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A technique for the production of a high amplitude, high frequency, concentrated magnetic field for use in hyperthermia applications

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Abstract

Cancer of the liver is a common disease with a relatively poor prognosis. Hyperthermia is an exciting treatment that is under investigation. One modality of hyperthermia therapy makes use of an external magnetic field to produce losses in magnetic particles that have been supplied to the tumour. The losses result in the heating of the tumour cells thereby causing cell destruction. There exists a limit in the product of magnetic field intensity and frequency, above which eddy currents reach levels capable of causing thermal damage in healthy tissue. This limit is well documented in the literature and, due to the seriousness of the disease, can be increased to 5×10^9 A/ms.

The magnetic field used by most researchers is produced by simple coils. Using these simple coils, it is very difficult to produce sufficient heating throughout the tumour cells without exceeding the safety limit in healthy tissue. This research provides a machine that is capable of producing a magnetic field of sufficient energy to cause therapeutic heating within the tumour region whilst remaining within the safety limit elsewhere. A design methodology for this machine is demonstrated. A prototype machine is built and tested in order to validate the design procedure. The results from the prototype experiment are in good agreement with those predicted by the theory. The idea of "focussing" a magnetic field in distances far smaller than the wavelength of the field is a novel concept. This fundamentally new research has the potential to assist in the development of a treatment for tumour sufferers.