# LICENSING OPPORTUNITY: INTEGRATED MICROCHIP INCORPORATING ATOMIC MAGNETOMETER AND MICROFLUIDIC CHANNEL FOR NMR AND MRI

## DESCRIPTION

### Problem

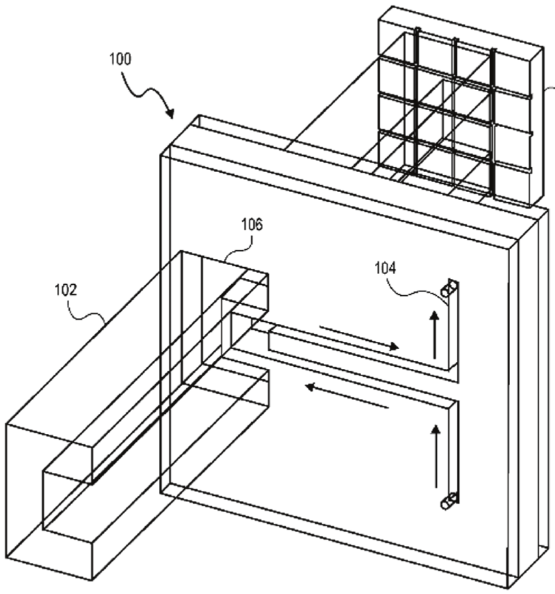
Nowadays, low-field magnetic resonance imaging (MRI) must operate with high sensitivity at very low frequencies associated with low magnetic fields.

### Invention

Our invention uses very small alkali vapor cells with sensitivity for detecting very small DC magnetic fields produced by a small sample of fluid without cryo-cooling.

It improves on existing remote detection of low-field NMR and MRI: The invention uses a very small atomic magnetometer with dimensions on the order of 1 mm and sensitivity in the range of 100 fT/rtHz in the frequency range of 1 Hz to 100 Hz. This sensitivity detects a very small DC magnetic field produced by a small sample of a fluid, such as water, prepolarized in a 1T (or less) magnetic field. The fabrication process allows for integration of the chip scale magnetometer with a microfluidic channel. This allows very small fluidic samples to be brought very close to the magnetometer.

Because the fabrication process is based on lithographically-defined patterning, our device is highly scalable and can be miniaturized far beyond current devices. Miniaturization implies not only reduced cost, but improved sensitivity to very small samples, since the fluid can be brought even closer to the magnetometer. It can easily incorporate multiple alkali vapor cells and interconnecting microfluidic channels to study fluid mixing and reactions directly on the chip.




Illustrates a microfluidic device including an alkali vapor cell and a microfluidic channel where the alkali vapor cell is illuminated by a laser beam and a segmented photodiode detects the laser beam after its transmission through the alkali vapor cell according to an embodiment of the present invention. Item 100 is the microchip; item 102 is the laser; item 104 is the fluidic channel; item 106 is the alkali vapor cell; and item 108 is the segmented photodiode.

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## BENEFITS

### Potential Commercial Applications

The detection limit of our device is superior to conventional inductive detection in a 300 MHz magnet. It can be manufactured with conventional microfabrication techniques for ease of mass production and can be applied in industry whenever the trace amounts of chemicals are being analyzed.

A variety of applications:

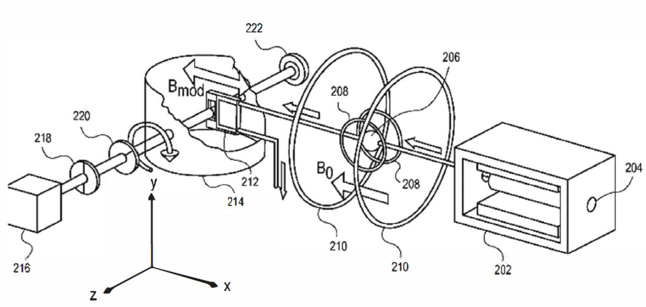
- Remotely Detects Low-Field Nuclear Magnet Resonance (NMR) and MRI.
- Detection Limit Superior to Conventional Inductive Detection in a 300 MHz magnet.
- Manufactured with Conventional Microfabrication Techniques for Ease of Mass Production.
- Widely Applied in Industry Whenever Trace Amounts of Chemicals are Being Analyzed.

### Competitive Advantage

The most sensitive DC magnetometers are superconducting quantum interference devices (SQUIDs) - very high sensitivity but large and cumbersome to operate because of the cryogenic cooling required to reach the superconducting states. Existing compact sensors are typically not sensitive enough to enable low-noise recording of the very weak nuclear polarization. Our device eliminates these issues.

- This device resolves industry issues in healthcare
- Chemical analysis
- Geology
- Benchtop NMR
- Microfluidics
- MRI and reservoir analysis

Opportunity for multiple collaborative development relationships with research and development. There is an opportunity for collaboration with fabrication facilities!




This advanced technology provides a means of NMR detection in magnetic fields near zero, thus no cryogenics required and noise associated with currents used to null the field are minimized.

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