the sample. The scatter in the data gives the uncertainty in temperature δT shown in Table I.

The sensitivity of the silicon carbide thermometer can be compared with that of carbon or germanium thermometers using Blakemore's[2] definition, i.e., $d(\ln R)/d(\ln T)$. For silicon carbide this value is 1.4 in the 4 to 10°K temperature range whereas for carbon[3] and germanium[2] the values range from 0.8 to 2.0.

[1] C. Kittel, *Introduction to Solid State Physics* (John Wiley & Sons, Inc., New York, 1953), 2nd ed., Chap. 16, p. 458.
[2] J. S. Blakemore, Rev. Sci. Instr. **33**, 106 (1962).
[3] E. W. Horning and D. N. Lyon, Rev. Sci. Instr. **32**, 684 (1961).

Observation of Photomultiplier Pulses with a Sampling Oscilloscope*

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SAMPLING oscilloscopes are now available with rise times less than 1 nsec. These oscilloscopes can only display repetitive signals. Unfortunately some of the fast signals one wishes to observe are not repetitive, e.g., the pulses from photomultiplier tubes. However, sampling techniques can still be used with photomultipliers if one selects pulses within a narrow portion of the pulse-height spectrum.

The circuit used to observe photomultiplier pulses is shown in Fig. 1; although it was designed for one particular sampling oscilloscope[1] it should be adaptable to any sampling system. It is a window discriminator which gates the oscilloscope unblanking pulse. Pulses from the anode of the photomultiplier trigger the oscilloscope through inverting transformer X1 and, if they are large enough, turn on transistor T1. If T1 is not turned on too hard it triggers a blocking oscillator (T2 and X2); if T1 is turned on hard it turns on emitter follower T3 which prevents the blocking oscillator from firing. Thus only a narrow range of photomultiplier pulse heights will cause the blocking oscillator to fire. The negative oscilloscope unblanking pulse is applied to the collector of transistor T4, which is normally biased off. The blocking oscillator drives T4 into saturation, causing the unblanking pulse to enter the oscilloscope.

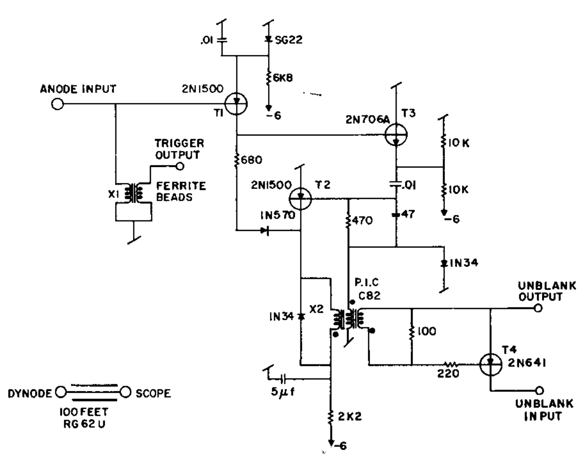

FIG. 1. Window discriminator.

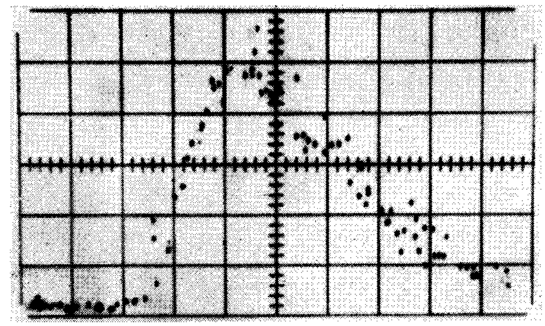

FIG. 2. Photograph of display obtained with a 56 AVP photomultiplier. Vertical scale: 0.5 V per division; horizontal scale: 2 nsec per division.

Figure 2 shows pulses from a 56AVP photomultiplier. A gamma-ray source irradiated a plastic scintillator crystal which was optically coupled to the full cathode by a Lucite light pipe. At rates high enough to permit comfortable direct viewing there is some pile-up and the oscilloscope trigger bias must be set fairly high; the photograph in Fig. 2 is a 1-sec exposure.

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[1] Tektronix type N sampling preamp, Tektronix, Inc., Beaverton, Oregon.

Refining the Mercury U-Tube Manometer*

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SEVERAL sources of error are inherent in the visual observation of the mercury level in a U-tube manometer. Illumination of the surface is critical, and parallax is a problem. The cathetometer or traveling microscope might be inadvertently moved during a lengthy experiment. Often another consideration is the eye strain an operator experiences using a high magnification cathetometer. Visual systems have been used in this laboratory and were found to suffer from these defects. These difficulties are remedied by constructing a micrometer within the U-tube itself. With a system of relays and indicator lights, a range of 0–25 mm, a sensitivity of 0.0025 mm, and an accuracy of 0.005 mm are possible.

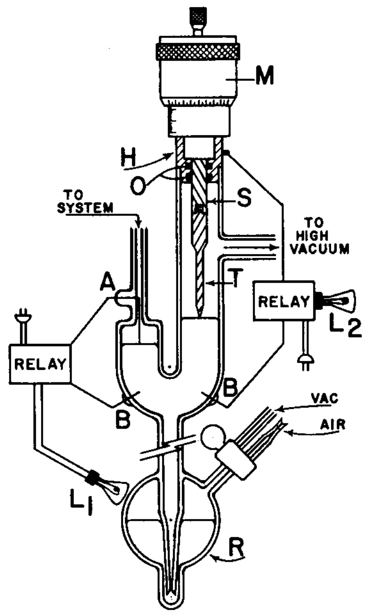

FIG. 1. Schematic diagram of manometer. A—constant reference height electrode, B—common electrode, L_1—spotlight, R—mercury reservoir, M—micrometer head, T—micrometer tip, S—micrometer spindle, O—O-rings, H—aluminum hub, and L_2—light.

The manometer system is pictured in Fig. 1. On the left arm of the U-tube sealed into the glass system are two tungsten electrodes, (A) the constant reference height electrode and (B) the common electrode. Electrode (A) permits the mercury level on the left to always be positioned at a reproducible height thus requiring only a single measurement during operation. The trigger circuit of a relay ("Electronic Relay" built by Central Scientific Company, Cat. No. 99783), with a 30-W spotlight L_1, is connected between electrodes A and B. The light L_1 serves a second purpose in addition to signaling electrical contact of the mercury surface and electrode A. When pointed toward the air space in the mercury reservoir (B) the small spotlight heats the trapped air space, raising the mercury level in the U-tube. When the level reaches electrode A the light goes out. The room air cools the air space, the mercury level drops below the electrode, and the light comes on to regenerate the cycle. Under appropriate conditions (ambient temperature regulated to $\pm 1°C$) the heat cycling excursions are usually 0.005 mm and rarely more than 0.0075 mm. The amount of air in the reservoir and the distance of the light are also considerations of obvious importance.

The micrometer for measuring the variable leg of the manometer is positioned in the right side of the U-tube. The micrometer head M used is made by Brown and Sharpe (No. 599–299–100). It has graduations of 0.0001 and 1 in. total travel with an accuracy of 0.000075 in. over the entire range. The stainless steel tip T was carefully machined to be straight as possible. The vertically and circularly moving spindle S of the micrometer is sealed by two lightly greased O-rings O. This O-ring seal is leak-tight to a 10^{-7} mm pumped vacuum and hardly restricts rotation of the micrometer. An aluminum hub H is grooved to hold these O-rings. This aluminum piece is sealed to the U-tube with Apiezon wax at the top of the Pyrex U-tube carefully ground to a flat surface. A second relay is connected between the common electrode B and the micrometer. A light L_2 activated by a second identical relay, signals electrical contact of surface and micrometer tip.

The best technique developed so far is as follows: Light L_1 is necessarily on when the mercury level in the left arm is below electrode A. Light L_2 is connected so that it lights when the mercury level rises to the micrometer tip. The micrometer is adjusted so that L_1 goes off simultaneously with L_2 coming on. A bench mark or equilibrium point is initially obtained with a 10^{-7} vacuum above each arm. Subtracting bench mark from pressure reading gives actual pressure.

Accuracy is limited by technique and, more importantly, the steadiness of the mercury surface. A wide U-tube (30 mm) minimizes capillary depression but aggravates vibration of the Hg surface.

The manometer as described is used in adsorption studies of water vapor at room temperature and thus the range covered by the micrometer is ideal. For higher pressures the range could be extended by replacing the micrometer head by extended travel dial micrometer heads.

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Photographic Method of Coding Counter Pulses*

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WHEN taking data from scintillation detectors by means of an oscilloscope and camera, it is frequently necessary to apply some code to each photograph in order,

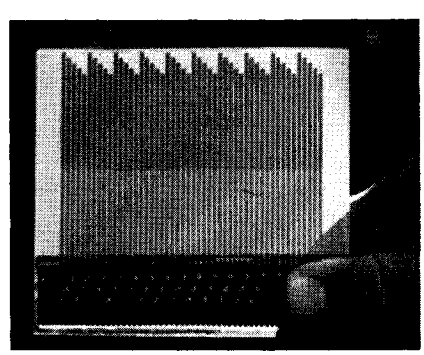

FIG. 1. An electroluminescent panel with 50 separate elements.