Imaging

Anger Rectilinear Tomographic Scanner*

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Although not a new development in the field of nuclear medicine, the Anger rectilinear tomographic scanner has recently gained popularity because of its clinical usefulness. A prototype of this instrument has been under evaluation at Rush Presbyterian–St. Luke's Medical Center for the past three years, during which time over 2000 studies have been performed. Although the majority of the studies have been brain, bone, and gallium-67 scans, other routine scans have also been performed. This article describes the instrument, its basic operation, and various techniques used. Clinical evaluation of the Anger rectilinear tomographic scanner shows the system's advantages in certain areas. It offers better information density and superior resolution away from the geometric focal plane than other rectilinear scanners with comparable collimation. The tomographic capability also allows accurate determination of lesion depth. Use of the device significantly increases the identification of pathology and reduces error and confusion resulting from normal variants.

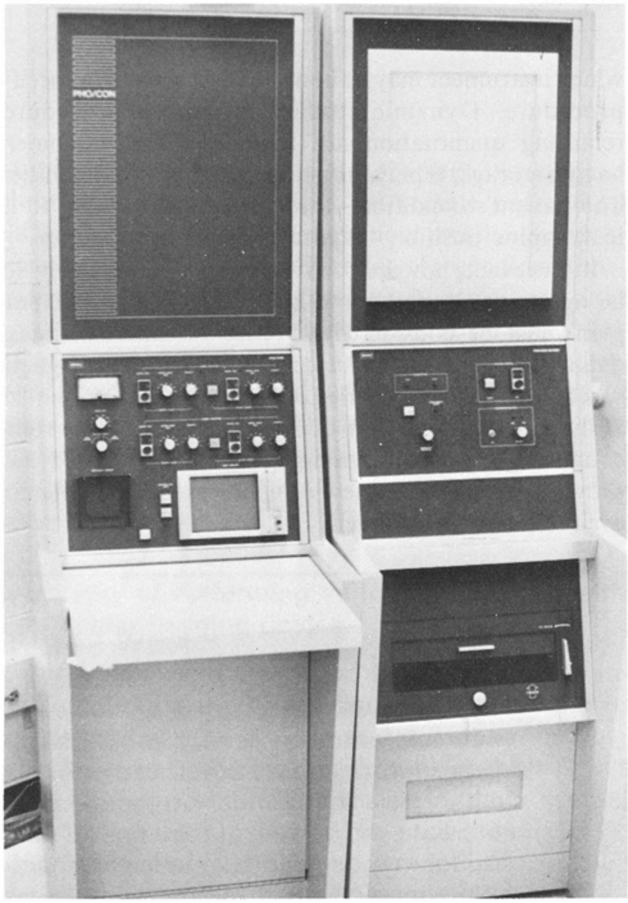
The clinical advantage of the tomographic scanner is its ability to demonstrate foci of activity at different depths that are superimposed and, therefore, inseparable in ordinary two-dimensional images. This scanner aids in separation of lesions adjacent to or hidden by overlying normal anatomical structures [e.g., brain scans in the temporal area (*1-3*) and gallium-67-scans in the abdominal area to establish lesion depth]. In some cases, detection of these lesions has resulted in reclassification of the patient's condition and, consequently, affected the nature of treatment.

Materials and Methods

The Anger rectilinear tomographic scanner (Pho/Con, Searle Radiographics, Inc.) is basically a dual-probe rectilinear scanner incorporating principles of the Anger scintillation camera. Each probe has an 8.5-in.-diam, 1-in.-thick sodium iodide crystal viewed by seven photomultiplier tubes. The scanner's basic function is to obtain multiple tomographic images having equal plane separation.

The original prototype console housed the optical readout system on the top, as well as a spectrum window, image display, cpm rate meter, and two panels, one each for the upper and lower detectors. Each panel consisted of an intensity potentiometer, focal plane separation dial, and nine automatic isotope selection settings with energies ranging from 75 to 560 keV with a selection of windows from 5% to 40%.

An upright console (Fig. 1A) now replaces the prototype console. The updated console not only houses



(A) **(B)**

FIG. 1. (A) Console. (B) Electronic tomographic imaging system—"Microdot."

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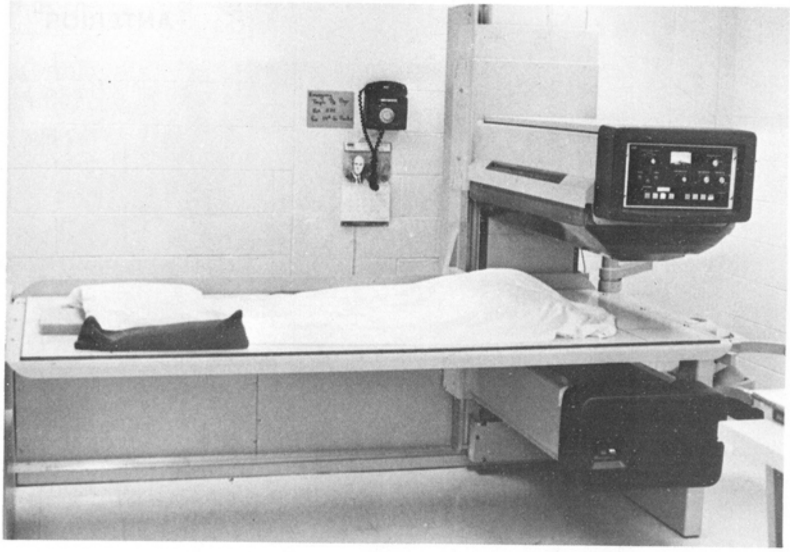


FIG. 2. Scanning table and dual-probe main frame.

the same basic controls but also contains a dual-channel analyzer that allows simultaneous photopeak detection with each probe. This component is invaluable for gallium-67-scanning as it will yield higher information density for equivalent scanning time.

The operating controls located on the main frame (Fig. 2) include vertical and horizontal probe adjustments, image format, whole-body mode, line spacing, marginal limits, and density rate meter. Image format capability ranges from $15 \times 15\ \text{cm}^2$ to $65 \times 65\ \text{cm}^2$, in addition to a $65 \times 178\ \text{cm}^2$ area in the whole-body mode. Scan speed ranges from 65 cm/min to 1000 cm/min, and line spacing spans from 0.3 cm to 0.9 cm.

The image density rate meter indicates a deflection value which is inversely proportional to cpm, index width, and speed. As a safety device, a plastic shield covers the collimator of the upper detector. If the shield touches the patient during scanning, it activates a microswitch and automatically renders the instrument inoperative until the detector is raised and power returned.

The collimator-changing program, also located on the main frame, simplifies this usually cumbersome task. The main frame is automatically programmed and positions itself at the proper level in the storage area when activated by the technologist. No lifting is required by the technologist during removal or attachment of collimators. The operator need only swing the half-ring "lazy Susan" (Fig. 3) up to the detector and slide the collimator and the lazy Susan away from the detector. As many as four collimators can be stored for each detector.

For this system the prototype optical readout system projected tomoplanes through lenses of different focal length. These lenses provided equal separation for each tomoplane by reducing image size from the CRT by a fixed ratio. The Dove prisms used in the prototype dispersed light and inverted the desired image axis for planes above and below the geometric focal plane (*4,5*). Tomographic images were obtained because each of the

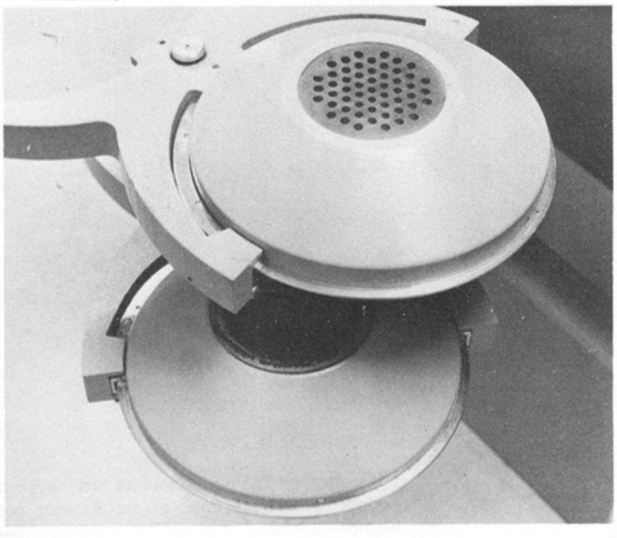


FIG. 3. Lazy Susan collimator storage.

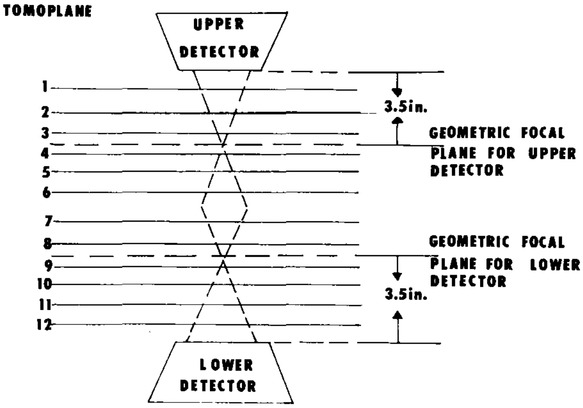
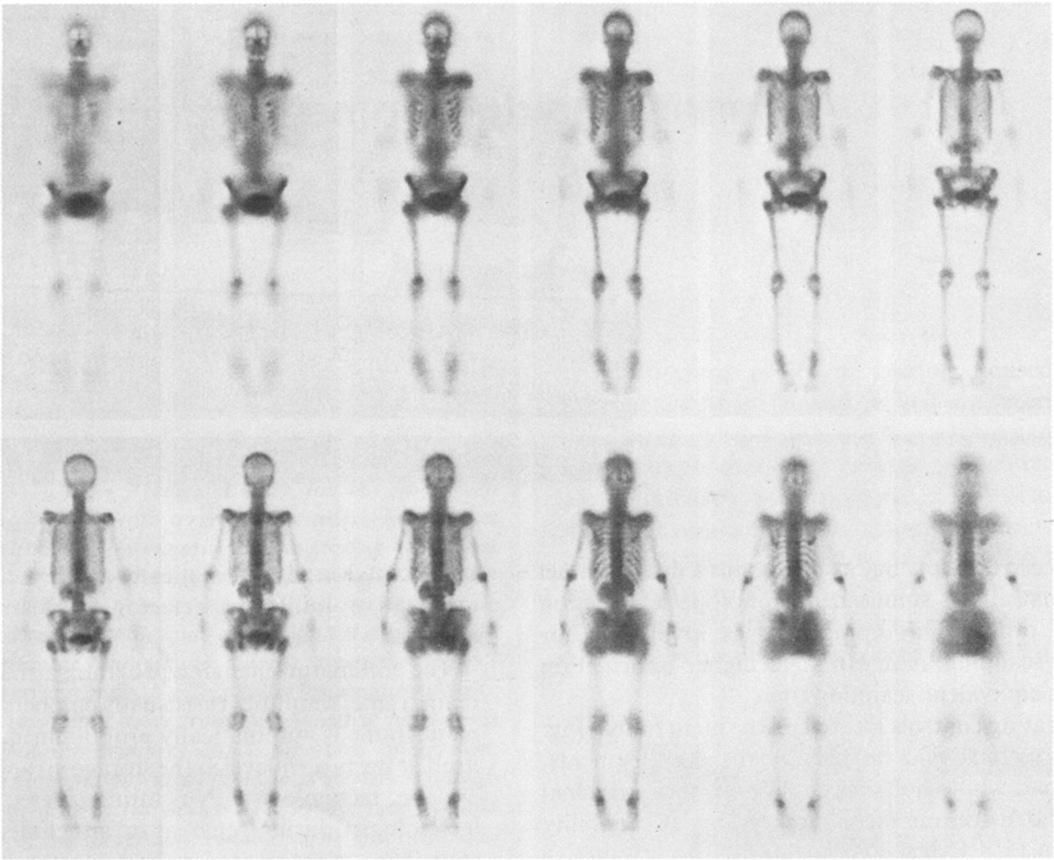


FIG. 4. Identification of tomoplanes as seen by each detector.

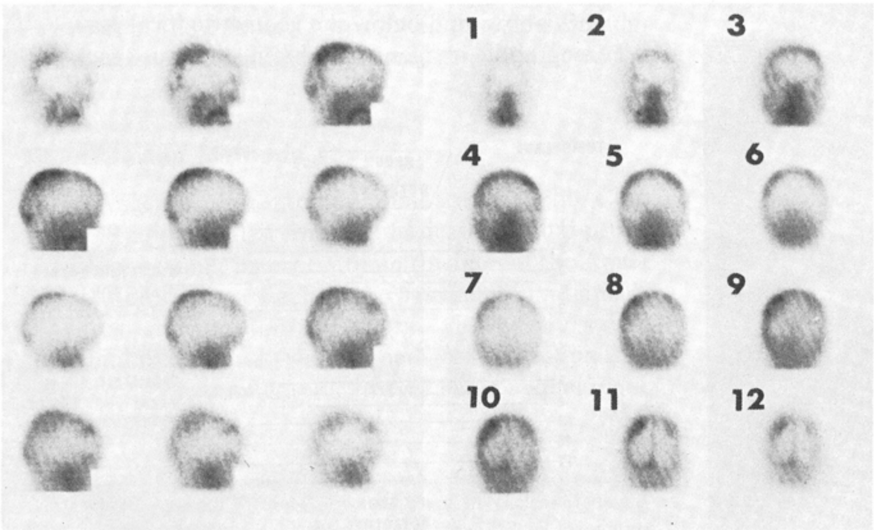
ANTERIOR



POSTERIOR

FIG 5. Tc-99m EHPD bone scan of patient with lung cancer: collimator—150 keV; format—whole body; line space—0.3 cm; speed—700 cm/min; focal plane separation—3.

RIGHT LAT. ANTERIOR



LEFT LAT. POSTERIOR

FIG. 6. [^{99m}Tc] pertechnetate brain scan of patient with metastatic breast cancer; collimator—150 keV; format—25 × 25 cm^2; line space—0.3; speed—130 cm/min; focal plane separation—5.

tomoplanes was projected in the same direction as the moving film.

Now a "Microdot" (Fig. 1B) multi-imaging format system (Searle Radiographics, Inc.) has replaced the Dove prism optical system and electronically produces the tomographic images. Six images are projected from each detector, with three tomoplanes above and three below the geometrical focal plane (Fig. 4). The Microdot houses a cassette, a high-low intensity button for the CRT filter (depends on format and type of film used), intensity potentiometer, and photobalance controls.

The tomographic scanner displays six images from each detector and 12 in all. The whole-body format displays upper left, anterior superficial tomoplanes progressing to the right to deeper planes; the most superficial tomoplane from the lower probe is at the bottom right corner (Fig. 5). When using any of the other format sizes, the most superficial cut of the upper detector is the upper left corner (Fig. 6). The depth of any lesion is indicated indirectly by noting which plane shows the lesions with the best resolution. A flood demonstrates the field size and the sharp focus in planes 3 and 4 for the upper probe, and 9 and 10 for the lower detector (Fig. 7).

A general understanding of tomographic separation is required to determine properly the placement of tomoplanes in the clinical procedure. The 12 tomoplanes reproduced by the scans should be evenly distributed throughout organ depth. Focal plane separation depends upon organ thickness and format size.*

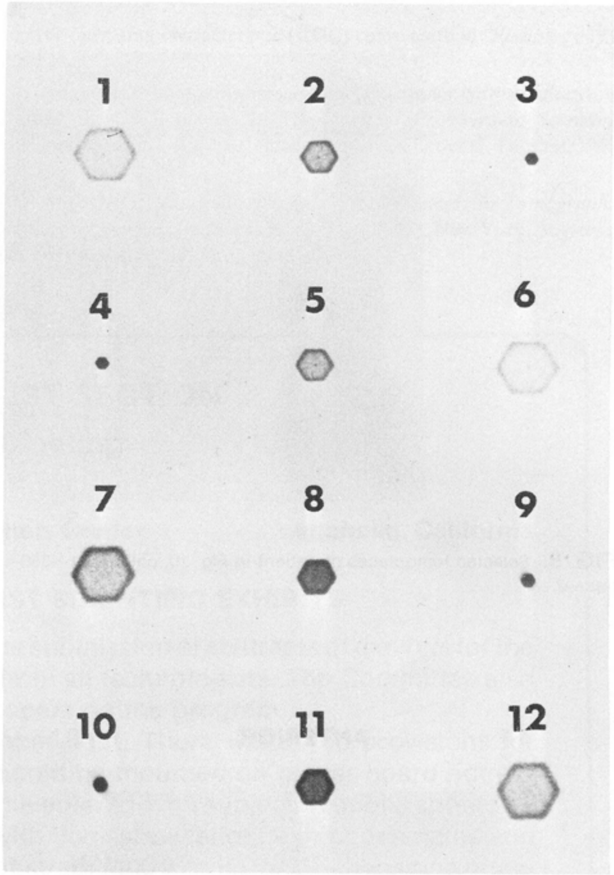
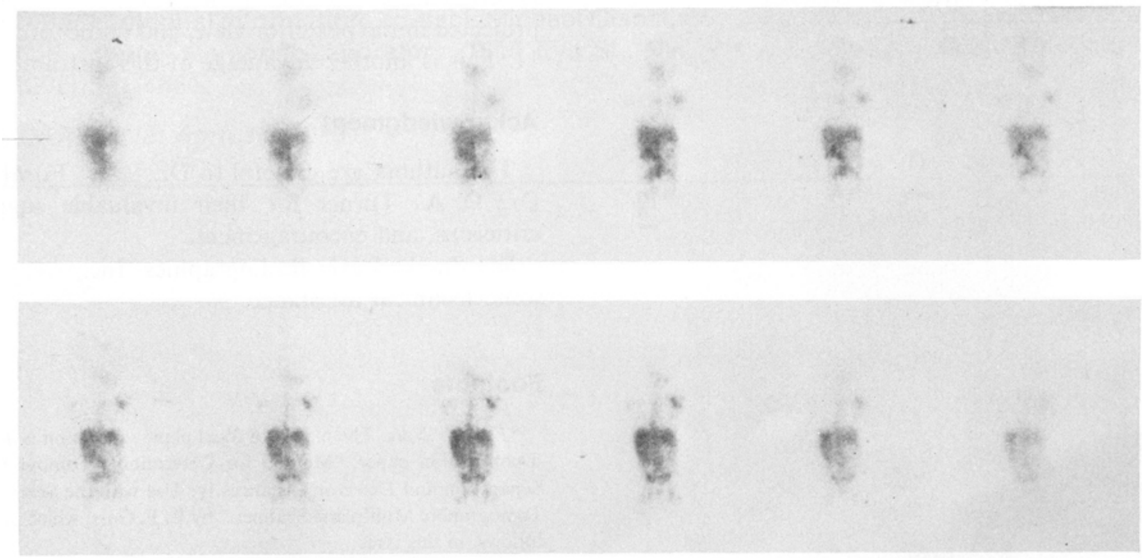


FIG. 7. Tc-99m flood field; no collimator; format—65 × 65 cm^2; speed—0; focal plane separation—10.

ANTERIOR



POSTERIOR

FIG. 8. Gallium-67-scan, patient with suspected abscess; collimator—380 keV; format—whole body; line space—0.3; speed—250 cm/min; focal plane separation—2.

ANTERIOR

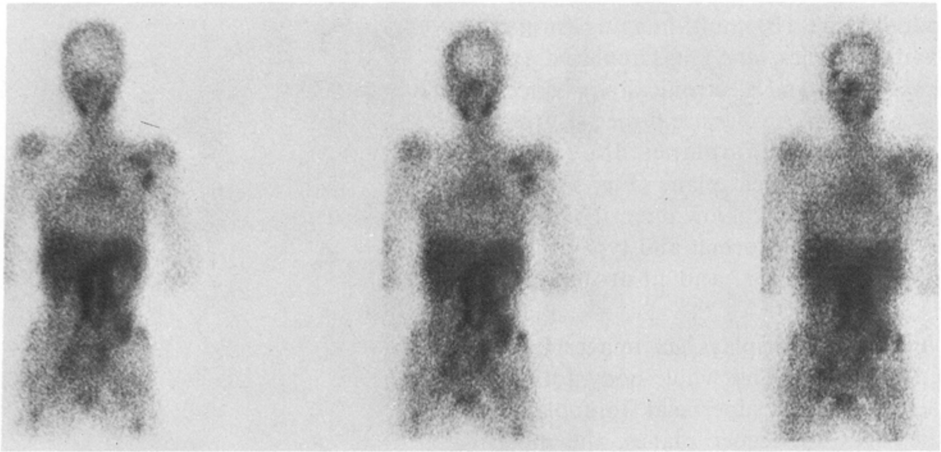
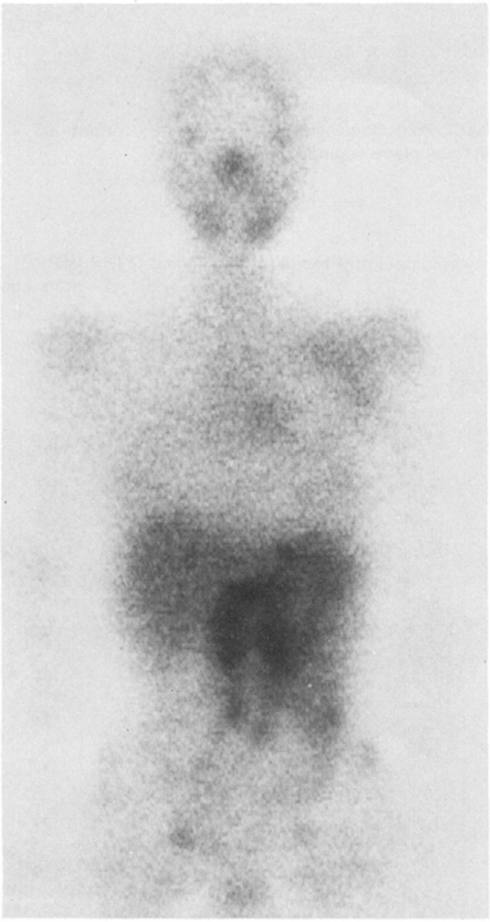


FIG. 9. Selected tomoplanes of patient in Fig. 10; collimator—380 keV; format—whole body; line space—0.3; speed—250 cm/min; focal plane separation—2.

ANTERIOR

RIGHT



LEFT

FIG. 10. Ohio Nuclear model 84 rectilinear gallium-67-scan, patient with Hodgkin's disease; collimator—medium energy; 5:1 ratio; line space —0.3; speed—250 cm/min.

Results and Discussion

The tomographic scanner used in gallium-67-scans has delineated foci of activity at different depths. In tomoplanes 2 and 3 anteriorly (Fig. 8), there is a linear uptake of activity in the abdominal area which fades out in deeper planes; this is a recent surgical scar. In a comparative gallium-67 study done using the Anger rectilinear tomographic scanner (Fig. 9), and a 5-in. dual-probe rectilinear scanner (Ohio Nuclear, Inc., model 84) (Fig. 10), the tomographic scanner resolved the increased uptake of activity in left axillae and left iliac crest better.

In the tomographic brain scan (Fig. 6), multiple lesions are demonstrated. The tomographic scanner separated superficial skull lesion from intracerebral lesion as projected in the posterior view, and in the torcula, plane 11. This is another advantage of this instrument.

Acknowledgment

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Footnote

**Editor's Note:* The matter of focal plane separation is described in a companion paper, "Method for Determining Tomographic Plane Separation and Detector Distances for Use with the Searle Pho/Con Tomographic Multiplane Scanner," by R. F. Gors, which immediately follows, in this issue.

References

1. Fordham EW, Turner DA: Tomographic radionuclide brain imaging with the Anger tomoscanner. In *Noninvasive Brain Imaging:*

Computed Tomography and Radionuclides, De Blanc HG, Sorenson JA, eds. New York, Society of Nuclear Medicine, 1975, pp 81 86

2. Turner DA, Ramachandran PC: Brain scanning with the Anger multiplane tomoscanner as a primary examination: Evaluation by the receiver operating characteristic (ROC) curve method. *Radiology* 121: 125 129, 1976

3. Turner DA, Fordham EW: Brain scanning with the Anger multiplane tomoscanner as a secondary examination: Evaluation by the receiver operating characteristic (ROC) curve method. *Radiology* 121: 115-124, 1976

4. Anger HO: Tomographic gamma-ray scanner with simultaneous readout of several planes. In *Fundamental Problems in Scanning*, Gottschalk A, Beck RN, eds. Springfield, IL, Charles C. Thomas, 1968, p 195

5. Anger HO: Multiplane Tomographic scanner. *In Tomographic Imaging in Nuclear Medicine*, Freedman GS, ed. New York, Society of Nuclear Medicine, 1973, pp 2-18