Measuring weak magnetic fields – magnetic compass

In the measurement of weak magnetic fields (for example the earth's field), it's often advantageous to omit the auxiliary magnet in order to get maximum sensitivity from the sensor. The sensor, however, is then in danger of being flipped by any stray magnetic field. The circuit of Fig.26 shows an excellent way of removing this danger by the use of a coil to periodically reset the sensor's polarity.

Another problem of measuring weak magnetic fields is that precision is limited by drift in both the sensor and amplifier offset. In these instances it's possible to take advantage of the 'flipping' characteristic of the KMZ10 series to generate an output that's independent of offset.

The sensor, located in a coil (Fig.27(a)) whose axial field is periodically reversed by alternate positive and negative going pulses (Fig.27(b)), is continually flipped from its normal to its reversed polarity and back again. The polarity of the offset, however, remains unchanged, so the offset itself can be eliminated by passing the two output signals (Fig.27(c)) through a comparator circuit.

For the most sensitive sensor, the KMZ10A, the switching field should not be less than 3 kA/m. Since there's no auxiliary field in this arrangement, the sensitivity of the KMZ10A is about 22 mV/V/(kA/m), and fields up to around 250 A/m can be measured without stability problems.

The normal KMZ10A sensor chip is encapsulated with its x axis (the axis of its permalloy strips) perpendicular to its leads, and this is rather inconvenient for locating it in a coil with its x axis aligned with the coil axis. A special 'turned' sensor, with its x axis parallel with its leads, type KMZ10A1, is therefore available for this application.

Figure 28 shows how a magnetic compass can be made using two mutually perpendicular 'turned' sensors inside a coil. As in the previous example, the magnetic field is periodically reversed to produce an output that's independent of offset. What's more, the compass needs no temperature correction since the determination of field direction relies on the ratio of the two signals and not on their absolute values.

A suitable coil for this compass would be 100 turns of 0.35 mm copper wire wound on a Philips 4322 021 30270 coil former – giving a resistance of $0.6\,\Omega$, an inductance of 87 µH and a axial magnetic field of 8.3 (kA/m)/A.

Figure 29 gives a circuit for delivering the current pulses (50 µs) and for processing the outputs of the two sensors. The current pulses for the coil L1 (70 Hz, 50% duty factor) are generated by transistors TR1, TR2 driven by a 140 Hz pulse generator via a 2:1 frequency divider.

Capacitors C5 and C6 suppress the offset of the two sensor signals. These are then amplified and fed to two synchronous demodulators which generate output voltages V_x and V_Y proportional to the x and y components of the earth's magnetic field.
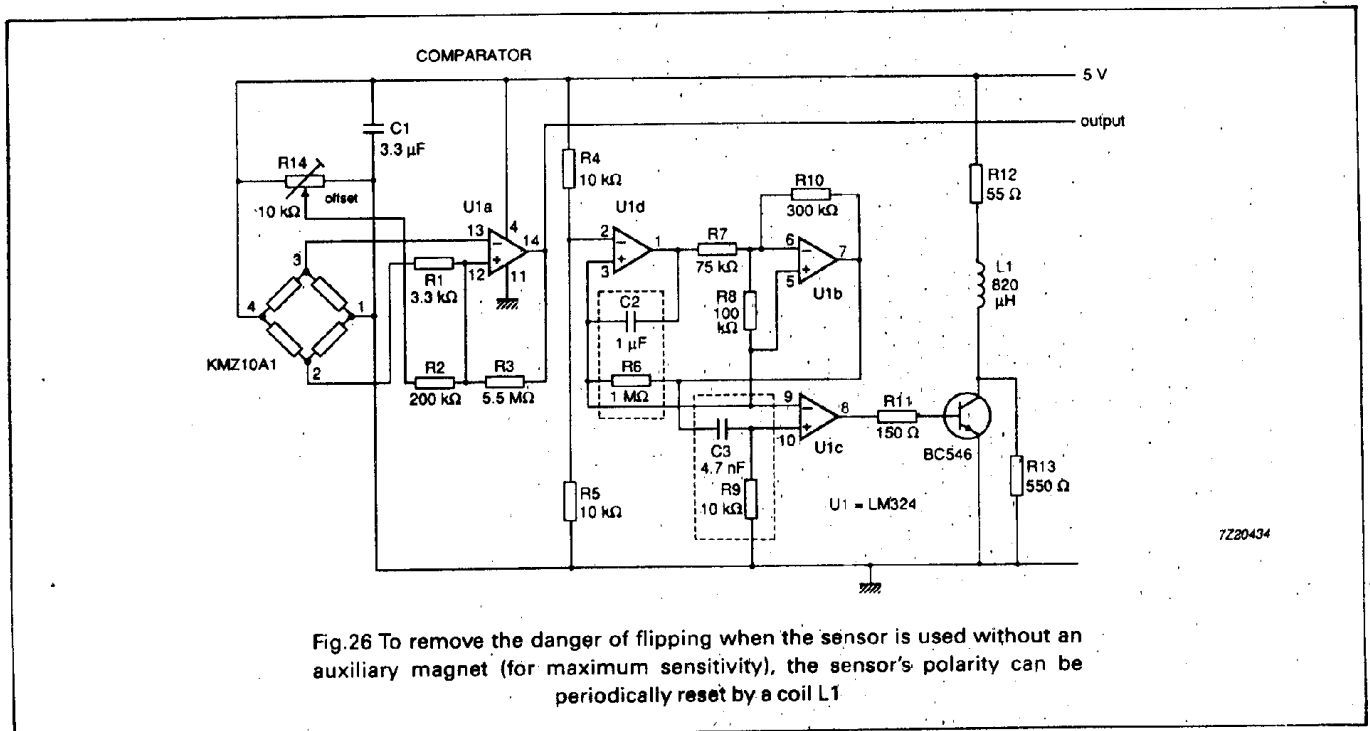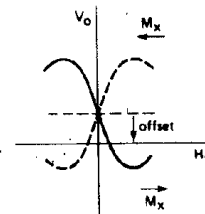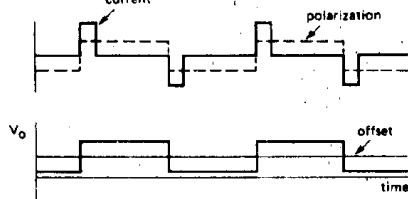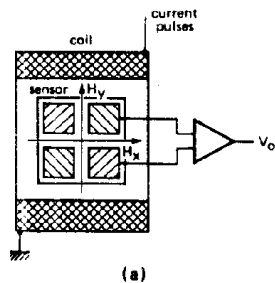

Fig.26 To remove the danger of flipping when the sensor is used without an auxiliary magnet (for maximum sensitivity), the sensor's polarity can be periodically reset by a coil L1
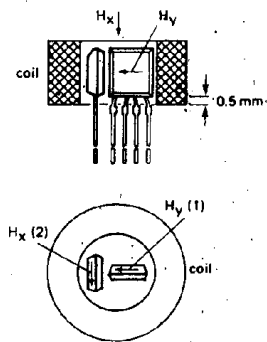
Fig.27 (a) Setup for measuring weak magnetic fields using a coil whose magnetic field is periodically reversed to continually flip the sensor's polarity and eliminate the effects of offset
(b) Pulse diagram
(c) Sensor output

Fig.28 Magnetic compass using two mutually perpendicular 'turned' sensors inside a coil. As in the previous example, the magnetic field is periodically reversed to produce an output that's independent of offset
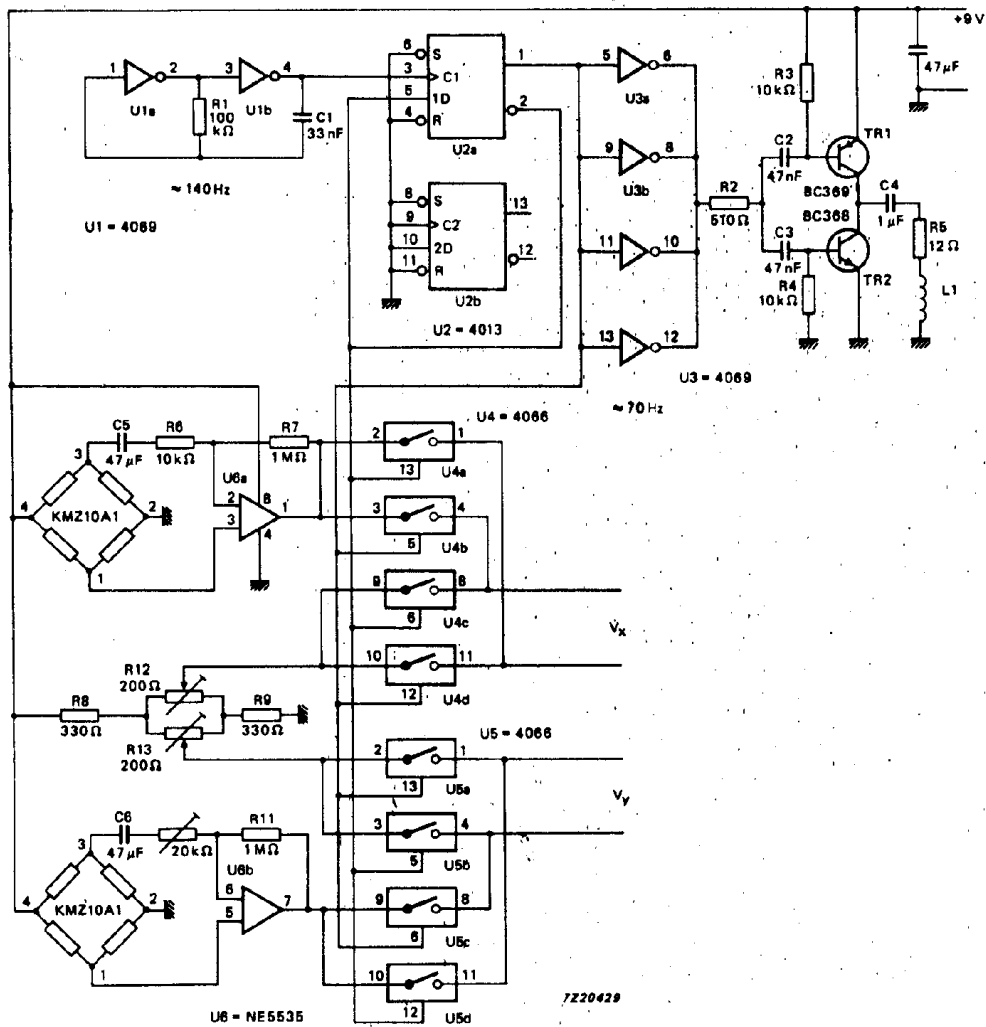
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Fig.29 Circuit for delivering the current pulses and for processing the outputs of the two sensors

KM210 cct   Dec 6/89

+12v

270

6.2v
Ref

100k

349

100 Λ

1m

230k

m85

8k2

8k2

270k

Iout

100k

2k2

20k
70k
PRE fiddle
GAIN

91 Ω

2.5v

100k

100k

100k