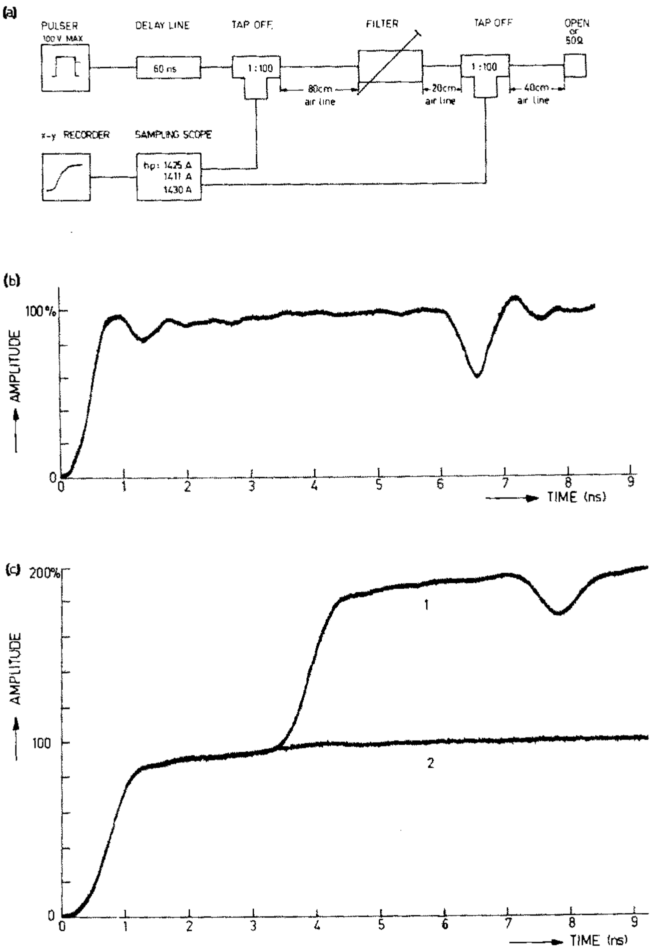

FIG. 3. Reflection tests. (a) Simplified block scheme; (b) input reflection; and (c) output reflection, curve 1 with open end, curve 2 with 50 Ω load. The time difference between the zero points of the time scales of (b) and (c) is about 4 nsec.

where m is the maximum slope (1.2×10^{11} V/sec), E the reflection amplitude (28 V), and Z_0 the characteristic impedance (50 Ω). The given values result in $C=8.5$ pF, whereas the design value $C_2=13$ pF (see insert of Fig. 2). Apparently this C value is somewhat compensated by the preceding L element.

When the indicated precautions are taken a practically distortionless waveform for the whole duration of the pulse is obtained. It will be very easy to vary the risetime to larger values. However, much shorter risetimes are not recommended. By using other connector types and larger diameter coax higher voltages could be handled.

[1] G. N. Glasoe and J. V. Lebacqz, *Pulse Generators*, MIT Radiation Laboratories (McGraw–Hill, New York, 1948), Ser. Vol. 5.

[2] B. J. Elliott, IEEE Trans. Instrum. Meas. **IM-17**, No. 4, 330 (1968).

[3] G. L. Matthei, L. Young, and E. M. T. Jones, *Microwave Filters, Impedance Matching Networks and Coupling Structures* (McGraw–Hill, New York, 1964).

[4] Hewlett–Packard, application note 62, "Time Domain Reflectometry."

Wide Aperture Channel Plate Electron Multipliers for Mass Spectrometer Applications

JOHN A. PANITZ*

Department of Physics, Pennsylvania State University, University Park, Pennsylvania 16802

(Received 14 December 1970; and in final form, 21 January 1971)

CONVENTIONAL electron multipliers such as the Bendix Channeltron or resistance strip have high gain but limited entrance apertures. Venetian blind multipliers with large active areas can be constructed by connecting several commercial dynodes side by side, but suffer from dead areas where the individual dynodes were joined together. By using a relatively new device (the channel plate) as an electron multiplier, or as the first active element in a conventional multiplier structure, secondary electron multipliers with active areas greater than 700 cm² become possible.

The performance and characteristics of channel plate electron multipliers, used for imaging applications, have been described previously in detail.[1] For the applications to be described here, a channel plate 2.5 cm in diameter with channels 40 μ in diameter (on 50 μ centers), a 5° bias angle (making the plate opaque to particles striking at normal incidence), and a resistance of 5×10^8 Ω was purchased.[2]

Figure 1 shows the mounting of a channel plate used as a single stage wide aperture electron multiplier. Electrode A is grounded. The channel plate is sandwiched between electrodes B and C, electrode C being maintained at −30 V dc. The collector, supported by plate D (at ground potential), is connected directly to an electrometer. By varying the voltage applied to electrode B, and therefore the potential difference, V_{plate}, applied across the channel plate, its gain can be changed. The results are shown in Table I. Although only a modest gain is obtained, the

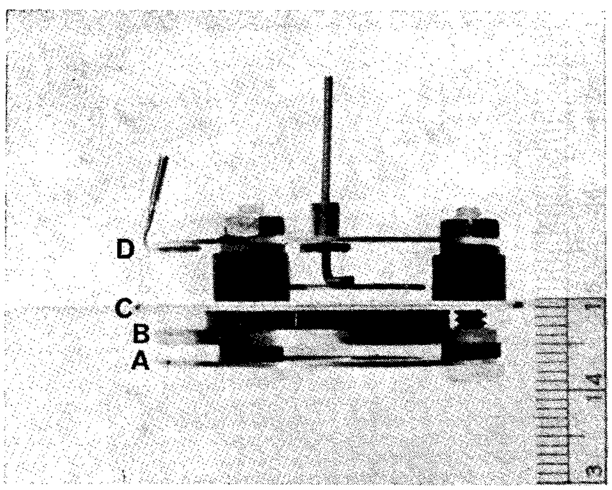

FIG. 1. Channel plate mounting details (scale is in centimeters).

TABLE I. Gain characteristics of a channel plate multiplier as a function of potential difference across the plate. J_{in} $(Na^+) = 5\times10^{-11}$ A/cm^2 $p = 5\times10^{-6}$ Torr.

V_{plate}	Gain
−600V	140
−700	530
−800	1600
−900	4000
−1000	8200

multiplier has several desirable characteristics. The size and shape of the active area are essentially unrestricted, since circular plates as large as 13 cm in diameter can be obtained, and almost any other shape is available. The channel plate is not harmed by repeated exposure to the atmosphere. However, it should be thoroughly outgassed before initial use in high vacuum since H_2, CO, CO_2, and hydrocarbons are evolved during pumpdown.[3] Operation at ambient pressures approaching 10 μ has been possible without severe breakdown or gain deterioration at the lower plate voltages. This fact, coupled with the small size and inherently simple and rugged structure of the multiplier, makes such a device particularly attractive for use with nonpumped rocket borne mass spectrometers such as those being developed in this laboratory.[4]

If a wide aperture multiplier with higher gain is desired, a channel plate can be used as the first dynode of a conventional electron multiplier. To test the feasibility of this hybrid system, a simple electrostatic lens was used to focus the electrons from a 4.7 cm^2 channel plate onto a multiplier whose first dynode active area was limited to 0.75 cm^2 (the channel plate effectively increasing the active area by several hundred percent). Although a 20% loss in gain over that expected from the performance of the individual components was encountered (and attributed to the crude focusing system used), the gain of the multiplier was effectively increased by several orders of magnitude. Alternately, it should be possible to stack two or more channel plates to obtain a multiplier with wide entrance aperture, significant gain, and small physical size.

By replacing the collector assembly (plate D) with a deposited phosphor screen, and operating electrodes A and B at 0 V dc, with electrode C and the screen at 1000 and 3000 V dc, respectively, the channel plate becomes a single stage image intensifier as used by Brenner[5] and others for the visual examination of weak field ion microscope images. In this mode of operation, the channel plate has been used to directly investigate the focusing properties of mass spectrometers and ion lens systems.

The author wishes to thank the National Aeronautics and Space Administration who supported this research under contract No. NGR-39-009-129 and NGL-39-009-032 during the author's one year post doctoral research associateship in the Mass Spectroscopy Laboratory at The Pennsylvania State University. In addition, thanks are due to J. Kreher of the Ionosphere Research Laboratory for his aid in the construction of channel plate mountings.

* Present address: Sandia Laboratories, Surface Kinetics Division, 5331, Albuquerque, N. M. 87115.

[1] R. W. Manley, A. Guest, and R. T. Holmshaw, Advan. Electron. Electron Phys. 28A, 471 (1969).
[2] Mosaic Fabrication Div., The Bendix Corp., Galileo Park, Sturbridge, Mass.
[3] R. Morgan, Field Emission Symp. 17th Yale University, New Haven, Connecticut (1970).
[4] M. F. Zabielski, IRL Sci. Rep. No. 353, Ionosphere Res. Lab., University Park, Pa. (1970).
[5] S. S. Brenner and J. T. Mckinney, Field Emission Symp. 16th Pittsburgh, Pennsylvania (1969).

Specimen Cooling in High Power Spin Wave Experiments*

ALAN SHOWALTER† AND R. POPLAWSKY
Department of Electrical Engineering, The University of Toledo, Toledo, Ohio 43606

(Received 17 December 1970; and in final form, 18 January 1971)

WHEN investigating spin wave phenomena using high microwave power, the problem of excessive specimen heating invariably arises. The particular form of the problem and variation of solution depend on the nature of the experiment.

One such experiment is the investigation of spin standing wave phenomena in yttrium iron garnet monocrystal disks as first described by Wang *et al.*[1] In this case, specimen heating effects were alleviated by using pulsed microwave power rather than a continuous wave (cw) arrangement. In conducting an extension of Wang's work to an investigation of the effects of magnetocrystalline anisotropy the authors[2] have found a somewhat different ap-

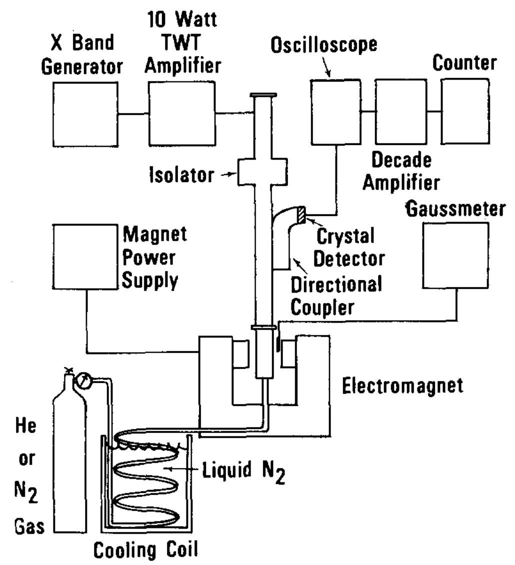

FIG. 1. Apparatus for the investigation of spin standing wave magnetic anisotropy effects.