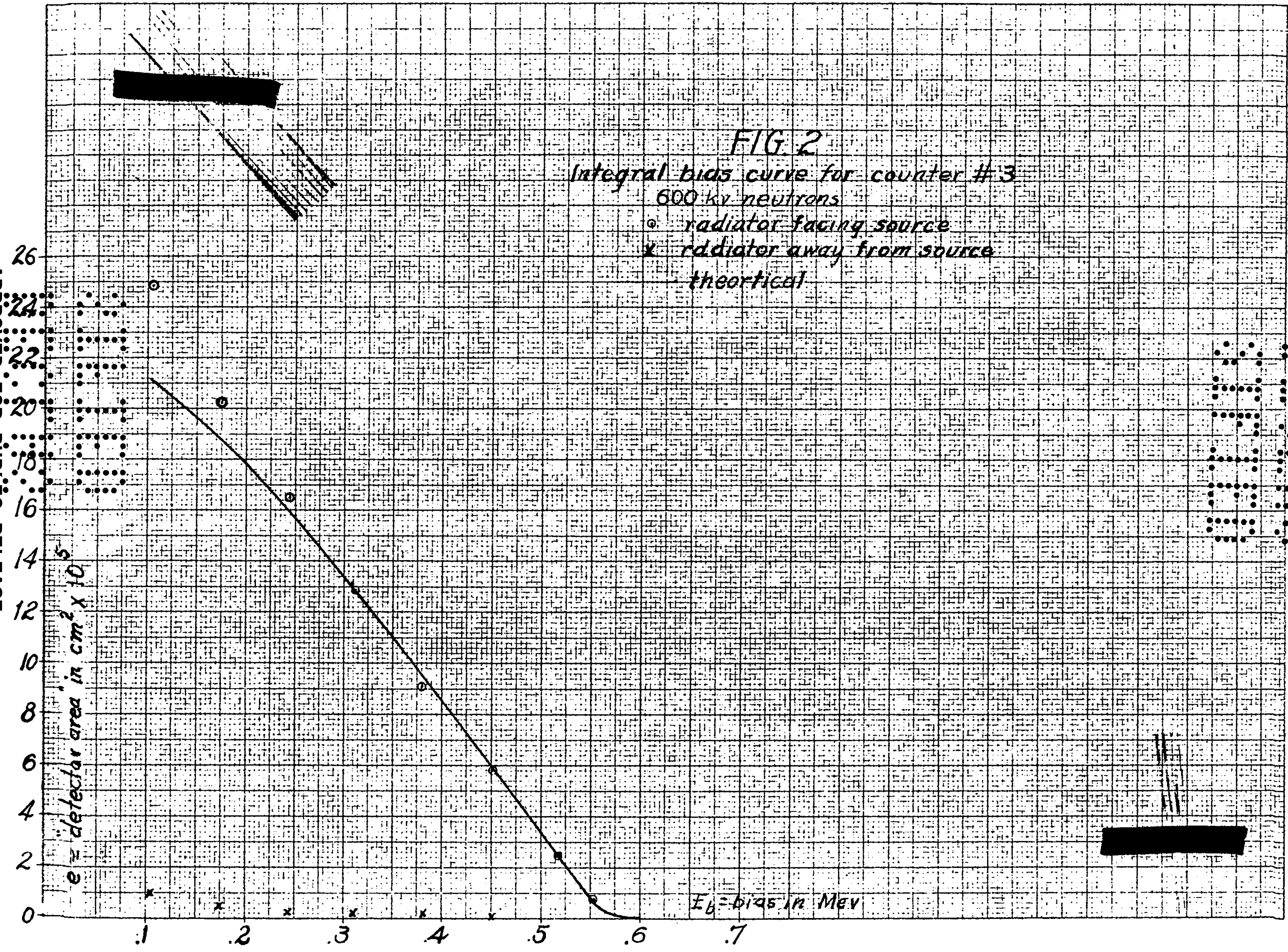

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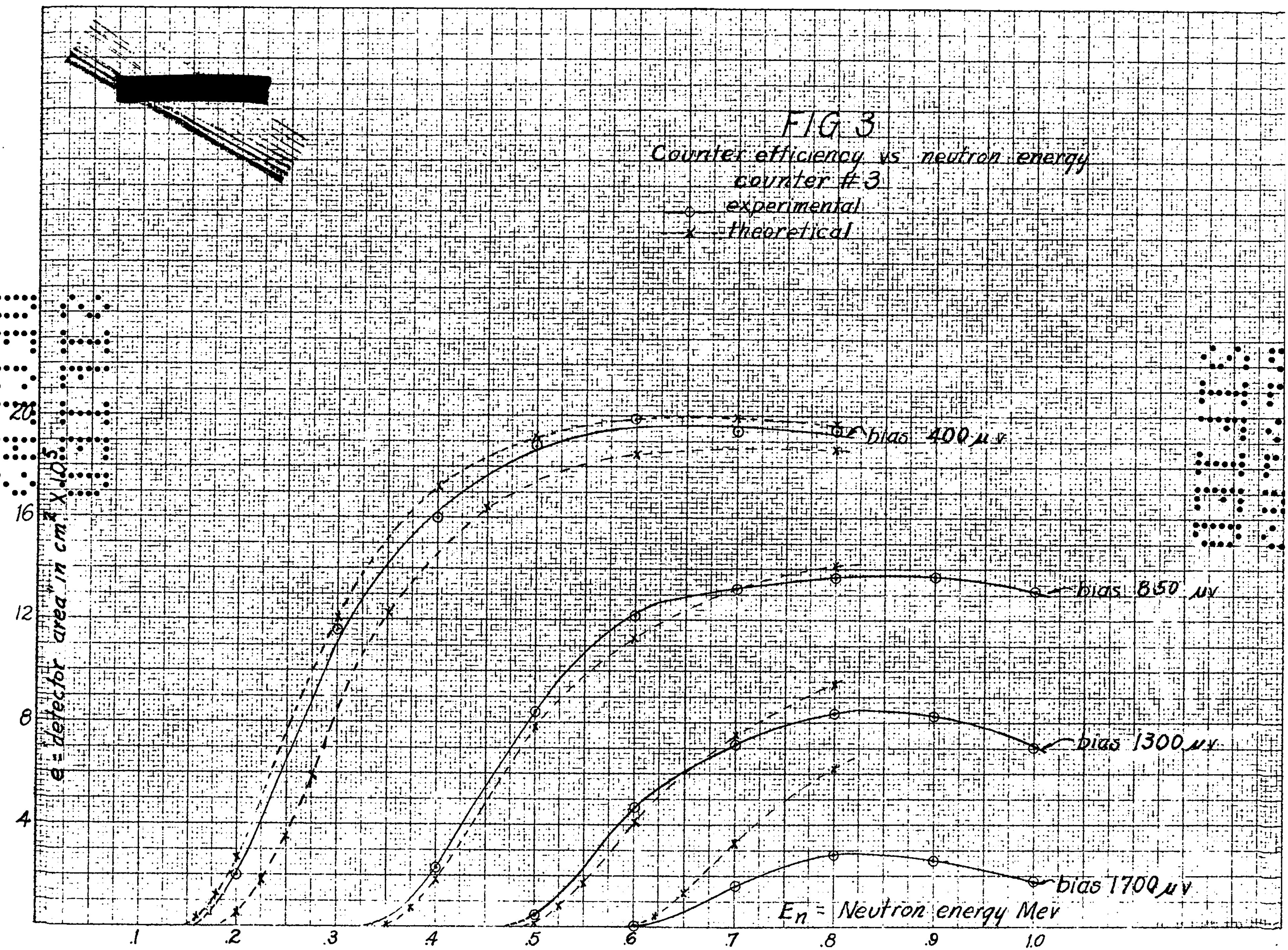

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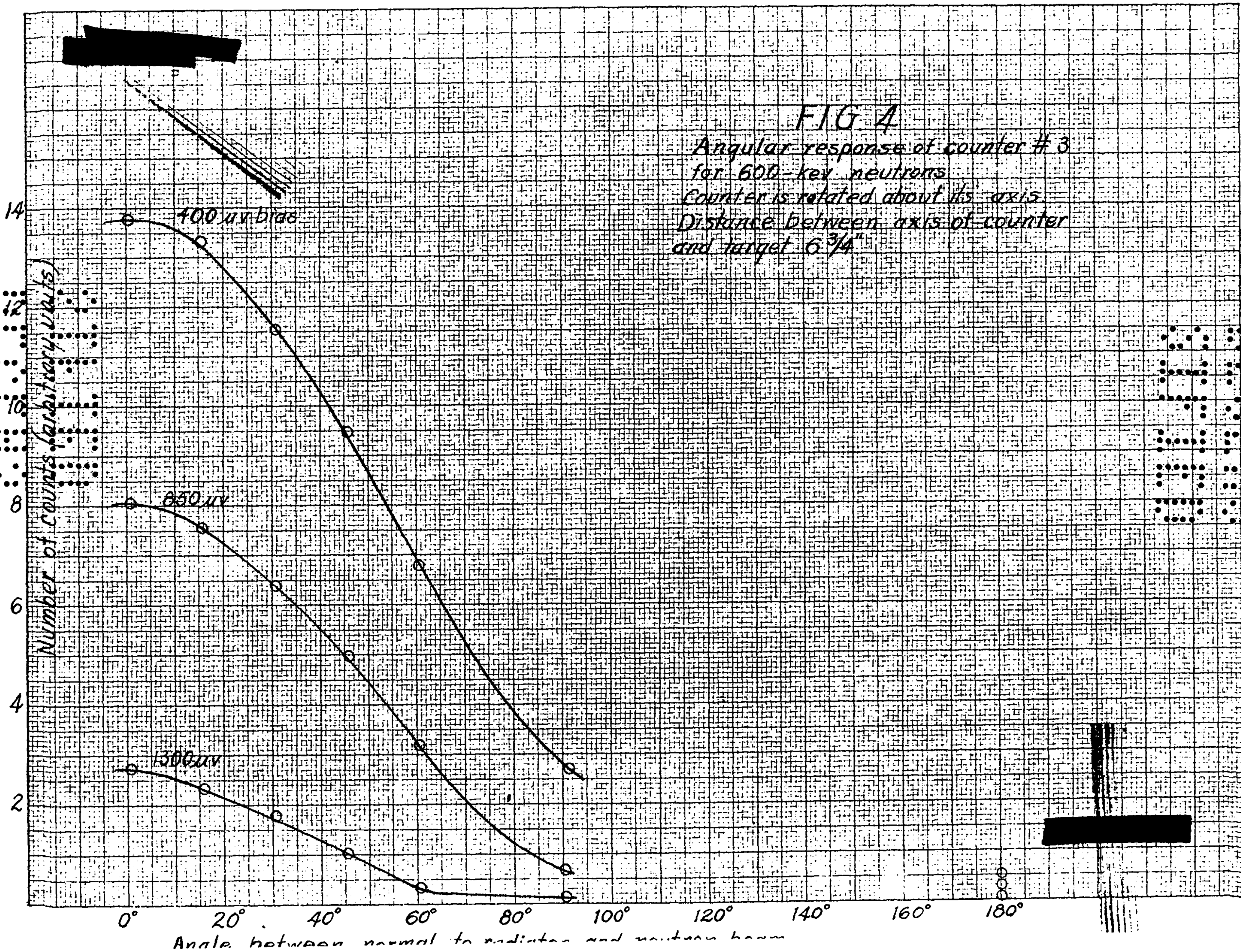

FIG 4
Angular response of counter # 3 for 600 kev neutrons
Counter is rotated about its axis
Distance between axis of counter and target 6 3/4"

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