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EP 1338900 A2 **WO 1991/014946 A1**
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(54) Abstract Title: **Fluxgate magnetic sensor with overload detection**

(57) A measurement system for magnetic fields and electric currents uses a single-core fluxgate device 70 driven with a radio frequency excitation source 72 and is provided with a means 78 to indicate saturation of the core of the sensor. A means is provided for detecting overload of the sensor as the core approaches continuous saturation using a pair of demodulators 73, 74 and a comparator 77. The demodulators may be envelope detectors. Saturation is thus determined by monitoring the time averaged impedance of the core, and an indication is given when the core becomes continuously saturated. This prevents a large magnetic field being erroneously determined to be a zero field.

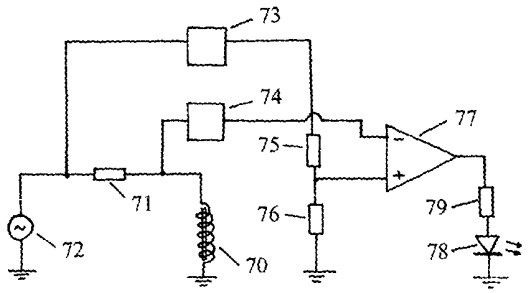

Figure 1

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Fluxgate magnetic sensor with overload detection

The invention relates to the electronic sensing of magnetic fields and electrical currents with fluxgate sensors such that the response of the sensor may be improved when the device is overloaded or saturated by detecting the onset of such overload or saturation.

Fluxgate magnetic sensors rely on the interaction of an alternating excitation magnetic field with a high permeability core wherein that interaction is altered by the presence of an external magnetic field which also couples into the core. Such systems are well known in the prior art, for example, in the measurement of the Earth's magnetic field for electronic compasses. Typically one or more coils couple to the high permeability core, where one coil provides an alternating excitation flux and the same, or another coil or coils, picks up an induced voltage dependent on the rate of change of magnetic flux linking that coil or coils. When an external field also couples into the core, even harmonics of the excitation frequency are induced in these pick-up windings. Such systems are known to be very sensitive and typically produce an output signal proportional to the even (usually second) harmonic derived from a demodulator circuit. For optimum linearity, the demodulated signal can used in a feedback loop to maintain the core at zero net flux, where the output signal is then derived from the feedback current. These issues are widely known and reported in the literature and further details of the operation of such a sensing system are given in patent GB2319621 for example.

The fluxgate sensor does however suffer from a serious drawback when it experiences magnetic fields stronger than its flux nulling feedback system can cope with, or stronger than its excitation field, such that the high permeability core becomes magnetically saturated for a significant portion of the excitation cycle. Under these conditions the magnitudes of the even harmonics diminish – in the extreme case, when the core is continuously saturated in a given direction, no even harmonics will be produced at all; hence resulting in an ambiguity where zero external field and a large external field both produce the same zero output signal.

The object of the invention is to provide a means of overload detection and indication in the case of the sensor being a fluxgate magnetometer or other magneto-inductive sensing device which can indicate a false near-zero reading under conditions of sensor saturation.

The invention will now be described with reference to the following figure, which illustrates an overload detection circuit incorporates into a fluxgate interface circuit.

With reference to figure 1, an overload detection circuit is shown for a fluxgate, magneto-impedance or magneto-inductive sensor 70 driven by an RF oscillator 72 through impedance 71. Demodulation and feedback circuits, as illustrated and described previously herein are not shown in this case, although can be implemented if a linear output signal is required. When the sensor 70 is overloaded such that its magnetic core is at or near saturation, there may only be a small amplitude of even harmonics of the excitation waveform produced, which in turn will give a sub-linear output signal level. Under this condition ie. when the sensor system is over-range, the impedance of the sensor will be seen to reduce as its inductance falls, due to a decrease in the effective permeability of the core. As the sensor impedance falls, the peak-to-peak voltage across the coil terminals due to the excitation current also falls. This change may be monitored with a demodulator (envelope detector) 74 which produces a d.c. signal related to the peak-to-peak amplitude of the alternating voltage across the sensor coil; so providing a time-averaged indication of the sensor impedance. This signal may be compared with a fixed threshold, or preferably, a threshold level derived from the excitation oscillator 72 amplitude by means of a second envelope detector 73 and scaling means, such as a pair of resistors 75 and 76. In the linear operating range of the sensor, the d.c. voltage from demodulator 74 is higher than the voltage from demodulator 73 scaled by resistors 75 and 76. This pair of voltages is compared with a comparator 77 or other means and may be used to drive a visual, audio or other indicator 78, such as a light emitting diode, though a resistor 79. Under sensor saturation or overload conditions, the voltage from demodulator 74 falls causing the output of comparator 77 to change state. The comparator 77 may preferably have some hysteresis and / or pulse stretching circuitry included so that momentary overloads may be more easily noticed.

It will be appreciated by those skilled in the art that other combinations of sensors, coils and interface electronics, beyond those illustrated by way of example herein, are possible. The examples described herein are intended for illustration and not to limit the scope of this patent specification, which is defined by the following claims.

Claims

1. A fluxgate magnetic sensor system in which additional circuitry monitors the time-averaged impedance of the sensor such that magnetic field overload conditions resulting in excessive magnetic saturation of the sensor core may be detected.

2. A magnetic sensor system according to claim 1 wherein the overload detection circuitry comprises one or more demodulators and threshold detection means to detect the fall in impedance experienced as the sensor approaches saturation.

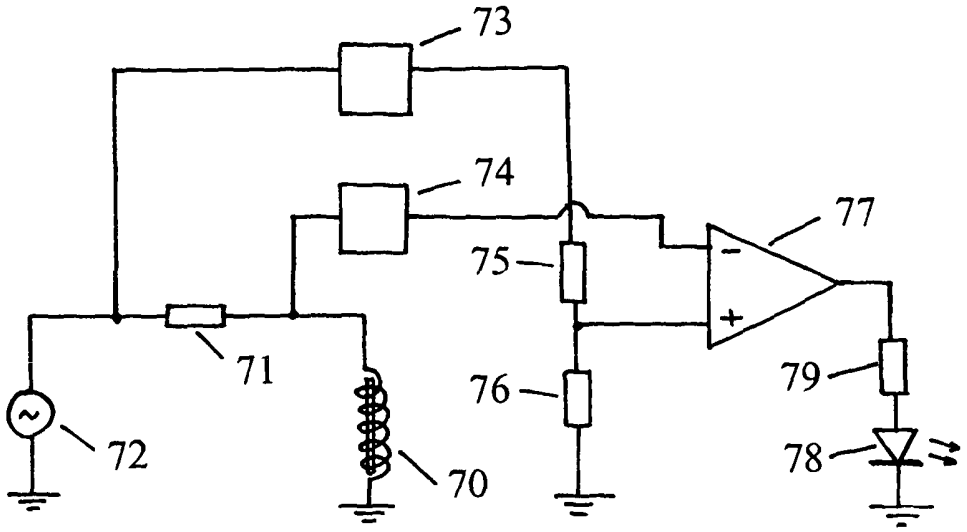

Figure 1

Application No:	GB0917780.9	**Examiner:**	Ian Rees
Claims searched:	1 and 2	**Date of search:**	23 October 2009

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	EP 1338900 A2 NATIONAL UNIVERSITY OF IRELAND. See abstract, paragraphs 0001, 0003, 0004, 0006 to 0010, and figure 1.
A	-	WO 91/14946 A1 ANALOG DEVICES. See abstract, page 1 (para 3) to page 5 (para 3), page 7 (paras 4 and 5), page 8 (para 4), page 10 (para 1) to page 12 (para 3), and figures 1 to 3, 6 and 7.
A	-	JP 2004340953 A JAPAN SCIENCE AND TECH AGENCY. See English abstract.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

G01R

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI, TXTE

International Classification:

Subclass	Subgroup	Valid From
G01R	0033/04	01/01/2006