Radio Frequency (RF) Coil for an Improved MRI System

View U.S. Patent No. 7,714,581 in PDF format.

WARF: P06256US

Inventors: Matthew Erickson, Sean Fain, Krishna Kurpad, James Holmes, Thomas Grist

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing an improved RF coil system for magnetic resonance imaging (MRI) systems.

Overview

MRI systems have played a major part in safely imaging and diagnosing various bodily ailments. When human tissue is subjected to a uniform magnetic field from a large magnet, it will vibrate at what is called its characteristic Larmor frequency as a result of its polarity. If another magnetic field is applied perpendicular to the first using an RF coil and then resonated at that same Larmor frequency using capacitors, a Nuclear Magnetic Resonance (NMR) signal is emitted and measured by the same RF coil. The NMR then may be used to produce an image or spectrum of the human tissue. MRI systems are commonly rated based on the magnet strength, which is measured in teslas.

High field MRI, a technique that uses larger magnetic fields of 3T or higher to gain greater image quality and resolution as well as improve specific MRI applications, is gaining popularity in both clinical and research programs. The biggest challenge with high field MRI is the lack of homogeneity of the magnetic fields caused by both the non-conductive and conductive properties of the specimen. To compensate for the non-conductive properties, phase and amplitude control of the conductive RF coil elements are needed to “pre-distort” the magnetic field. To compensate for the conductive properties, instead of having the RF coil capacitance lumped at one end, its capacitance is distributed along the coil, such as in transverse electromagnetic (TEM) resonators. But in TEM resonators it often is a problem to maintain the same impedance in all the elements of the coil, which is necessary for proper operation.

Some clinical applications involve taking MRI images of two separate tissues requiring two different Larmor frequencies. Changing or tuning an RF coil to a new Larmor frequency is not practical. Multinuclear excitation and reception coils, which utilize two RF coils, have been proposed. However, due to their multi-modal resonant structure, unwanted excitation modes can occur in certain scenarios, which then require multiple scans. The subject may move during the time between scans, resulting in differences in the two scans.

The Invention

UW–Madison researchers have developed a TEM resonator coil with drive circuitry that can be used in an MRI system to transmit a uniform magnetic field or receive NMR signals. It differs from previous TEM resonators because the device itself is not a resonance structure and its multiport excitation suppresses unwanted resonant modes.

This device consists of a coil that has a cylindrical shield encircling a central axis, which supports multiple pairs of opposing conductive legs arranged symmetrically around the central axis. Terminal susceptance elements, most commonly capacitors, are connected between the legs and the Faraday shield. Each pair of legs is connected to a current balun, which maintains equal currents in the leg pairs. A tune and match circuit, which matches impedances, is connected between the balun and conductive legs. The coil also can be utilized to operate at multiple Larmor frequencies at once while not creating unwanted excitation modes.

Applications

- MRI system to produce an image or spectrum of human tissue
- High polarizing magnetic field strengths operation

Key Benefits

- Well suited for high polarizing magnetic field strengths
- Easily adjusted for different magnetic field strengths
- Easily and inexpensively constructed
- Good magnetic field homogeneity
- High signal to noise ratio when receiving NMR signals

Additional Information

For More Information About the Inventors

- Sean Fain
- Thomas Grist

Tech Fields

- Medical Imaging : MRI

For current licensing status, please contact Jeanine Burmania at jeanine@warf.org or 608-960-9846