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NEUTRON RADIOGRAPHY WITH A MULTI-WIRE PROPORTIONAL CHAMBER--A STATUS REPORT*

Summary

Previously reported prototype studies[1,2] have been extended through the construction of a 25 cm × 25 cm neutron-sensitive multi-wire proportional chamber. The basic chamber consists of three parallel wire-grid planes in a gas-filled envelope. The central, anode plane consists of a parallel array of 13 μm-diameter gold-plated tungsten wires separated from each other by 1.5 mm but terminating electrically in common on an outer frame. The outer, cathode grids consist of 37 μm-diameter wires separated from each other by 1 mm. The two outermost grid planes have their wire axes mutually orthogonal. The proportional gas used was 93% Ar and 7% methane. The inner faces of the chamber windows are coated with ^{10}B to achieve neutron sensitivity. A signal that indicates the occurrence of an ionizing event in the chamber is obtained from the central plane. The two outer grids provide the spatial information. Each wire of the orthogonal outer planes is coupled capacitively to an electromagnetic delay line. The time interval between the occurrence of the central grid signal and the delayed cathode signal determines the location of the event in each of two orthogonal directions. This information may either be digitally encoded for computer storage or converted, by means of time-to-amplitude converters into x-y deflection pulses for an oscilloscope display. (A more complete design description may be found in Ref. 2.) An example of such an oscilloscope-displayed image is compared with a high-resolution Gd-screen photographic image in Fig. 1. The single B conversion screen converter used for obtaining this image was made simply by embedding

powdered ^{10}B (92% enriched) in double-sided masking tape placed on the inside face of one of the chamber windows. The converter made in this manner caused no observed electrical problems, had a mean thickness of 4 mgm-cm^{-2}, and gave a measured useful converter efficiency of 2%. The resolution characteristics of this larger chamber are approximately the same as those of the small prototype previously described.[1,2] Improvements in converter construction as well as the addition of a second converter are expected to increase the efficiency to a value closer to the calculated 7%. Increasing the gas density, either by pressurizing the chamber or by using a heavier gas such as xenon, is expected to improve resolution by shortening the alpha-particle track lengths.

Figure Caption

Fig. 1. Neutron radiographs of an aluminum-cased electric drill. (The screw in the drill chuck is made from nylon.)

(a) High resolution film-type neutron radiograph requiring approximately 10^{10} n/cm^2.

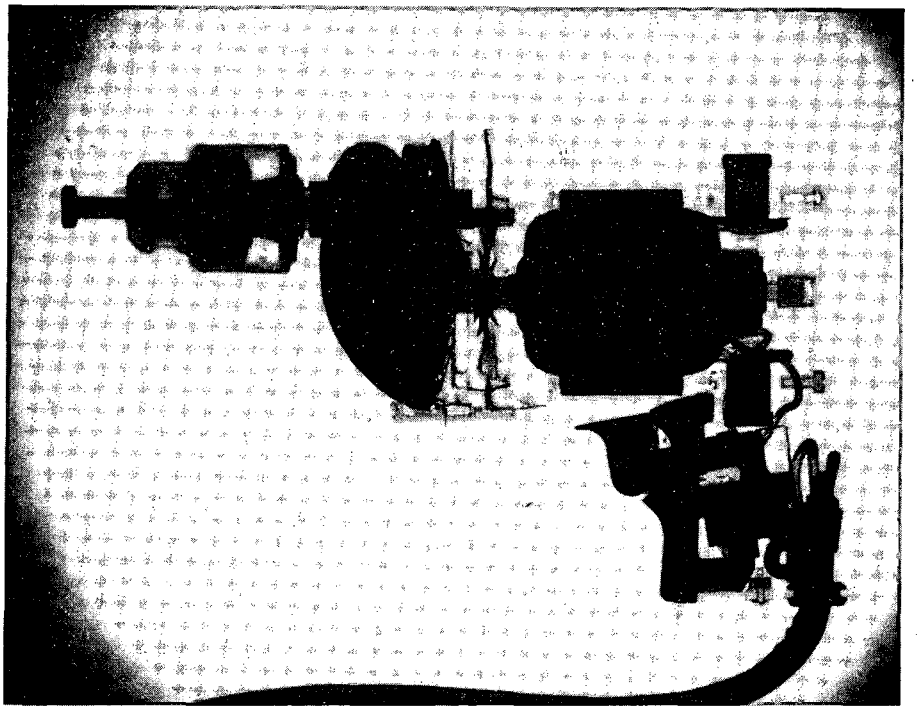
(b) Wire-chamber image as produced by a succession of points displayed on a conventional oscilloscope. Note that the wire chamber image while not showing fine details such as the threads on the nylon screw nor the features of the brush housing can show larger features such as the grease in the gear box and the plastic components of the trigger mechanism. The wire chamber image required 10^{-5} the flux of the photographic image and corresponds to 20 detected neutrons per square millimeter. An image of 1-2 n-mm^{-2} shows essentially all of the same features but has a more grainy appearance.

Footnote and References

* Work done under the auspices of the U. S. Atomic Energy Commission.

1. S. KAPLAN, K. VALENTINE, LEON KAUFMAN, and V. PEREZ MENDEZ, Neutron Radiography With a Multi-Wire Proportional Chamber - Performance and Projections, Trans. Am. Nucl. Soc. 13, 140 (1972).

2. S. KAPLAN, L. KAUFMAN, V. PEREZ MENDEZ, and K. VALENTINE, Multi-Wire Proportional Chambers for Biomedical Application, Nucl. Instr. Methods, in press.



(a)

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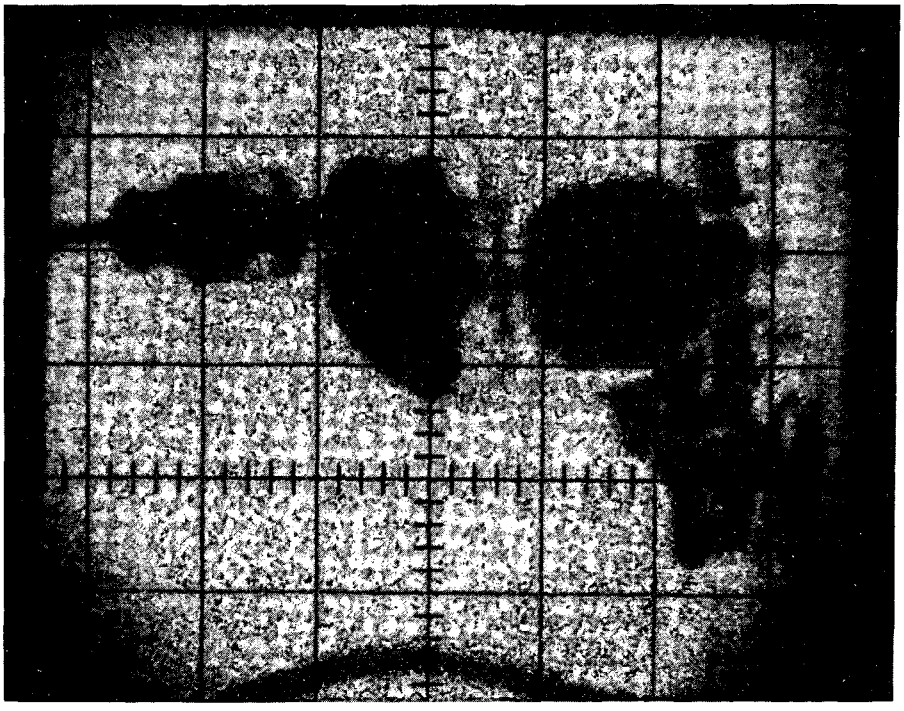

(b)

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Fig. 1

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