similar process[7] although the layer deposited and the gas disintegration products may very well be different.

While photon counters have been compared favorably with certain types of photo-multipliers, they have had few applications because of lack of reliability or limited spectral response.[8] A reliable photon counter of high surface quantum efficiency in the near ultraviolet or visible light region could find important uses in spectroscopy, as a Čerenkov radiation detector,[9] and possibly as an alpha-particle and low energy β-ray detector without thin-window techniques by the use of suitable phosphors.

Work is proceeding on the investigation of the reported photoelectric effect for various gases and cathode materials.

The author wishes to express his appreciation to Mr. W. E. Ramsey for many stimulating discussions and to Dr. W. F. G. Swann for his interest in this investigation.

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* Supported by the Office of Naval Research.

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Cosmic-Ray Bursts in the Upper Atmosphere*

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On July 29 a successful V-2 rocket carried a bundle of four automatically calibrated pulse ionization chambers mounted in the rocket nose (Fig. 1) to an altitude of 100 miles. During the flight there were recorded 150 seconds of good quality telemetered data above 180,000 ft.

The ionization chambers were similar to those used by Bridge and Rossi,[1] 20 in. long and 3 in. in diameter filled with 5 atmospheres of purified argon. Calibration was achieved by periodically sliding tubes internal to the chambers by means of external solenoids, thereby uncovering fairly thin polonium sources. There were 11 Po α-particle pulses per second during calibrations compared to a high altitude cosmic-ray counting rate of 4 per second (mostly smaller pulses). The pulses of 10-μsec. duration were amplified by a feed-back type pulse amplifier with 2-μsec. rise time. These pulses were shaped by an artificial line, amplified, lengthened by an integrating circuit, and then transmitted to the ground by the 23-channel radio telemetering system of the Naval Research Laboratory. Before firing, an artificial pulser was used to establish the amplitude calibration of the over-all amplifier, telemetering, and recording system. The system was linear and the scale and reliability were assured by the six Po-α-calibration periods of two-second length each at 27-second intervals during flight.

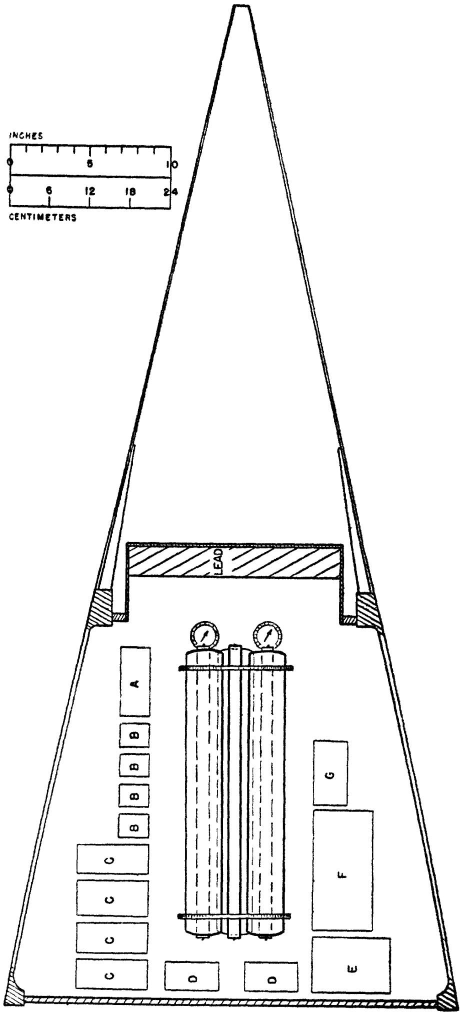

FIG. 1. Schematic diagram of ionization chambers in V-2 instrument cone. *A*, *B*, *C*, etc. represent electronic chasses. Remainder of rocket extends 40′ below.

The results of three of the chambers are concordant and yield the distribution of pulse height shown in Fig. 2. The data from the fourth chamber are in disagreement with these three, and by examining the distribution, we have deduced that there were 24 spurious large pulses, and so we have not used the data from this chamber although the distribution of smaller pulses is in complete agreement with the group of three.

Selecting the pulses with amplitude greater than 1.5 and 2.5 times the extrapolated integral pulse amplitude of a

Po-α, comparison can be made with the results of Bridge and Rossi taken up to 35,000 ft. (Fig. 3). It is not entirely clear whether our data should be considered an extension of their results taken in the case with 1 in. of lead surrounding the chamber or in the case without lead. In order to ballast the rocket, 250 pounds of lead were placed above the chamber, as shown in Fig. 1; however, the solid angle of this lead is small compared to the complete surrounding of the chambers. If there are no electrons of high energy above the atmosphere, there should be little difference between the two cases. The counting rates shown in Fig. 3 are unadjusted and the fluctuations indicated are the statistical probable errors only. The absorption coefficient, μ, derived from $I=I_0e^{-\mu h}$, is (180 g/cm^2)$^{-1}$. However, if the Gross transformation,

$$I=I_0\mu h\int_{\mu h}^{\infty}\frac{e^{-x}dx}{x^2},$$

is used, then an absorption coefficient of (215 g/cm^2)$^{-1}$ gives the best fit to the data and fits only the data of the case without lead. Inasmuch as an ion chamber is a nondirectional detector, we believe the Gross transformation to be more significant.

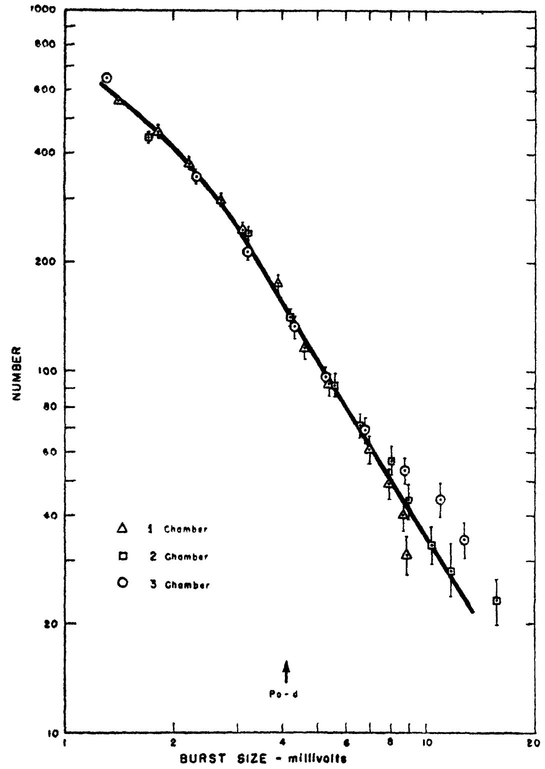

FIG. 2. Integral number—size curve of bursts recorded above 180,000-feet altitude.

Since the distribution of burst sizes is similar to that of Bridge and Rossi and the absorption curve of Fig. 3 indicates a monotonic increase of burst rate, we believe (a) that on the plateau in the upper atmosphere, where the counting rate is constant, we were measuring a direct effect of the primaries; (b) that the absorption coefficient of this portion is that associated with a nuclear cross section of 1.0×10^{-25} cm^2; and (c) that an ever diminishing portion of this primary radiation still exists at lower altitudes.[2] The departure of the burst rate from the Gross transformation at low altitudes may be due to the diminishing of the energy of these primaries in normal ionization through the atmosphere.

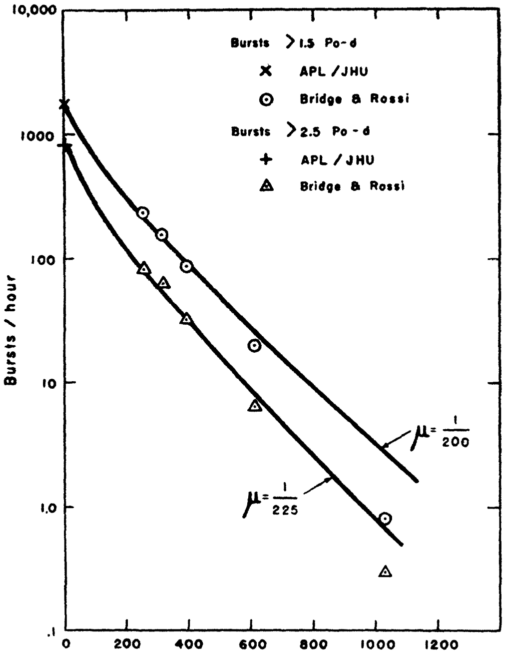

FIG. 3. Bursts/hour *vs.* pressure. Composite plot of V-2 data and data from reference 1 for the case without lead. The smooth curves are Gross transformations with $\mu=(200\text{ g/cm}^2)^{-1}$ and $(225\text{ g/cm}^2)^{-1}$, respectively.

We are grateful for the help given by Mr. Bridge and Professor Rossi and their colleagues in the preparation of this experiment.

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