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TITLE: AUTOMATIC MATERIAL IDENTIFIER

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AUTOMATIC MATERIAL IDENTIFIER

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ABSTRACT

Radiation survey instruments could be used to verify the presence of radioactive material inside a container, but identification of the material would not be possible. One could imagine a very complex detector-analyzer system to analyze the radiation being emitted from a container, but it would be very large and difficult to use. At Los Alamos, a portable instrument with some limitations has been developed to identify plutonium and uranium inside a container. The instrument consists of a thin NaI crystal and an electronics package which is based on a microcomputer. The instrument uses the energy spectrum of the emitted radiation to identify the nuclear material present. The function of this instrument is to provide the user a tool for qualitative verification of nuclear materils in a container. The instrument can distinguish plutonium-239 and uranium-235 from other radioactive materials. A count rate indicator provides some measure of the quantity of material.

INTRODUCTION

It is very important during the transporting of special nuclear material that the transporter can verify quanitatively the contents of the item. It is also very important to monitor the entrances and exits of nuclear facilities and to distinguish between "allowable" radioisotopes (medically administered isotopes or gamma-ray sources) and nuclear weapons materials. A small portable instrument which could perform the task of identifying nuclear weapon isotopes is a very desirable instrument for these jobs. A compact portable pulse height analyzer known as the "Violinist" was developed at Los Alamos, and incorporating this circuit into an instrument which included a detector and microcomputer to process the information measured by the instrument was not difficult. 1) Until recently portable instruments consisted of circuits to convert some detector response to a meaningful value which was displayed to the user/operator. The availability of low power microcomputers and other support microelectronics has changed the concept of a small portable instrument.

GENERAL DESCRIPTION

The instrument, shown in Fig. 1, is packaged in a single case 20 cm in length, 14 cm in width, and 13 cm in height. It weighs approximately 3 Kg. Operating controls consist of a power switch and a start button on the handle. Once the instrument is powered up the operator starts the operation with the start button. For the advanced operator additional controls are located underneath the top panel. These controls consist of a 12-key keyboard which calls all the analyzer functions of the instrument. The instrument is powered by a rechargeable battery pack, and it my also be powered indefinitely with an accessory battery charger.

The instrument is designed around a 3 millimeter thick sodium iodide scintillator mounted on a 1.5 cm diameter photomultiplier tube. A thin scintillator was chosen to reduce the interference from high energy photons. The energy of the gamma rays of interest are less than 200 KeV. The electronic pulses from the detector are amplified and analyzed and converted to spectral information. From the resulting pulse height spectrum, the observed radio-isotope is determined. Counting rate information is displayed on the liquid crystal display (LCD). This information provides the operator some idea of the quantity of nuclear material present.

ELECTRONIC DESCRIPTION

The block diagram of the instrument is shown in Fig. 2. The instrument contains a high voltage supply for the photomultiplier tube, a preamp, shaping amplifier, a Wilkinson-type 256 channel analog to digital converter, a microcomputer and a built-in 32X84 dot matrix LCD. The microprocessor is a Motorola MC146805. The incoming data are stored in a memory and the data are analyzed in several ways by the microcomputer. Results of the analysis are displayed on the LCD. The 12-key keyboard provides operator access to the microcomputer. Four C size NiCd batteries provide eight hours of operation for the instrument.

FUNCTIONAL DESCRIPTION

For normal operation the operator powers up the circuit and presses the start button to initiate data collection and analysis. The instrument collects and stores data for ten seconds before displaying the result. A count down clock on the display alerts the operator as to the progress of the measurement. A bar graph at the bottom of the display provides count rate information to the operator in counts per second. Experience with this feature provides the operator with some quantitative information regarding the amount of material being observed. When the measurement is complete one of four messages appears on the LCD: "PLUTONIUM", "URANIUM", "UNKNOWN", or "NOTHING". The message "UNKNOWN" means that there is some radioactive material present, but the analysis does not reveal plutonium or uranium. The message "NOTHING" means little or no radioactive material present. If more detailed spectral information is required the information is accessed through the 12-key keyboard. The analysis function depends on certain regions of interest in the energy spectrum, and these regions can be changed through the keyboard. Both the graphics mode and the alpha-numeric mode can be accessed through the keyboard.

PERFORMANCE AND CONCLUSIONS

For identification purposes, the instrument is designed to analyze the 60-keV gamma ray from 241-Am which is always present with plutonium. In the case of enriched uranium, it is the prominent 186-keV gamma ray from 235-U which is analyzed. Any other radioactive material which emits gamma rays is analyzed as an "UNKNOWN" material. The instrument is limited to a count rate of less than 18,000 counts per second, so for items that exceed this limit, the operator must move the item further away from the instrument to reduce the count rate.

The instrument has been tested with various quantites of plutonium and uranium stored inside metal containers. Quantities of plutonium as little as 0.5 grams and uranium as little as 1 gram have been successfully identified. With minimum training the operator can use the instrument to distinguish between plutonium, uranium, and other radioisotopes.

REFERENCES

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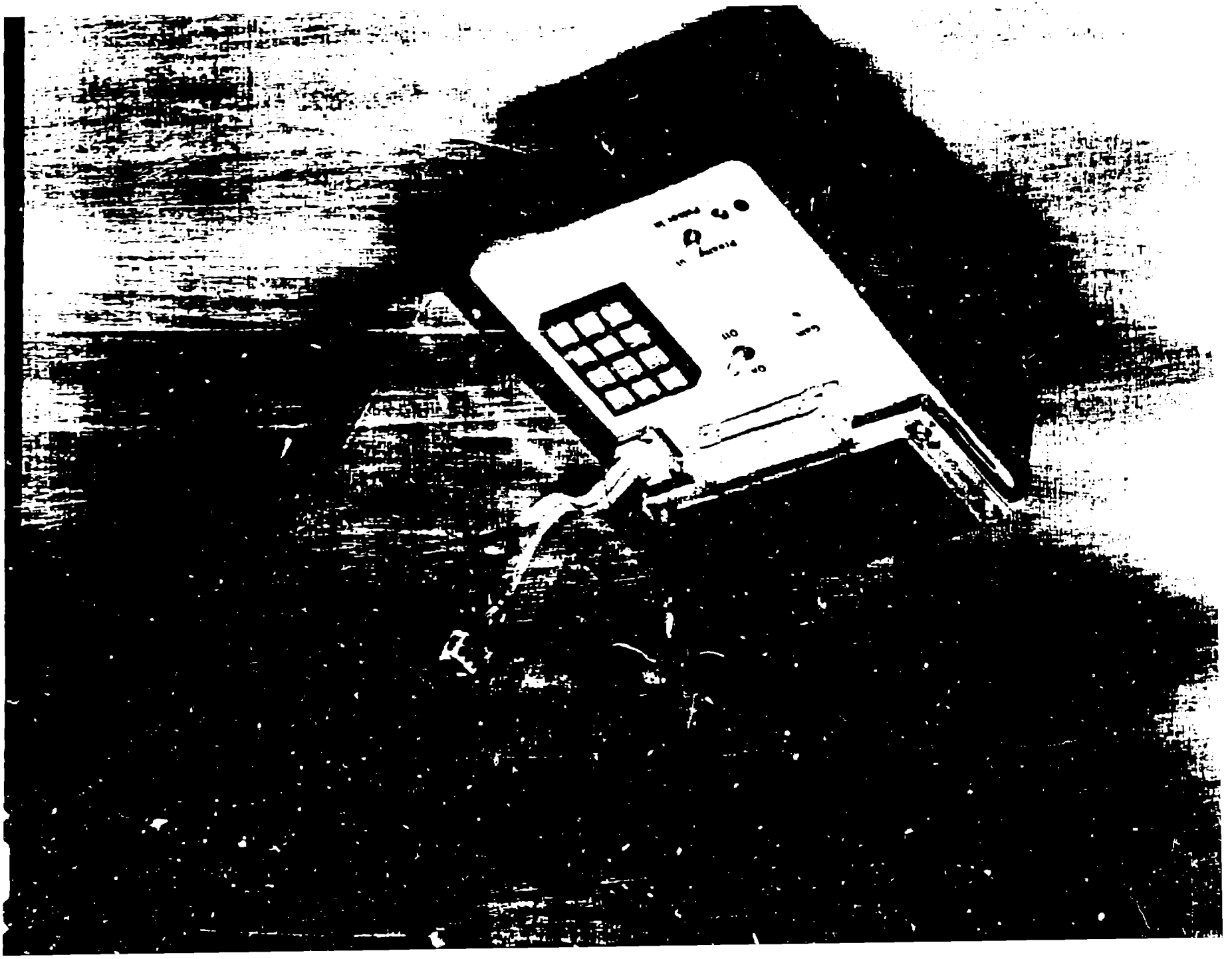

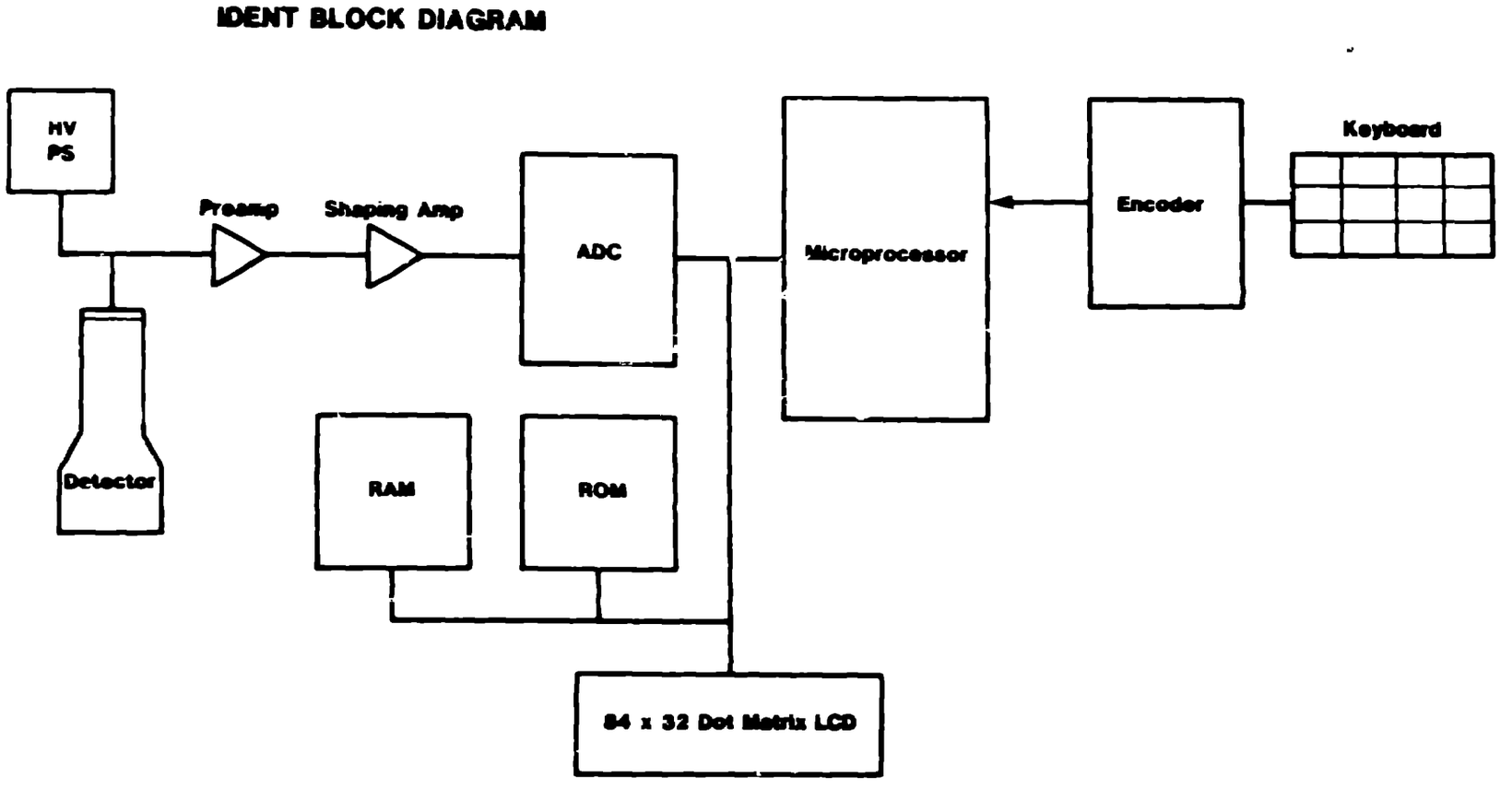
IDENT BLOCK DIAGRAM
HV
PS
Preamp
Shaping Amp
ADC
Microprocessor
Encoder
Keyboard
Detector
RAM
ROM
84 x 32 Dot Matrix LCD

FIG. 2