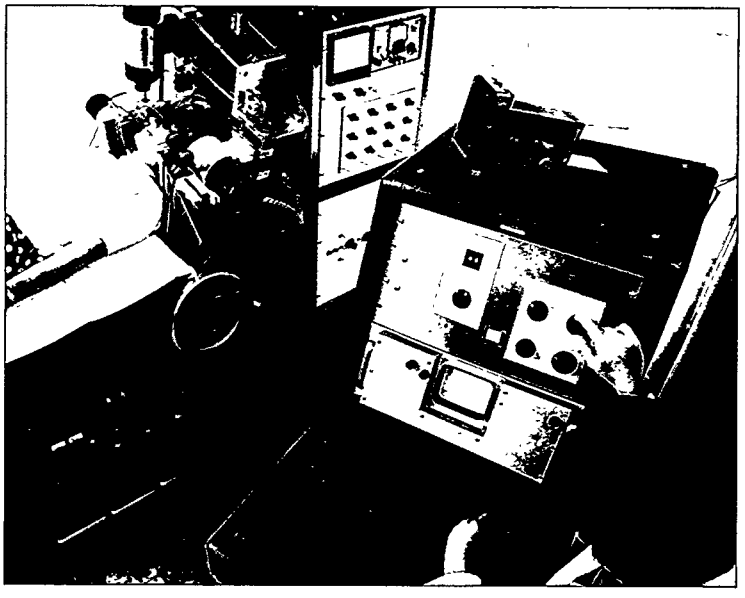
despite the lack of sophisticated mathematical algorithms for doing tomographic reconstructions, he produced the first transverse section images ever obtained by single-photon imaging. As did Kuhl's prototype, today's SPECT scanners—mainstays of present-day nuclear medicine—detect a radiotracer's gamma-ray emissions by rotating detectors around the body. In today's machines, a computational algorithm then reconstructs the distribution of the tracer that gave rise to the detected signals. This reconstructed slice is then combined with others to produce a 3-D image. Six years later, Kuhl performed the first transmission transverse section scan of a patient's chest, this time producing images by detecting gamma-rays transmitted through the body from source to detector. This concept is similar to that now embodied in commercial x-ray CT scanners.

Yet another stride in medical imaging exploited a peculiar property of some radioactive isotopes: As they decay, they emit a positron, an elementary particle of antimatter that promptly undergoes mutual annihilation with a nearby electron. The product of this annihilation is two gamma-rays traveling in exactly opposite directions. Detecting this pair of gamma-rays thus fixes their origin along a straight line between the two opposing detectors. Detecting many such pairs can pin down the point of origin to within a few millimeters—a process called positron emission tomography. PET emerged as an important medical tool only in the seventies, its practical development supported by both the NIH and the AEC. The breakthrough was a series of machines constructed by Michael Phelps, Edward Hoffman, and Michel Ter-Pogossian at Washington University in St. Louis. But much of the groundwork had been laid earlier. In 1953, at MIT, Gordon Brownell fabricated the first detectors designed to take advantage of the positron-annihilation process, and in 1961 James Robertson at Brookhaven built a ring-shaped detector system that foreshadowed later instruments. One element missing from Robertson's prophetic device, however, was again an efficient mathematical algorithm for computing the three-dimensional tomographic images.

Today, more than 260 centers around the world make use of PET scanners, among them one at Berkeley with the world's highest resolution. PET scanning technology has been the key to a whole generation of metabolic studies, as well as clinical diagnostic tests. An organ of especially keen interest is the brain. Mapping its activity usually means following the uptake and metabolism of glucose, the brain's dominant source of energy. In the early seventies, a collaboration among Brookhaven researchers,



**IN-DEPTH ANALYSIS** Beginning in the late fifties, supported by the AEC and other agencies, David Kuhl at the University of Pennsylvania constructed some of the earliest forerunners of today's SPECT and CT scanners. The Mark III scanner shown here detected photons from an injected tracer and applied interactive reconstruction techniques using a built-in computer. The first quantitative three-dimensional measures of brain function were performed with this machine

**1953** Gordon Brownell at MIT constructed the first device to exploit positron-electron annihilations as an imaging tool, another precursor of today's PET scanners.

**1954** Oak Ridge researchers successfully transplanted functional bone marrow from a rat to an irradiated recipient mouse, thus demonstrating the immunosuppressive effects of radiation, a key to future organ transplantation.

**1955** At UCLA George Taplin used rose bengal labeled with iodine-131 to image the liver and similarly labeled hippuran to image kidney function.

**1958** Walter Tucker and his coworkers at Brookhaven invented a means of making the short-lived nuclide technetium-99m available to sites far removed from research reactors. This isotope is now the most widely used radionuclide in medicine.

**1958** Hal Anger at Berkeley developed the "scintillation camera," which would make dynamic studies with radionuclides practical for the first time. This updated instrument superseded Anger's first "gamma camera," which he developed in 1952. Anger cameras are now in use around the world.