A MICROWAVE DIATHERMY APPLICATOR

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ABSTRACT

The existence of some indication that microwave induced hyperthermia may be successful in the treatment of certain types of cancer, and the forthcoming introduction of the government regulations on microwave diathermy devices in the U.S. and Canada have stimulated an increased interest and progress in the development of new improved applicators.

This paper provides a design method and experimental results for a direct contact circular aperture applicator. The applicator is equipped with a corrugated flange which purpose is twofold, to improve the uniformity of the heating pattern and to limit the leakage. The performance of the applicator operating at 2.45 GHz, has been tested using a short monopole probe and a thermographic camera, and the results obtained by the two methods have been compared.

SUMMARY

Numerous microwave diathermy applicators for therapeutic heating have recently been developed [1-4]. The basic features that such applicators should provide are: (1) uniform heating of a specified volume; usually of muscle, with minimal heating of fat and skin, (2) uniform heating over a selected area in the plane parralled to the applicator aperture, and (3) minimum leakage.

This paper presents the design and experimental results for an improved contact applicator and compares two methods of determination of the heating pattern of the applicator.

The applicator shown in Fig. 1 consists of a section of circular waveguide operating in the TE_{11} mode terminated at one end by a short circuited rectangular waveguide with a transition to a standard 50-Ω coaxial line. The other end of the circular waveguide is terminated by a corrugated flange. The flange serves a twofold purpose, namely, it improves the symmetry of the heating pattern [5,6], and limits the leakage. The selection of the waveguide diameter and the dimensions of the corrugations is critical in obtaining the desired effects. The applicator operating at 2.45 GHz has a diameter of the aperture of 7.6 cm, and the X band applicator has a diameter of 2.7 mm, both are air filled. The applicator, if desired, for example at lower frequencies, can be filled with a porous dielectric material as previously described in [2]. In both cases, air can be blown through the applicator to provide cooling of the skin surface.

Heating patterns in simulated tissue phantoms irradiated by microwave diathermy applicators can be determined by the thermographic method [7] or by the short dipole method [8]. Both methods have been used to evaluate the performance of the corrugated flange applicator. The advantages and limitations of these methods and a comparison of the obtained results are discussed.

Figures 2 and 3 show the square of the electric field intensity in simulated muscle tissue for the applicators operating at 2.45 GHz and 9.6 GHz.

Better symmetry of the pattern has been obtained at 9.6 GHz, as the ratio of the aperture diameter to the wavelength is closer to the optimum value of 0.8 [6]. The results of the evaluation by the thermographic method, of the leakage and of the impedance matching will be presented.

References

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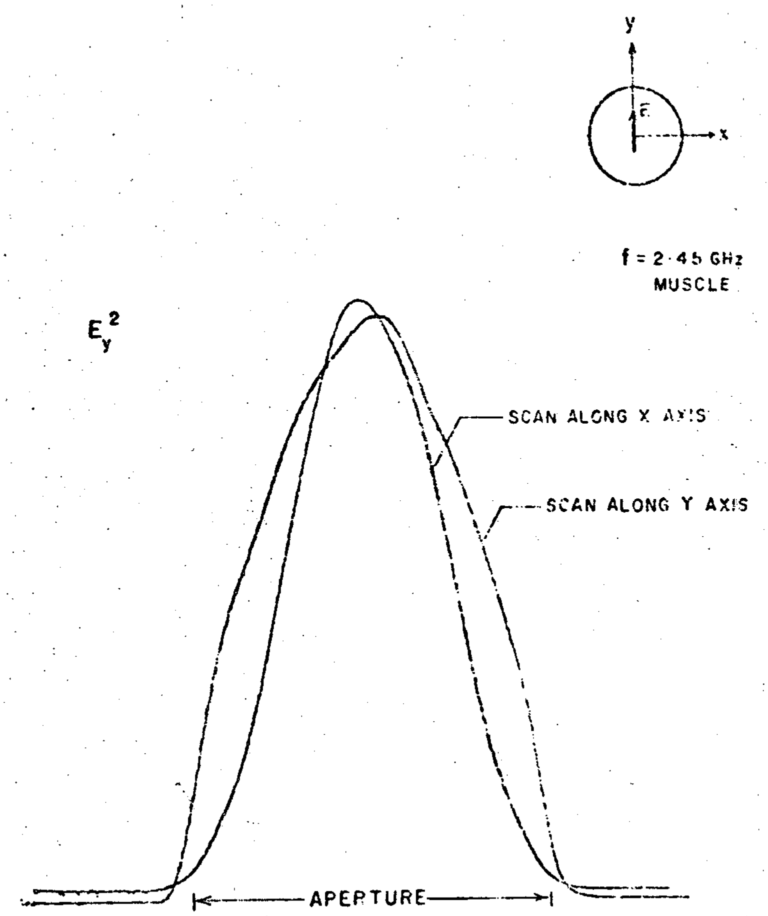


Figure 2. Intensity of the electric field in muscle tissue measured by the short probe method, f = 2.45 GHz.

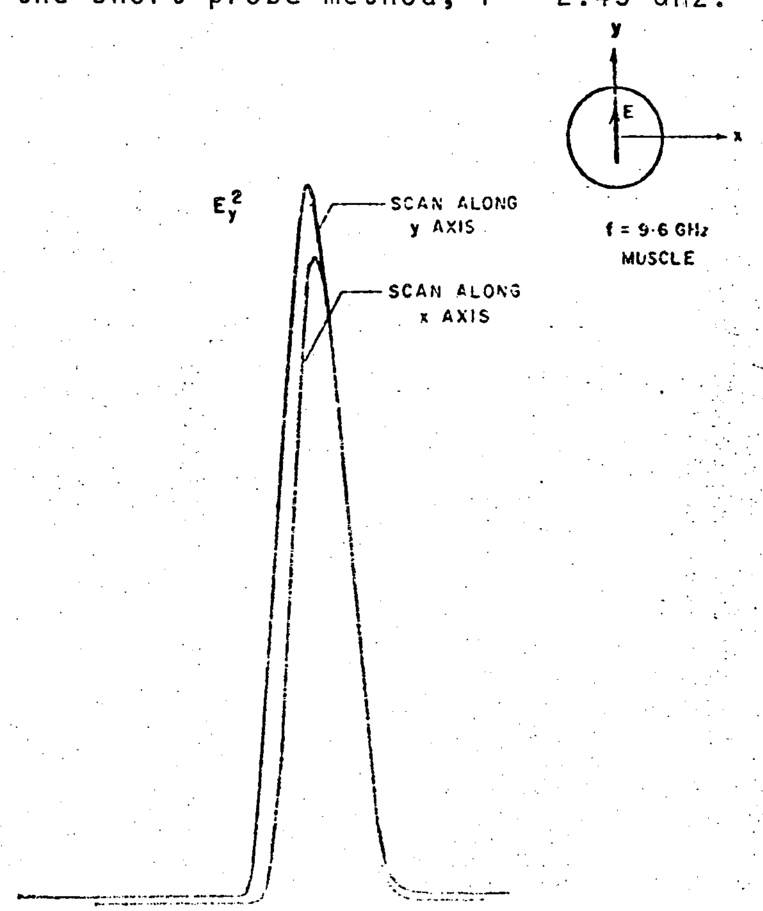
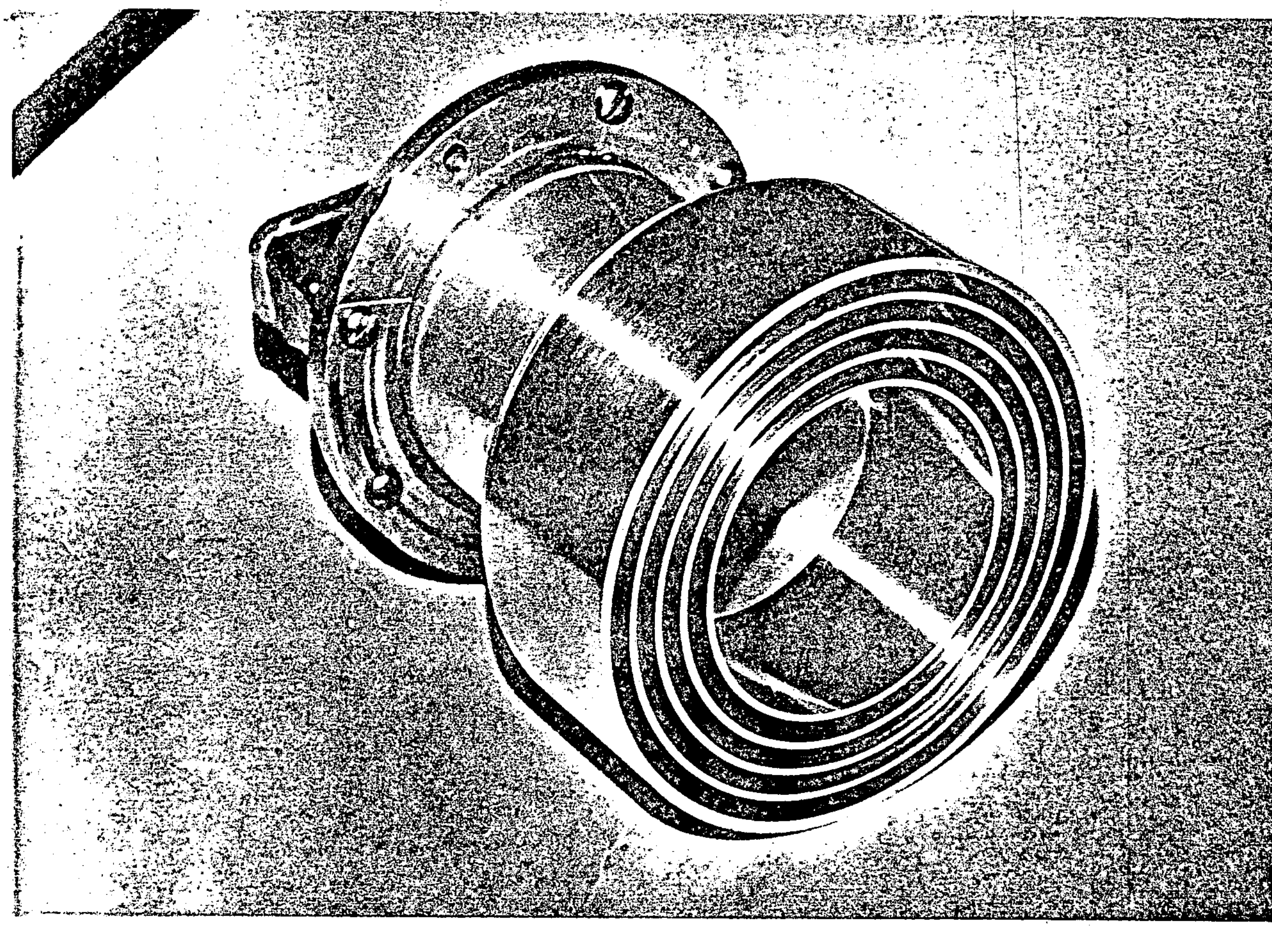


Figure 3. Intensity of the electric field in muscle tissue measured by the short probe method, f = 9.6 GHz



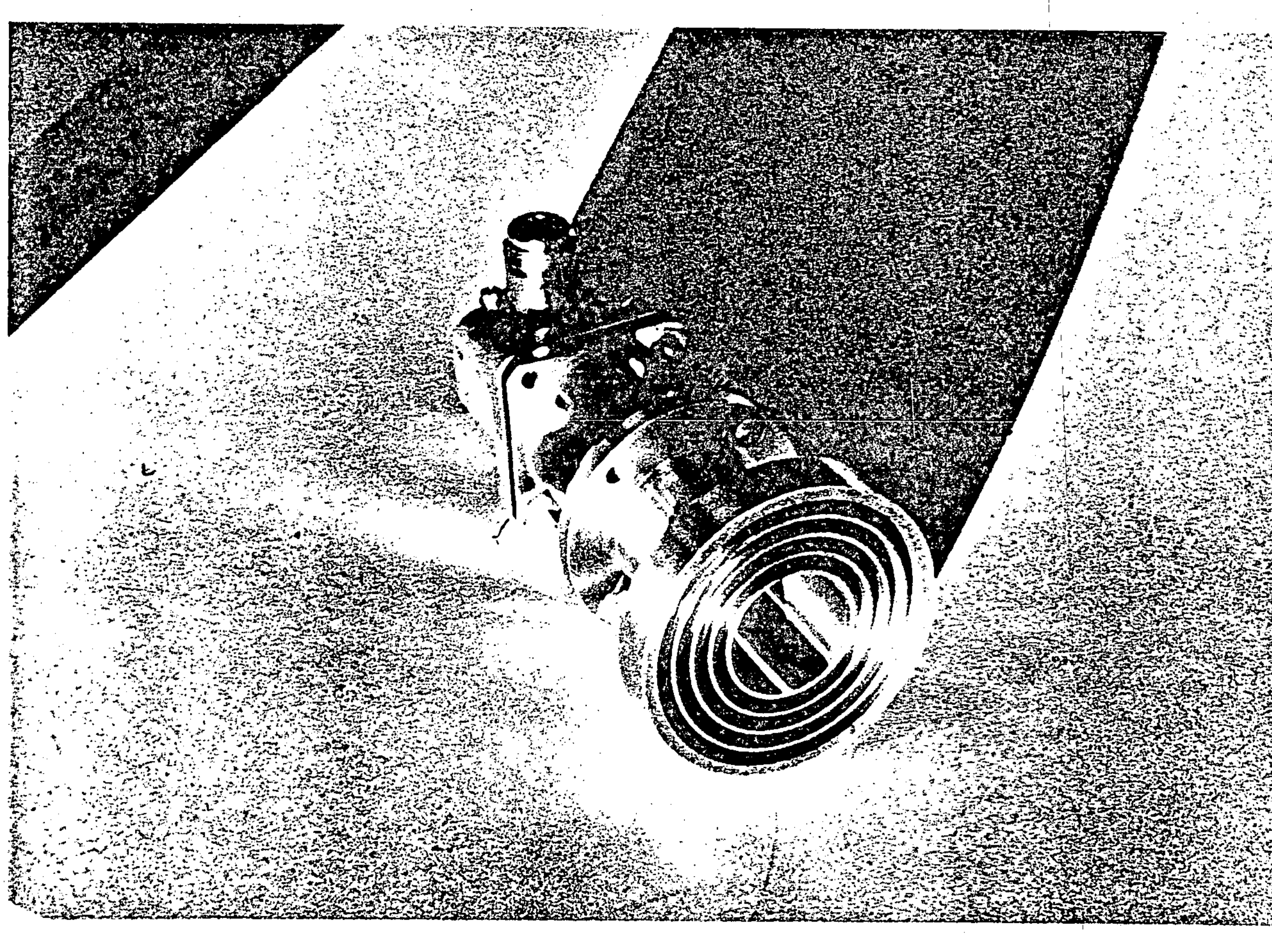


Figure 1. External view of the corrugated flange applicators; upper - S band, lower - X band.