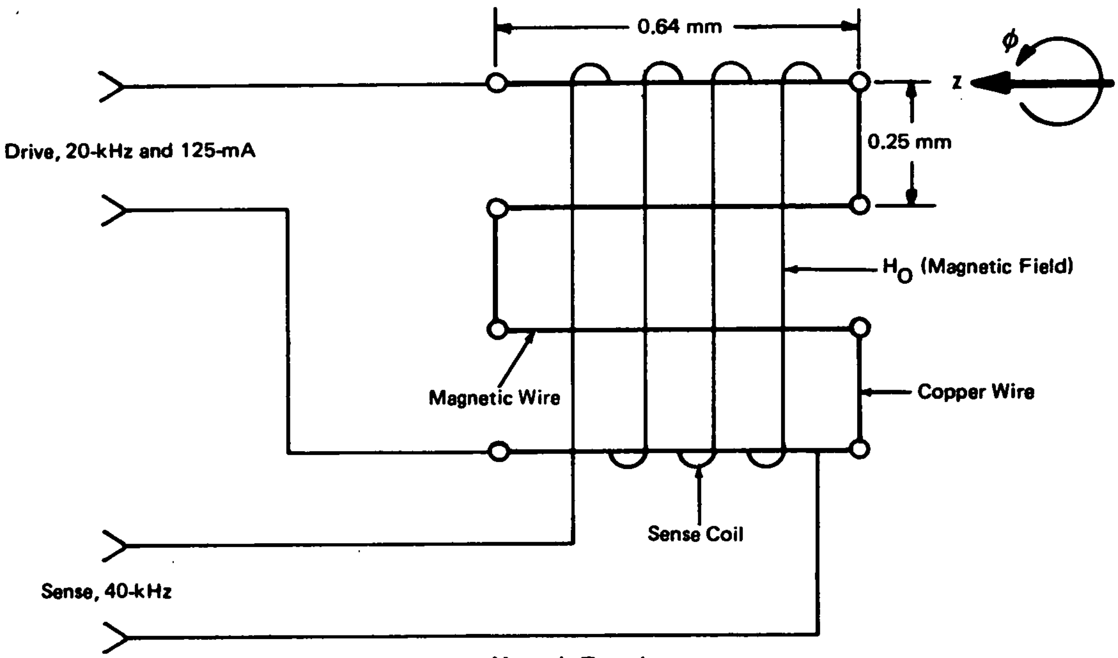
NASA TECH BRIEF

Langley Research Center

Magnetometer With Miniature Transducer and Automatic Transducer Scanning Apparatus



Magnetic Transducer

A new magnetometer is simple to operate, has fast response, and employs an automatic transducer scanning technique. The transducer is rugged and flat and can measure magnetic fields as close as 0.08 mm from any relatively flat surface. A unique feature of this magnetometer is an active region of approximately 0.64 by 0.76 mm. It is capable of very good spatial resolution of magnetic fields as low as 0.02 Oe (1.6 A/m).

The drive circuit (see schematic) is constructed from four wires plated with a magnetic coating which are connected in series by copper wire. The plated wire consists of a thin layer of nickel-iron magnetic alloy plated on a copper-beryllium substrate. Copper wire wound 10 to 30 turns around the drive circuit serves as a sense coil.

A clip-on milliammeter delivers a 20-kHz drive signal which is stepped up by a transformer to the required level of 125 mA. This current is sufficient to drive the magnetic coating of the wire into saturation in the circumferential direction twice each cycle. As a result, the magnetic permeability associated with the axial direction of the wire is reduced to a small value twice each cycle coincident with the alignment of the magnetic domains into the circumferential direction. For sufficiently-small, external, axial magnetic field intensities, the axial magnetic flux density is the product of the external field and the magnetic permeability. Since the sense coil predominately links the axial magnetic flux, then, by Faraday's law, the open-circuit voltage developed across the sense coil has a dominant 40-kHz component and is proportional to the magnetic field perpendicular to the plane of the same coil and along the length of the magnetic wires.

(continued overleaf)

The clip-on milliammeter performs the following functions:

a. The 40-kHz sense signal is returned to the milliammeter where it undergoes synchronous detection and amplification;
b. A fraction of the output current is returned as a dc negative feedback current to the sense coil, which, in turn, generates a dc magnetic field that very nearly cancels the external field to be measured; and
c. The output signal of the synchronous detector becomes almost zero, and the feedback current monitored by the meter is proportional to the external magnetic field.

The novel scanning apparatus, the transducer holding mechanism that replaces the recorder ink pen, was developed to assist in the measurement of the transverse magnetic field on relatively flat surfaces. It is not a precision instrument but can be readily assembled and permits relatively rapid measurements to be made. A signal proportional to the transducer output is fed into an X-Y recorder with its sweep synchronized to the scanning recorder. After marking (e.g., by colored ink) the desired scan line oriented along the X direction, the transducer is placed above the line of interest with the Y-position control, and a slow time sweep in the X direction is initiated. The transducer and the object with a magnetic field to be measured are placed inside a Mumetal box, for protection from extraneous magnetic fields, that is located on the X-Y recorder.

The one-strap resolution of the transducer can be a useful diagnostic tool in studies of the nature of the magnetic anomalies in plated-wire memory planes. Another application is the measurement of both transverse components of the magnetic field taken 0.15 mm above the surface of geological rock samples. An alternate embodiment would be the use of a combination of three transducers, in mutually perpendicular orientations, to provide for a measurement of the total magnetic field vector near the surface of a magnetic specimen.

Note:

Requests for further information may be directed to:

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Patent status:

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