V. B. Shteĭnshleĭger, G. S. Misezhnikov, and A. G. Sel'skiĭ. *A Radiophysical Method for Detection of Thermal Anomalies in Human Internal Organs.* Exploration of possibilities for the use of the human body's own radio-band thermal emission in the diagnosis of inflammatory processes and oncological disease has been under way for a few years.[1] However, the need to use comparatively long radio wavelengths (in the decimeter band) to obtain satisfactory penetration of the human body has been quite detrimental to the spatial localizing ability of the method.

The present report describes a method and radiometric apparatus[2] to help overcome this deficiency in the detection of deep-seated temperature anomalies in the human body. For this purpose, the radiometer's antenna takes form of a dielectric lens that is focused on the deep region of the body to be examined and has a permittivity ε_l equal to the permittivity ε_t of human internal tissues. The lens is brought up to the part of the body in question, which acts as an immersion medium for this lens.

The width Δx of the diffraction spot (at 0.5 of maximum intensity) of a dielectric lens is[3]

$$\Delta x = \frac{0.5\lambda}{\sqrt{\varepsilon_T}\sin\theta},$$

where λ is the wavelength in air and 2θ is the exit aperture angle. For a large aperture angle, $\Delta x \approx \lambda/2\sqrt{\varepsilon_t}$ regardless of how deep the region to be examined is situated.

Experiments with the dielectric lens were performed at $\lambda = 18$ cm. Water, which has a permittivity about equal to that of most internal body tissues with high water content, was used as the lens dielectric and the body-tissue equivalent.[4] The measured value of Δx was approximately 1.4 cm in the H plane, or close to the theoretical value, and slightly higher in the E plane.

The accuracy of localization is poorer along the optical axis than in the focal plane, amounting to $\Delta z \approx 6$ cm.

The superficial fatty layer, which has a comparatively low ε,[4] introduces aberrations and broadens the focal spot. Experimentation showed that this broadening is insignificnat at a typical thickness (~1 cm) of a plane-parallel fatty-layer equivalent.

More significant errors are introduced by the change in temperature that results from reflection of the waves from the boundaries of the fatty layer, the thickness of which is different at different points of the body.

This error can be reduced by feeding noise at an intensity adjusted (with a special automatic control circuit[5]) to the same level as that of the body thermal radiation to be registered into the antenna through a ferrite circulator built into the radiometer input. The influence of fatty-layer thickness nonuniformity can be further reduced by comparing the results of temperature measurement at symmetric points of the body.

The ability of the instrument (radiothermograph) to detect small temperature anomalies is determined by its fluctuation sensitivity and by such factors as the attenuation of power in the layer between the region of the anomaly and the surface of the body and the extent to which the region of the anomaly fills the cross section of the focal spot.

The antenna-temperature increment δT_a due to the presence of a temperature anomaly in the focal region within the body was calculated with consideration of these factors (and on the assumption that the influence of reflection from the fatty layer on the sensitivity of the method is offset with an impedance transformer in the radiometer's microwave channel).

The result showed that there is an optimum wavelength λ_{opt} at which δT_a is largest. Under typical conditions, $\lambda_{opt} = 20 - 30$ cm. If $\lambda < \lambda_{opt}$, δT_a decreases as a result of higher losses in the tissues, and if $\lambda > \lambda_{opt}$ it decreases as a result of focal-spot enlargement.

The diagnostic capability of the instrument could evidently be improved by using microwave hyperthermia.[6] Combinations with hyperthermia are particularly convenient in the apparatus described here: heating of the surrounding tissues during hyperthermia would be reduced as a result of energy concentration at the lens focus.

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