III. Apparatus etc.

The Gamma-Ray Source Calibrator

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Very short-life radioisotopes have come to be used in nuclear medicine by the progress of generator milking technique. We have developed a new type of gamma-ray source calibrator for the routine and accurate radioassay of many kinds of radioisotopes.

The detector part of the instrument consist of a well-type ionization chamber and electrometer head. The measuring part consist of a electrometer circuit, detecting ionization current, and a operational amplifier, converting electrometer output to Curie-unit signal.

The main features of the instrument are as follows:

1) The activities of eleven selected radioisopes can be read in Curie-unit directly from pannel meter and other can also be relatively measured by using in ionization current range.
2) By setting the knobs of the isotope-selector and the range-selector, full scale of the meter deflection is displayed automatically in the range indicator.
3) Various packaging of sample, vial, ampoule, beaker, injection syringe, test tube etc. can be measured by only inserting them into the well of ionization chamber.

The Performance data of the instrument are as follows:

Range:

From 3×10^{-9} to 3×10^{-13} amps full scale deflection in ionization current range.

Accuracy:

$\pm3\%$ in ampere unit range
$\pm5\%$ in Curie unit range

Radioisotopes:

^{24}Na, ^{51}Cr, ^{59}Fe, ^{60}Co, ^{99m}Tc, ^{125}I, ^{131}I, ^{133}Xe, ^{198}Au, ^{197}Hg, ^{203}Hg.

Sensitivity:

^{24}Na, ^{60}Co	3	microcuries F.S.
^{59}Fe	10	〃
^{131}I, ^{198}Au, ^{203}Hg	30	〃
^{99m}Tc, ^{125}I, ^{133}Xe, ^{197}Hg	100	〃
^{51}Cr	300	〃

Development of Catherter-Type Semiconductor Detector and its Medical Application

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The use of radioisotopes for biological study often requires internal detection of radioactivity. A detector which can be inserted into living subjects will make it possible to get new information which are unobtainable by the conventional external measurement of radioactivity. The detector for this purpose must be small, harmless to living tissue, and of high sensitivity.

Previously, a catheter-type micro G-M

counter was used for this purpose with a certain degree of success. However, the application of this counter to clinical cases was limited because of the rapid deterioration of the counter due to radiation, high operation voltage and restricted sensitivity to higher energy betarays of the counter.

Recently developments on a semiconductor detector overcame these disadvantages and are opening new possibilities in this field. Preserving the important characteristics of this detector, such as smallness, durability and low operation voltage, we made our detector into a catheter-type one and investigated its utilization in the field of clinical medicine. The first report was published in The Japanese Journal of Nuclear Medicine (vol. 3 (2) 110, 1966). We have continued to improve the detector and its associated electronic circuits.

The probe used in our experiment is made of a oxide-passivated silicon p-n junction detector, the outer diameter of which is reduced to 3 mm. The detector is enveloped in a thin silicone rubber sack (about 200 μm thick) and the signal cable is put into a KIFA catheter. As the window of this detector consists of a dead layer (about 2 μm) and the silicone rubber layer mentioned above, it is thin enough to be sensitive to medium and high energy beta-ray emitting nucleides such as ^{131}I, ^{32}P, ^{203}Hg and ^{85}Kr.

A completely transistorized low noise charge-sensitive preamplifier is developed to eliminate microphonic noise and to reduce the circuit voltage to ensure further safety. The field effect transistor is used in the first stage of the amplifier circuit.

All the basic characteristics of our device were studied and investigated into, including noise level; effect of bias voltage and temperature on count rates; linearity of count rates to the concentration of radiation sources; sensitivity and isoresponse curve. The noise increases with the raise of temperature and increase in bias voltage, but it can easily be excluded by the discriminator provided the temperature is below 45°C and the bias voltage is between 20 to 40 volts. The sensitivity of our detector is more than 3 cpm for 1 mμCi/ml ^{32}P solution and more than 2 cpm for 1 mμCi/ml ^{131}I solution. During the last several months we have been using the detector in our laboratory twice a week and left it in the vessels of dogs for several hours each time. So far, it seems to have practically unlimited life. Thus, it was proved that this device has many advantages over the catheter-type micro G-M counter as an in-vivo detector of radioisotopes.

Experiments were made on dogs and circulation time from femoral vein to inferior vena cava, and also from femoral vein to trachea was measured by using ^{85}Kr, with the detector inserted into the points to be measured. Experiment with circulation models showed the possibility of continuous measurement of the blood flow using ^{85}Kr infusion. Cardiac shunt detection was also performed with animals, using dogs.

Measurement of coronary and hepatic flow; detection of malignancy and bleeding in the gastro-intestinal tract; measurement of localized tissue activity with a needle-type semiconductor detector are scheduled to be conducted in the near future.

A Study on Small Type of Body-Surface Attachable Scintillation Detector

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With the available radio-isotope (RI) dynamic function detector, which is a stationary type, it is possible to take reliable external countings and recordings only when both the subject and the detector are fixed, but it is not so when the subject is in an unstable posture or while moving.

For the past three years we have been studying the hemodynamics of the liver with the use of RI, and have reported some interesting findings relative to changes in the liver accumulation coefficient (KL) at the