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A Novel Design of Repetitive Pulsed Magnetic Stimulator

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Repetitive pulsed magnetic stimulator has been verified as an important device for psychological and neurological disorders. However, repetitive pulsed current in time-varying magnetic field produces large Joule heat in coil which undermines curative efficacy and prevents repetitive high frequency stimulation.
After analyzing the advantages of existing coils and the unique nonplanar structure of human brain, an innovative geometric coil design applied in transcranial stimulation is proposed. The stimulating coil is designed into coil pair with an irregular form of cambered surface based on the inspiration of special-shaped magnet. From the front view, the overall structure is in arc-shaped whose inner arc radius is set at 115 mm (a bit larger than the average radius of human brain). From the vertical view, the outline is rectangular. The stimulator is mainly composed of a charging circuit, a discharge circuit and a stimulating coil. The discharge circuit is a feedback loop using a bidirectional thyristor where the energy of the capacitor is recovered. Repeating charging the capacitor to expected value and energizing the stimulating coil, the repetitive pulsed current is produced.
The Finite-Element Method(FEM) is adopted to analyze the 3D spatial distributions of intracranial induced electromagnetic field. To unify coil evaluation standard and enable meaningful comparison for new design' s feasibility, a comparison function reflecting medical efficacy is constructed. Comparing to conventional structure, it has been proved that the optimization of this design can enhance the peak of induced electric field for 11%, raise the value of RPN for 20% while improving the overall efficacy by 40%. This design makes it possible to obtain superior intracranial focusing field in targeted tissues with lower stimulation current.

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