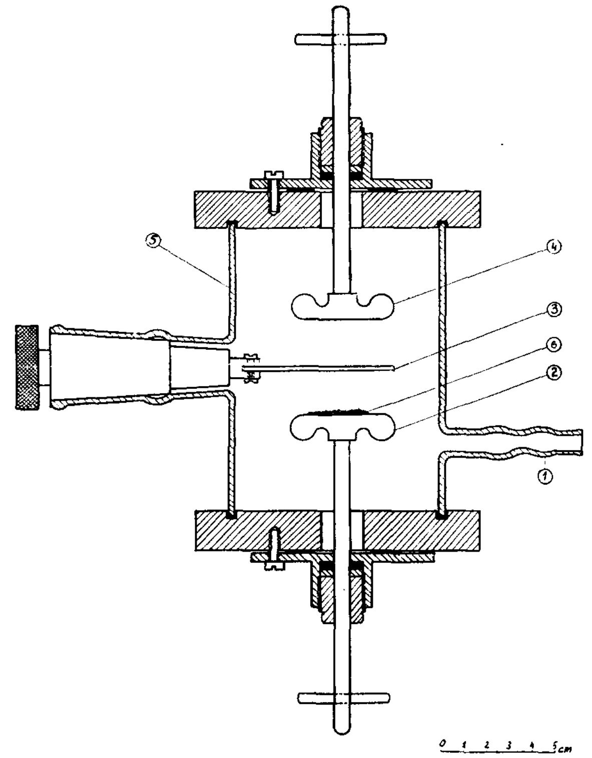

FIG. 1. Sputtering chamber. 1-vacuum inlet, 2-cathode, 3-aluminum plate on which the source holders are fixed, 4-anode, 5-glass cylinder, 6-radioactive material.

strong sources were obtained to be used in a large permanent-magnet spectrometer. Only a part of the material was used, so that more sources can be prepared from the same initial quantity.

The Eu sources were prepared from 10 mg of Eu oxide in powder form. The rate of sputtering was not as uniform as it was with metallic iridium. When the discharge starts the sputtering is initially high and after about 10 min, it decreases considerably. The surface of the material is changed and it is sufficient to scratch it with a sharp tool in order to restore the initial sputtering rate. This has to be repeated every 10 to 15 min.

The heating of the source holder is sufficiently low, so that β-ray sources on thin foils can also be prepared. We have prepared sources on Formvar films 80μ g/cm^2 thick.

The main advantage of this method over the thermal methods is that the materials with high melting point which are very difficult to evaporate, can be easily sputtered.

Another advantage is that the source can be taken out during the sputtering, and its strength and thickness checked in the spectrometer, in order to obtain the best compromise between intensity and thickness.

Beta Gauge for Localized Measurements on Thin Films*

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A GAUGE employing a narrow pencil of beta rays has been developed to determine the thickness of films used as cyclotron targets. The instrument allows an estimate of the evenness of films a few mg/cm^2 thick by reproducibly scanning the sample with a collimated beta-ray beam $\frac{3}{32}$ in. in diameter.

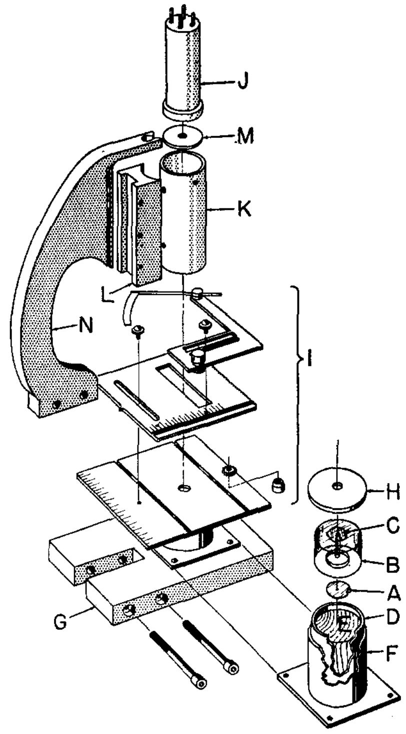

FIG. 1. Beta gauge. (*A*) 5 mc Pm^{147} point source; (*B*) Lucite collimator; (*C*) 20-μg/cm^2 zapon film as dust guard; (*D*) ⅛-in. lead shielding; (*E*) wood support; (*F*) brass mount; (*G*) base plate; (*H*) ⅛-in. lead collimator; (*I*) movable stage; (*J*) G-M tube; (*K*) G-M tube mount; (*L*) guide; (*M*) plastic disk; (*N*) G-M tube support arm.

The beta-ray point source of Pm^{147} [1] was prepared[2] by depositing approximately five millicuries of carrier-free promethium chloride in a circle about 0.05 in. in diameter on a 0.04-in. thick Lucite disk. The source was covered with Cellophane tape and mounted in a ⅞-in. thick Lucite collimator with a smooth-walled hole of $\frac{3}{32}$ in. diameter. The details of the source and collimator assembly are given in Fig. 1. A microscope type movable stage mounted on the source assembly allows reproducible scanning of the thin film samples. A thin window Geiger-Müller tube is suspended above the collimator hole and is protected by a 0.04-in. thick plastic disk with a ¼-in. central collimating hole.

The instrument is most sensitive for films up to 6 mg/cm^2. In this range it is possible to discover thickness variations from point to point of less than 0.1 mg/cm^2 (Fig. 2). Use of more energetic beta-ray emitters will shift the sensitive range of the gauge to greater thicknesses, with some loss in resolution.

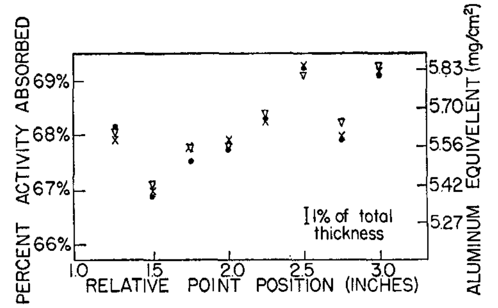

FIG. 2. Typical scanning data obtained with a relatively uneven sulfur target. Nine points ¼ in. apart were scanned three times in random order. (×) Scan No. 1; (▽) Scan No. 2; (●) Scan No. 3. Counting time was 10 min per point giving a reliable error of 1% per count.

The primary advantage of the gauge is that it allows the measurement of film thickness at a predetermined point with good accuracy and without destruction of the sample.

The assistance of Mr. John Mannlein in the construction of this instrument is gratefully acknowledged.

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* Work supported in part by the U. S. Atomic Energy Commission.

[1] L. Mandel, Brit. J. Appl. Phys. 5, 287 (1954).

[2] O. U. Anders, Nucleonics 13, No. 7, 46 (1955).

Protecting Device for Thermoelectric-Type Vacuummeters

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In pressure measurements especially in the range of 1–10^{-3} mm Hg the thermoelectric vacuummeter is often used. The type described first by Moll[1] has great advantages using thermoelements instead of thermocouples.

The thermoelements T_1, T_2 and resistors R_1, R_2 form a bridge supplied by ac. With proper adjustment of R_2 one gets zero ac potential-difference across the meter, M, and at the same time the meter measures the sum of the thermoelectric forces of the two elements connected in series. Resistances in the two other arms of the bridge should have negligible shunting effect on the meter.

In connection with the apparent advantages of this construction it has one drawback over the thermocouple-type of meters. Namely in the case of sensitive meters, in the order of a few mv full scale and internal resistance approximately 10 ohms, the meter will usually be destroyed when one of the two thermoelements is broken while setting up the balance of the bridge.

A simple method of protecting the meter is shown in Fig. 1. Two coils of the same number of turns forming the primary of a transformer are connected in series with each thermoelement in such a sense, that no flux exists when current flows in each of the primary coils. Flux appears only if one of the thermoelements is broken. The secondary of the transformer will energize the relay, which, in turn, shorts the meter.

As dc current flows through the transformer primary its resistance must be kept as low as possible. By using an ac relay with a suitable coil-system it is quite possible to avoid the use of a transformer. The relay must be adjusted for minimum switching time. More precisely, if Q is the energy which destroys the meter, U is the ac supply voltage, R_T the resistance of the thermoelements, R_M that of the meter, and t_S the switching time of the relay, then the following relation must be satisfied

$$P=\frac{U^2R_1^2R_Mt_S}{[R_1(R_2+R_M)+R_T(R_1+R_2+R_M)]^2}<Q$$

neglecting the impedance of the transformer.

The instrument constructed in our laboratory had the following component values: $U=10$ v, $R_1=200$ ohms, $R_2=200$ ohms, $R_M=20$ ohms, $R_T=10$ ohms, and $t_S=0.1$ sec. According to the foregoing relation, we have

$$P=3.4\times10^{-3}\text{ watt sec.}$$

The meter will be destroyed if the insulation of the moving coil is injured by too much heat dissipated. The usually allowable maximal temperature is about 100°C according to the standards available. In this temperature range the total amount of heat is dissipated almost entirely by convection. This convection heat loss may be expressed[2] by the following formula,

$$q=2.57\times10^{-4}\vartheta^{1.25},$$

where q is the heat dissipated per unit time and unit area (watts per cm^2), and ϑ is the difference in temperature between the coil and its neighborhood in degrees centigrade.

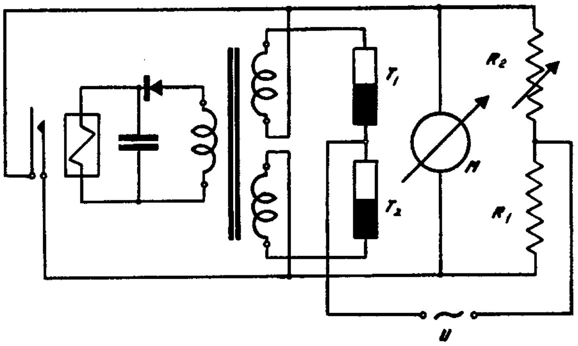

Fig. 1. Bridge circuit for thermoelectric vacuum gauge with provision for meter protection. Failure of one thermoelement energizes the relay and shorts the meter.

For safety purposes let the temperature difference be $\vartheta=40$°C and the total surface of the moving coil approximately 1 cm^2, then the total heat dissipated in unit time is

$$Q=2.6\times10^{-2}\text{ watt sec.}$$

By comparison of the computed values we find

$$P<Q.$$

Evidently this is satisfactory protection for a meter with 6-mv sensitivity and internal resistance of 20 ohms.

Several instruments of this type were assembled in our laboratory. They are performing excellently.

We are indebted to Professor Dr. P. Gombás for kind permission to perform this work in the Institute.

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[1] Moll and Burger, Z. techn. Phys. 21, 199 (1940).

[2] Liska, *Electrical Machines* (Budapest, 1950) (in Hungarian), Vol. I.

Increasing the Sensitivity of a Commercial Spectroradiometer

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In some measurement applications, a sensitivity greater than that afforded by commercial spectroradiometers is required. An example of such applications is the measurement of spectral-energy distribution of phosphor screens of black-and-white kinescopes operating at standard conditions. A commercial spectroradiometer operating at full sensitivity and maximum slit width furnished only half-scale deflection in this application. When color kinescopes were tested, the instrument deflection for a normal red field was only five percent of full scale at the peak emission of the red phosphor. This paper describes a method for increasing the sensitivity of a commercial spectroradiometer by a factor of 200 through the use of a simple cathode-follower bridge circuit between the multiplier phototube and the recorder amplifier.

In a standard commercial spectroradiometer, such as the General Electric Cat. No. 9169777G2, the multiplier phototube works into a load resistor having a maximum value of about 5000 ohms. The maximum slide-wire potential used to balance out the signal voltage is about 5 mv. The anode current required for full-scale deflection, which is determined by the value of the load resistor and the slide-wire potential, is approximately 1 μa.

Because the multiplier phototube is a high-impedance device, the output signal voltage developed across the load resistor in series with the anode is directly proportional to the size of the load resistor. If, for example, the value of the load resistor used were increased from 5000 ohms to 5 meg, the output voltage generated for one microampere of phototube current would be 5 v instead of 5 mv. Similarly, a voltage of 5 mv could be obtained