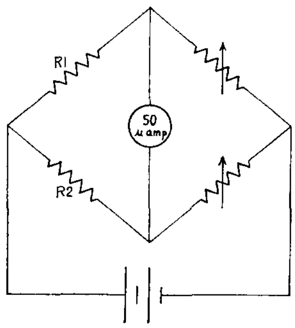

FIG. 1. Wheatstone bridge circuit for cryogenic liquid level detector.

the top of the Dewar into the cold gas the resistance changes keep the bridge unbalanced until just above the liquid level and it is therefore necessary to have the detector (meter, light, buzzer, etc.) suitably biased so that it will not respond to this initial unbalance. This requires a modest amount of electronic circuity but such probes work quite well and are readily available commercially.

We have constructed a carbon resistance probe that uses the simplest possible circuity and avoids the problem of detector bias. This probe uses two resistors instead of one (Allen Bradley 200 Ω, $\frac{1}{8}-\frac{1}{10}$ W). The resistors are placed in separate arms of a Wheatstone bridge circuit (R_1 and R_2). The other arms are about 1250 Ω and need some variation to effect initial balance. For these we have found it convenient to use two 2500 Ω pots mounted in tandem to a single knob and connected so that as one is increased the other is decreased. Balance is indicated by a standard 50 μA dc meter which may be shunted if required to give the desired sensitivity. The bridge is powered by four 1.5 V "C" batteries in series. The two resistors are mounted at the end of a thin wall stainless steel tube with one slightly above the other. The separation is kept quite small (6 mm or less) as this determines, in part at least, the uncertainty with which the level may be measured.

The system is balanced at room temperature and the probe slowly lowered into the Dewar. As both resistors are cooled approximately equally by the vapor the system remains balanced until the first resistor strikes the surface. When this occurs the system is suddenly thrown out of balance as indicated by a full scale deflection of the meter. When the second resistor strikes the surface the meter returns to zero. This gives effectively a double indication at the surface, from zero to full scale and back to zero, and takes place in a distance corresponding to the separation of the two resistors.

We have found this probe works equally well in liquid nitrogen or liquid helium. When used with helium it is noted that because of the high temperature coefficient of resistance at the low temperatures, the resistors do not "track" each other perfectly and the bridge may not remain exactly balanced in cold vapor. However, this partial unbalance does not interfere with the double indication at the surface or the accuracy with which the level is measured.

Simple Extrusion Die for *in vacuo* Production and Explosion of Lithium Wires*

T. A. LEONARD†

Department of Nuclear Engineering, The University of Michigan, Ann Arbor, Michigan 48105

(Received 31 January 1969)

A PREVIOUS note[1] described an *in vacuo* extrusion system for lithium wire using an extrusion die-electrode developed by Oktay.[2] A significant change has been made in the extrusion die which allows many high current discharges without an increase in size of the extruded wire. This is important for *in vacuo* extrusion since it is difficult to manipulate a lithium wire larger than about 0.01 cm diam with electrostatic forces.

The construction of the extrusion die is shown in Fig. 1. Molybdenum was chosen as the die material because of its high melting temperature and hardness and also for the ease with which the small hole can be made using simple techniques. The disk can be punched out of a molybdenum

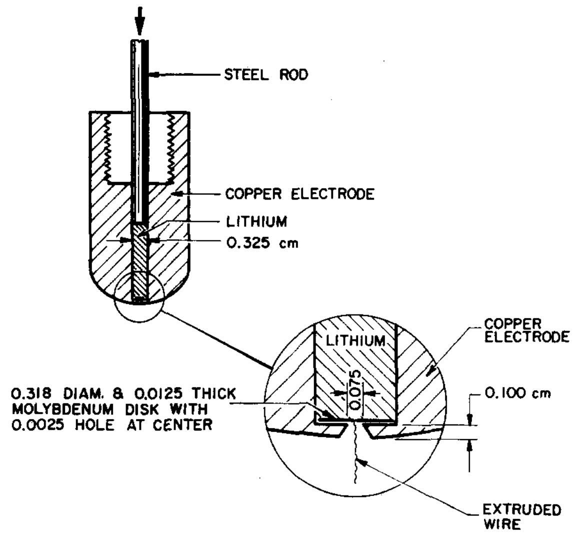

FIG. 1. Lithium extrusion die.

sheet with a hand operated punch and die. The small hole is made with a hardened steel punch having a radius of curvature at the tip of less than 0.0010 cm. A technique of dimpling and grinding is used to obtain circular holes as small as 0.0025 cm.

Pressure on the lithium will "seat" the disk at the bottom of the 0.325 cm hole in the copper electrode, but it is easily removed after washing out the lithium with water.

It is not clear whether the relatively high melting temperature and hardness of molybdenum or its recessed position prevents erosion of the small hole. A 0.0025 cm die used in the system previously described[1] did not noticeably increase in size after more than 50 shots at 8 and 10 kV.

The author would like to thank Gene Robinson of the Electron Physics Laboratory at the University of Michigan for helpful suggestions.

* This work was supported by the Advance Research Projects Agency (Project DEFENDER) and monitored by the U. S. Army Research Office, Durham under Contract No. DA-31-124-ARO(D)-403.

† Supported by NASA traineeship.

[1] T. A. Leonard and D. R. Bach, Rev. Sci. Instrum. **39**, 1374 (1968).

[2] E. Oktay, D. R. Bach, and W. Rekewitz, Rev. Sci. Instrum. **39**, 924 (1968).

A Phenomenon-Energized Point-Discharge Current Meter

R. A. CUDNEY AND C. T. PHELPS

State University of New York at Albany, Albany, New York 12203

(Received 7 February 1969; and in final form, 5 March 1969)

MORE data on point discharge during electrical storm activity are necessary before firm conclusions about the global atmospheric electrical budget may be drawn. An instrument designed to measure average point discharge currents of the order of 1 mA to 1 μA has been developed. It is simple and inexpensive to construct, requires no power supply for its operation, need not be continuously monitored, and has proven to be rugged and reliable.

A discharge point, mounted vertically in the atmosphere, will go into corona when the electric field exceeds a critical value. The capacitor C_1 (Fig. 1) is in series with the discharge point so that all the charge leaving the point is drawn from the capacitor. When the voltage across the capacitor reaches the firing voltage of the neon bulb, the triac Q_1 is triggered into conduction discharging C_1 through R_L. The diodes D_1 and D_2 serve to route the resulting

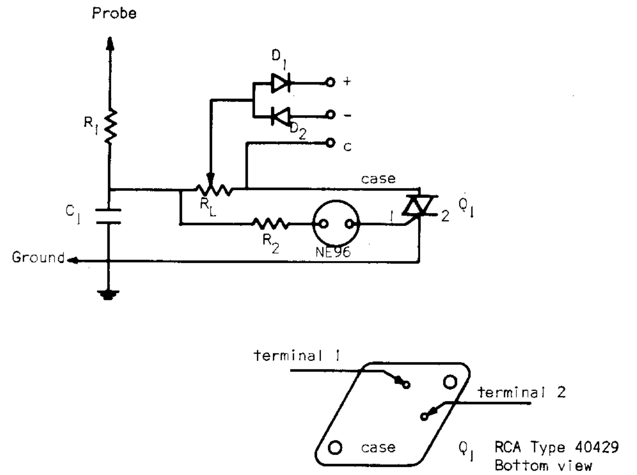

FIG. 1. Schematic of corona current meter and base diagram of triac thyristor. C1—5μF, 200V; D_1, D_2—400 V, 100 mA; R_1—100 kΩ; R_2—270 Ω; R_L—15 kΩ potentiometer; Q_1—type 40429 triac thyristor.

positive and negative pulses to the appropriate readout devices connected between the + and − terminals, respectively, and point c.

Suitable readout devices include electromechanical counters (Presin Company type FE4A) as used in our installations, chart recorders, and portable, battery operated tape recorders.

The data derived from this device consist of a series of pulses, each pulse representing, and generated by, the accumulation of a known amount of charge C_1V_b (0.65 mC for the values indicated in Fig. 1), where V_b is the firing voltage of the neon bulb.

The accuracy of the device is limited by leakage across the capacitor and triac, variations in V_b, residual voltage across the capacitor after triac cutoff, and by the quantized nature of the data. However, accuracy of $\pm 10\%$ over a period of several hours at a current of 1–1000 μA may be achieved.

A Technique for Preparing and Mounting Thin Nickel Foils*

D. L. CARR

Lockheed Palo Alto Research Laboratory, Palo Alto, California 94304

(Received 24 February 1969)

IN our work, we recently had need of a method for mounting thin self-supporting nickel foils onto aperture plates to be used for setting the energy thresholds of low energy particle detectors for satellite measurements on auroras.[1] The nickel foils to be used had to be approxi-