A New Type of Nuclear Imaging Device

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Two types of devices are now in practice for nuclear imaging. One is so called moving detector system, and the other is stationary system. The latter is the advanced type of nuclear imaging device in the sense of short time of imaging. It makes possible to record the dynamic process of radioisotope distribution in each period of minutes.

There are several types of the stationary detector system as listed in the table. While scintillation camera, autofluoroscope, and autofluorography are sensitive enough to make the scintigram in a few minutes, they are very expensive and electronically complicated, and their resolutions are not as the conventional moving detector type scanner. Since 1964, Kellershohn developed a spark chamber type stationary detector which does not include a scintillation crystal nor a photomultiplier tube. The principle of radiation imaging with the spark chamber is as follows. The sparks between two disc electrodes by the interaction of low evergy gamma-ray with the Xenon gas are recorded by the camera kept open for the time required. The multihole collimator makes the image of the gamma-ray emitting organ. Kellershohn's spark chamber is triode and it takes about 10 to 20 minutes to make image of thyroid containing ^{125}I 20 μCi. In 1965, Horwitz reported a diode spark chamber. His chamber filled with argon gas and alcohol and equipped an electronic quenching circuit. The efficiency of the chamber is about the same of Kellershohn's. Pullan and Perry's cross wise chamber is not in practice yet. Kellershohn type spark chamber seems to have some advantages over the Horwitz type. Xenon gas is more effective in interaction with the low energy gamma ray than argon gas because of its high atomic number. Triode gives more efficiency in collecting the electrons for sparks than diode. The inexpensiveness and the simplicity of the spark chamber in the stationary detector systems make us to follow the trial of making the Kellershohn type chamber. It has 20 cm diameter and 5.5 cm thick. The spark gap is 12 mm and the Xenon gas with methyl formate is filled. Spurious spark discharges, perhaps because of the insufficient quenching action, annoyed us. Unfortunately, the satisfactory results of making the image of radiation are not obtained get. The electronic quenching circuit must be added.

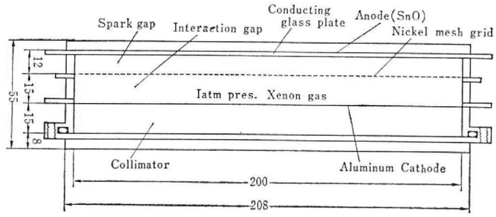
Though Kellershohn and Horwitz use their spark chamber for thyroid or kidney the efficiency is not sufficient for dynamic studies. But once the drawbacks of the spark chamber overcome, this type of stationary detector will be the best nuclear imaging device for the low-energy-gamma-ray emitting radioisotopes.

STATIONARY DETECTOR SYSTEMS

1. Scintillation-crystal-photomultiplier-tube arrangeTments
   1.1 Gamma-ray scintillation camera (Anger 1958)
   1.2 Digital autofluoroscope (Bender & Blau 1963)
2. Autofluorography with an X-ray image amplifier (Ter-Pogossian 1963)
3. Spark chamber approaches
   3.1 Self-triggering spark chamber (Kellershohn 1964)

3.2 Spintharicon (Horwitz 1965)

3.3 Cross-wire chamber (Pullan & Perry 1965)



Cross-section view of the spark chamber

Studies on the Autofluoroscope

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The autofluoroscope is radioisotope imaging instrument designed to visualize and record the distribution of gamma emitting isotopes within the human body.

We tried to manufacture an autofluoroscope with a small sized detector. The detector consists of a matrix of 30 sodium iodide crystals 12×12 mm in section and 58 mm thick. These were packed in 5 files and 6 ranks in a 60×72 mm array. Each of the 30 crystals were optically coupled to two light pipes with 5 light pipes from a given rank going to one phototube and 6 light pipes from a given file going to another phototube. The collimator was composed of two 25 mm thick slabs of lead which were superimposed to provide a single collimator aperture for each crystal. If a decreased resolution with an increase in efficiency is required one of the lead slabs can be removed. Pulses occurring simultaneously in any pair of phototubes uniquely identifies the crystal in which the interaction occurred. The position signals derived from the phototubes are applied to the matrix of magnetic core and stored at the position corresponding to each crystal, and the distribution of radioactivity is shown on the oscilloscope with subsequent nondestructive continuous read out, and printed out numerically for quantitative analysis.

In the patient with goiter that contained 3.0 μCi of ^{131}I, a good contrast picture was taken in 5 min. exposure with a polaroid camera over the oscilloscope face. After intravenous administration of 30-50 μCi of ^{131}I-hippuran and 100 μCi of ^{197}Hg-neohydrin to the patients with various renal diseases, radioactivities in pelvis, medulla and cortex regions in the kidney were read out every 40 minutes, and it was very useful for fractional analysis of renal function.

The autofluoroscope produced the images in a shorter time and with a smaller amount of radioisotope compared with the conventional scanner, and was continuously sensitive to all areas within their field of view. Therefore, it was considered that the autofluoroscope is well adapted to measurement of dynamic processes and measurements with isotopes having short physical or biological half-lives.